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~ AUGUST 2013 ~

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(FORMERLY *DELHI COLLEGE OF ENGINEERING*)
GOVT. OF N.C.T. OF DELHI
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PREFACE

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This issue contains the information published during August 2013. The arrangement of the contents is alphabetical wise starting from A-Z. The Full text of the article, which is either subscribed by the University or available in the web, is provided in this Bulletin.

CONTENTS

12. Performance Evaluation Of Sewage Treatment Plant Based On Advanced Aerobic Biological Filtration And Oxygenated Reactor (BIOFOR) Technology- A Case Study Of Capital City - Delhi, India *$Charu Sharma, *S.K Singh*, Department of Environmental Engineering

13. Studies of Poly(lactic acid) based Calcium Carbonate Nanocomposites *Vimal Kumar, *Anshu Dev* and *AP Gupta,* Department of Applied Chemistry and Polymer Technology

14. Study of Microstructure, Impact Strength on Manual Metal Arc Welding Of Gray Cast Iron Using Enife–Ci Filler Metal *$Ravi Butola* and *$Jitendra Kumar,* Mechanical Department

15. SYNTHESIS AND CHARACTERIZATION OF NANOHYDROXYAPATITE POWDER USING WET CHEMICAL PRECIPITATION REACTION Syed Sibte Asghar ABIDI, *Qasim MURTAZA* Mechanical and Production Engineering Department

16. Tertiary recycling of poly (ethylene terephthalate) wastes for production of polyurethane2 polyisocyanurate foams. P.K.Roy, *R.Mathur, *D.Kumar*, Department of Applied Chemistry and Polymer Technology

17. VANET (Vehicular Ad-Hoc Networks): Avoidance of Risk Factor in Secure Communication Manoj Diwakar, Nitin Thapliyal and *$Dhirender Kumar*, Computer Technology & Applications

18. Waste Energy Management and Recovery: A Novel Solution to Energy Conservation and Sustainable Development *Thomas Langford*

+ **Vice – Chancellor**
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A Comparative Survey Of Symmetric Encryption Techniques For Wireless Devices

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Abstract: Nowadays, internet and network applications are growing rapidly across the world. Many of the applications, for example e-commerce or e-government, have prime need for security. Information security plays an important role in data communication. Any loss to sensitive data can prove to be great loss to the organization. Encryption algorithm plays main role when confidential data is transmitted over the network. These algorithms consumes a significant amount of computing resources such as memory, battery power, CPU time. This paper provides comparison between different encryption algorithms.

Index Terms: Asymmetric encryption, Key, Security, Symmetric encryption

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1 INTRODUCTION

Today, the market for mobile communication and communication devices like cell phones and personal digital assistance(PDA) is growing rapidly. Applications e.g. mobile electronic payment , secure messaging have an inherent need for security. In information security, cryptography algorithms plays an important role. Cryptography converts the original message into the scrambled form. Cryptography ensures that the message should be sent without any modification over the network. The authorized person has the capability to open and read the message.

A. Basic Terms Used in Cryptography

- **Plain Text -**
  The original message is used to communicate with the other is defined as plain text. E.g. Alice send "Hello" message to Bob. Here, "Hello" is a plain text message.

- **Cipher Text -**
  The meaningless message is called as cipher text. In cryptography, the original message is converted into non readable message. E.g. "Pja734" is a cipher text produced.

- **Encryption -**
  Encryption is a process of converting plain text into cipher text. Encryption techniques are used to send secret message through an insecure channel. Encryption process require an encryption algorithm and a key. Encryption takes place at the sender side.

- **Decryption -**
  Decryption is the reverse process of encryption where it converts text into plain text. Decryption takes place at receiver side to obtain the original message from non readable message. Decryption process requires decryption algorithm and a key.

- **Key –**
  A key is a numeric or alpha numeric text. The key is used when encryption takes place on the plain text and at the time of decryption on the cipher text. In cryptography, selection of key is very important since the security of encryption algorithm depends on it.

B. Purpose of Cryptography

Cryptography provides a number of security goals to provide protection to data. Following are the goals of cryptography[1].

- **Confidentiality –**
  Ensures that transmitted information are accessible only for reading by the authorized parties.

- **Authentication –**
  Ensures that origin of message is correctly identified, with an assurance that the identity is not false.

- **Integrity –**
  Ensures that only authorized parties are able to modify the transmitted information. Modification includes writing, changing , deleting of transmitted information.

- **Non repudiation –**
  Requires that neither sender nor the receiver of message should be able to deny the transmission.

- **Access control –**
  Access to information may be controlled by or for the target system.

- **Availability –**
  Requires that information be available to authorized parties when needed.

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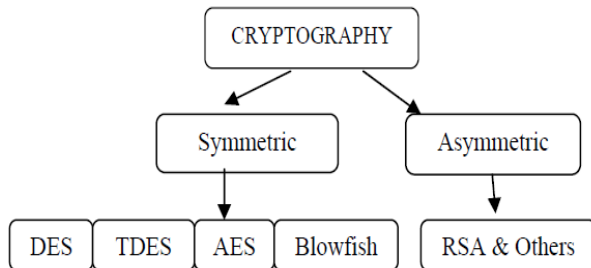
C. *Classification of Cryptography*

Fig.1. Classification of cryptography

- **Symmetric Encryption –**
  In Symmetric cryptography, same key is used for encryption and decryption. Key plays an important role in cryptography. The key should be distributed before transmission between two parties. The strength of symmetric key encryption depends on the size of the key. Data can be easily decrypted if a weak key is used in the algorithm. There are various symmetric key algorithms such as DES, 3DES , AES ,RSA ,Blowfish[2].

- **Asymmetric Encryption –**
  The problem of key distribution is solved by asymmetric key encryption. In asymmetric key encryption, two different keys are used for encryption and decryption - public and private key. The public key of the receiver is used to encrypt the plain text and only the authorized person can be able to decrypt the cipher text through his own private key. Private key is kept secret.

2 PROBLEM DEFINITION

Various encryption techniques are used in cryptography such as DES,,3DES,AES,RSA etc. The main problem is to select the algorithm with better key length. Other problem is to make choice on the implementation of cryptosystem. The choice of better algorithm depends on the advantages and disadvantages of each algorithm. Symmetric encryption technique have number of benefits. Symmetric encryption uses the same key to encrypt as well as to decrypt. Performance is relatively high. These algorithms can be directly implemented on hardware easily. The weakness of symmetric algorithm is sharing key between two parties. Asymmetric encryption uses two different keys for encryption and decryption. Private key is used to decrypt the encrypted message. Key distribution problem is solved by asymmetric encryption. The public key is known to everyone as it is used for encrypting the message. So, everyone can encrypt the message but, only authorized person can decrypt the message. Performance of asymmetric encryption is relatively low as compared to symmetric encryption. The main problem of asymmetric encryption is it works slower as compared to symmetric encryption.

3 METHODOLOGIES

A. *Asymmetric Key Cryptography*

RSA:
RSA is most widely used public-key cryptosystem. It provides data confidentiality, key exchange and digital signature. The strength of RSA is factoring large numbers[3]. It is a block cipher. In RSA, the plaintext and cipher text are integers between 0 and n-1 for some n. The description of the RSA algorithm is as follows[4]. Plaintext is encrypted in blocks , with each block having a binary value less than some number n.

Public key components:

n = product of two large primes, p and q

e = a random number relatively prime and less than (p-1)(q-1)

Primary key components:

$D = e^{-1}$ mod ((p-1)(q-1)) , the multiplicative inverse of mod((p-1)(q-1))

Encryption:

$C = M^e$ mod n

Decryption:

$M = C^d$ mod n

Digital Signature:

$S = M^d$ mod n

$M = S^e$ mod n $= M^{ed}$ mod n (to verify the signature)

The following requirements must be met for RSA to be satisfactory.
1. p and q , two large primes must remain secretive.
2. It is possible to find value of n, e, d such that , M^{ed} mod n for all M<n.
3. It is infeasible to determine d , given e and n.
4. It is easy to calculate M^e and C for all values of M<n.

Other Asymmetric Key Algorithm

Other asymmetric key algorithms are used in conjunction with RSA. These other algorithms have their limitations. These algorithms are Diffie–Hellman[5], Digital Signature Algorithm[6], ElGamal[7] and Elliptic Curve Cryptography[8]. The disadvantage of Diffie-Hellman(DH) algorithm is that it is not as versatile as RSA and key generation might be too computationally expensive for the mobile device. Digital Signature Algorithm (DSA) is not as versatile as RSA. Another problem is that the key varies from 512 to 1024 bits , so requiring a strong key size beyond 1024 bits is not possible. DSA is slower than RSA in terms of signature verification[9]. In ElGamal, the cipher text generated is twice the size as the plaintext, therefore it is not suitable in an environment with high latency and low bandwidth. ECC provides equal security for a smaller key size, thereby reducing processing

overhead[10]. So, ECC is more beneficial than RSA.

B. Symmetric Key Cryptography

DES (Data Encryption Standard)
It is a symmetric algorithm, means same key is used for encryption and decryption. DES is a block encryption algorithm. It uses one 64 bit key. Out of 64 bits, 56 bits used as independent key, which determine the exact cryptography transformation and 8 bits are used for error detection. The main operations are permutation and substitution. Bits permutation and substitution are performed in one round of DES. Six different permutation operations are performed both in key expansion and cipher part. Decryption process of DES algorithm is similar to encryption, only the round keys are applied in reverse order. The drawback of this algorithm is, it can be easily prone to Brute force Attack. It is easy for the hacker to break the key by applying all possible combinations. In DES, there are only 2^256 possible combinations which are easy to crack. So DES is not secure[11].

3DES(Triple Data Encryption Standard)
Triple DES is replacement for DES due to advances in key searching[12]. 3DES uses three rounds of DES encryption and has a key length of 168 bits. It uses either two or three 56 bit keys in the sequence Encrypt-Decrypt-Encrypt(EDE). Initially, three different keys are used for the encryption algorithm to generate cipher text on plain text message, t.

$$C(t) = E_{k1}(D_{k2}(E_{k3}(t))) \qquad (1)$$

Where, C(t) is cipher text produced from plain text t, E_{k1} is the encryption method using key k1, D_{k2} is the decryption method using key k2 and E_{k3} is the encryption method using key k3. Another option is to use two different keys for the encryption algorithm which reduces the memory requirement of keys in TDES.

$$C(t) = E_{k1}(D_{k2}(E_{k3}(t))) \qquad (2)$$

TDES algorithm with three keys requires 2^168 possible combinations and with two keys requires 2^112 combinations. It is practically not possible to try such a huge combinations, so TDES is a strongest encryption algorithm. The disadvantage of this algorithm it is too time consuming[1].

AES(Advanced Encryption Standard)
AES is replacement of DES. AES is a variable bit block cipher and uses variable key length of 128,192 and 256 bits. In AES, there are number of processing rounds. These rounds are based on the key size. If the key length is 128 bits, AES will perform nine processing rounds. If key is of 192 bits, AES perform 12 rounds and if the key size is 256 bits then AES perform 14 processing rounds[13]. Each processing round involves four steps:-

- **Substitute byte :**
  a non-linear substitution step where each byte is replaced with another according to a lookup table.

- **Shift rows :**
  a transposition step where each row of the state is shifted cyclically a certain number of steps.

- **Mixcoloumn :**
  a mixing operation which operates on the columns of the state, combining the four bytes in each column.

- **Add round key :**
  each byte of the state is combined with the round key using bitwise XOR.

AES encryption is fast and flexible. It can be implemented on various platforms especially in small devices.

Blowfish
Blowfish is a 64 bit block cipher and have variable length key from 32 bit to 448bits[14]. This algorithm has two parts – key expansion and data encryption. The key expansion part converts 448bit key into 468bytes A P array of size 18 and four S boxes whose size is 256, each of which are initialized to hexadecimal digits of π. XOR each entry in P array and S boxes with 32 bits of the key[15]. There are 16 rounds of data encryption[16]. In each round a 32 bit subkey is XORed with leftmost 32 bits of plaintext and the result is then passed to the F function of Blowfish. Now, this result becomes rightmost 32 bits for the next round and the output of F function is XORed with the original rightmost 32 bits of plaintext becomes leftmost 32 bits for next round and so on. The f function is distinguishing feature of Blowfish. In Blowfish, key length is 448 bits, s it requires 2^448 combinations to examine all keys[17]. The advantage of this algorithm is, it is simple to implement as all operations are XOR and addition.

Related Work
It is concluded that AES is faster and more efficient than other encryption algorithms [18]. There is insignificant difference in performance of different symmetric key schemes during the transmission of data. It would be better to use AES scheme in case of data transfer.

Comparison
The choice of algorithms depends on user needs and task. DES was designed to work better in hardware than software. DES involves lots of bit manipulation in substitution and permutation. Advanced Encryption Standard (AES) was designed to take into account software and hardware recital, safety measures [19].

63

TABLE 1
Comparison DES, 3DES, AES

Distinguishing Parameters	DES	3DES	AES
Block Size	64 bit	64 bit	128 bit
Key Size	56 bit	168 bit	128, 192,256 bit
Rounds	16	48	10,12,14
Speed	Low	Moderate	High
Security	Proven Inadequate	Still Insecure	Secure
Resource Consumption	High	Moderate	Low
Algorithm Structure	Fiestel Network	Fiestel Network	Substitution Permutation Network
Attacks	Brute Force Attack	Theoretically possible	Side Channel Attack

4 CONCLUSION

This paper gives a detailed study of the popular symmetric key encryption algorithms such as DES, Triple DES, AES, Blowfish and asymmetric key encryption algorithms such as RSA, D-H etc. The memory requirement of symmetric algorithms is lesser than asymmetric encryption algorithms and symmetric key algorithms runs faster than asymmetric key algorithms. Further, symmetric key encryption provides more security than asymmetric key encryption.

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A Measure of Inaccuracy in Order Statistics

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In this article, we consider a measure of inaccuracy between distributions of the ith order statistics and parent random variable. It is shown that the inaccuracy measure characterizes the distribution function of parent random variable uniquely. We also discuss some properties of the proposed measure.

Keywords: Kullback relative information, Kerridge inaccuracy, Order statistics, Survival function.

1. Introduction

In information theory, entropy is a measure of the uncertainty associated with a random variable. This concept was introduced by Shannon [2]. Shannon entropy represents an absolute limit on the best lossless compression of any communication. Shannon entropy of a discrete random variable X with possible values $\{x_1, x_2, \ldots, x_n\}$ and probability mass function p is defined as

$$H(X) = -\sum_{i=1}^{n} p(x_i) \log p(x_i). \tag{1.1}$$

In case of continuous sample, Shannon entropy is given by

$$H(f) = -\int_0^{\infty} f(x) \log f(x)\, dx. \tag{1.2}$$

Shannon entropy has been used as a major tool in information theory on in almost every branch of science and engineering. Let X and Y be two non-negative random variables with p.d.f. $f(x)$ and $g(x)$, respectively. Let $F(x) = P(X \leqslant x)$ and $G(y) = P(Y \leqslant y)$ be their distribution functions. The Kullback-Leibler [10] measure of discrimination of X about Y and Kerridge [3] measure of

inaccuracy are given by

$$H(f \mid g) = \int_0^\infty f(x) \log \frac{f(x)}{g(x)} dx \qquad (1.3)$$

$$H(f,g) = -\int_0^\infty f(x) \log g(x) dx \qquad (1.4)$$

respectively. Note that

$$H(f \mid g) + H(f) = H(f,g).$$

In this article, we assume X to be a positive continuous random variable.

Suppose that $X_1, X_2, \ldots, X_n$ are independent and identically distributed observations from cdf $F(x)$ and p.d.f. $f(x)$. The order statistics of the sample is defined by the arrangement of $X_1, X_2, \ldots, X_n$ from the smallest to the largest, denoted as $X_{1:n} \leqslant X_{2:n} \leqslant \cdots \leqslant X_{n:n}$. These statistics have been used in a wide range of problems like detection of outliers, characterizations of probability distributions, quality control and strength of materials; for more details [1,4,6]. In reliability theory, order statistics are used for statistical modeling. The kth order statistics in a sample of size n represents the life lengths of a $(n-k+1)$-out-of-n system.

Several authors have studied the information theoretic properties of an ordered data. Wong and Chen [5] showed that the difference between the average entropy of order statistics and the entropy of parent distribution is a constant. Park [11] obtained some recurrence relations for the entropy of order statistics. Ebrahimi *et al.* [8] explored some properties of the Shannon entropy of order statistics and showed that the Kullback-Leibler information functions involving order statistics are distribution free. We continue this line of research by deriving a measure of inaccuracy in order statistics and exploring some of it's properties.

Shannon's measure of uncertainty associated with i^{th} order statistics $X_{i:n}$ is given by

$$H(X_{i:n}) = -\int_0^\infty f_{i:n}(x) \log f_{i:n}(x) dx, \qquad (1.5)$$

where

$$f_{i:n}(x) = \frac{1}{B(i, n-i+1)} (F(x))^{i-1} (1 - F(x))^{n-i} f(x) \qquad (1.6)$$

is p.d.f. of ith order statistics, for $i = 1, 2, \ldots, n$. Here

$$B(a,b) = \int_0^1 x^{a-1} (1-x)^{b-1} dx, \quad a > 0, \ b > 0, \qquad (1.7)$$

is beta function with parameters a and b, [1].

Note that for $n = 1$, (1.5) reduces to (1.2). Using probability integral transformation $U = F(X)$, where U follows standard uniform distribution, the entropy of ith order statistics is given by

$$H(X_{i:n}) = H_n(W_i) - E_{g_i} \left[\log(f(F^{-1}(W_i))) \right], \qquad (1.8)$$

where

$$H_n(W_i) = \log B(i, n-i+1) - (i-1)[\psi(i) - \psi(n+1)] - (n-i)[\psi(n-i+1) - \psi(n+1)], \quad (1.9)$$

denotes entropy of ith order statistics from standard uniform distribution whose p.d.f. is given by

$$g_i(w) = \frac{1}{B(i, n-i+1)} w^{i-1} (1-w)^{n-i}, \quad 0 < w < 1, \tag{1.10}$$

and $\psi(z) = \frac{d \log \Gamma(z)}{dz}$ is the digamma function (for details [8]).

In this communication, we study a measure of inaccuracy in order statistics. In Section 2, we propose a measure of inaccuracy between distributions of ith order statistics and parent random variable X and study a characterization result based on this measure. In Section 3, we find bounds for inaccuracy measure and calculate the average of inaccuracy measure.

2. A Measure of Inaccuracy

Kullback-Leibler [10] measure of relative information between distribution of ith order statistics and data distribution is given by

$$K_n(f_{i:n}, f_X) = \int_0^\infty f_{i:n}(y) \log \left(\frac{f_{i:n}(y)}{f_X(y)} \right) dy \tag{2.1}$$

Using probability integral transformation $U = F(X)$, this becomes

$$K_n(f_{i:n}, f_X) = K_n(g_i, U) = \int_0^\infty g_i(w) \log g_i(w) dw = -H_n(W_i), \tag{2.2}$$

where $f_X(y)$ is the p.d.f. of parent random variable X, $f_{i:n}$ is p.d.f. of ith order statistics, g_i is the beta distribution (1.10) and U is the uniform distribution (for details [8]).

Adding (1.5) and (2.1), we get

$$H(X_{i:n}) + K_n(f_{i:n}, f_X) = -\int_0^\infty f_{i:n}(y) \log f_{i:n}(y) dy + \int_0^\infty f_{i:n}(y) \log \left(\frac{f_{i:n}(y)}{f_X(y)} \right) dy$$

$$= -\int_0^\infty f_{i:n}(y) \log f_X(y) dy. \tag{2.3}$$

Using probability integral transformation $U = F(X)$, (2.3) reduces to $-E_{g_i}\left[\log(f(F^{-1}(W_i)))\right]$. Further, adding (1.8) and (2.2), we obtain

$$H(X_{i:n}) + K_n(f_{i:n}, f_X) = -E_{g_i}\left[\log(f(F^{-1}(W_i)))\right],$$

which is in confirmation with the result already obtained.

We define the measure

$$I_n(f_{i:n}, f) = -\int_0^\infty f_{i:n}(x) \log f(x) dx = -E_{g_i}\left[\log(f(F^{-1}(W_i)))\right] \tag{2.4}$$

as a measure of inaccuracy associated with distribution of ith order statistics and parent distribution function $f(x)$, analogous to the Kerridge measure of inaccuracy between two density functions f and g given by (1.4).

Next, we show that the inaccuracy measure defined above characterizes the distribution function of parent random variable X uniquely. To prove this characterization result we use the following lemma [12].

Lemma 2.1. *For any increasing sequence of positive integers* $\{n_j, \ j \geqslant 1\}$, *the sequence of polynomials* $\{x^{n_j}\}$ *is complete in* $L(0,1)$, *if and only if* $\sum_{j=1}^{\infty} n_j^{-1}$ *is infinite.*

Here, $L(0,1)$ is the set of all Lebesgue integrable functions on the interval $(0,1)$.

Theorem 2.1. *Let X and Y be two positive random variables with p.d.f.* $f(x)$ *and* $g(x)$ *and absolutely continuous c.d.f.* $F(x)$ *and* $G(x)$, *respectively. Then, F and G belong to same family of distributions but for change in location if and only if*

$$I_n(f_{i:n}, f) = I_n(g_{i:n}, g), \quad 1 \leqslant i \leqslant n$$

for $n = n_j, j \geqslant 1$ *such that* $\sum_{j=1}^{\infty} n_j^{-1}$ *is infinite.*

Proof. The necessary part is obvious. We only need to prove the sufficiency part. If for all $n = n_j$, $j \geqslant 1$ such that $\sum_{j=1}^{\infty} n_j^{-1}$ is infinite and

$$I_n(f_{i:n}, f) = I_n(g_{i:n}, g) - \int_0^{\infty} f_{i:n}(x) \log f(x) dx$$

$$= -\int_0^{\infty} g_{i:n}(y) \log g(y) dy - \int_0^{\infty} \frac{F(x)^{i-1}(1 - F(x))^{n-i} f(x) \log f(x) \, dx}{B(i, n-i+1)}$$

$$= -\int_0^{\infty} \frac{G(y)^{i-1}(1 - G(y))^{n-i} g(y) \log g(y) dy}{B(i, n-i+1)}.$$

Put $u = 1 - F(x)$ and $u = 1 - G(y)$ and take $n - i = k$, then

$$\int_0^1 (1-u)^{i-1} \left[\log(f(F^{-1}(1-u))) - \log(g(G^{-1}(1-u))) \right] u^k du = 0, \quad \forall k \geqslant 0.$$

Using Lemma 2.1, we have

$$f(F^{-1}(1-u)) = g(G^{-1}(1-u))$$

Take $1 - u = v$, then

$$f(F^{-1}(v)) = g(G^{-1}(v)), \quad \forall v \in (0,1).$$

As,

$$\frac{d(F^{-1}(v))}{dv} = \frac{1}{f(F^{-1}(v))}.$$

Therefore, we have

$$F^{-1'}(v) = G^{-1'}(v), \quad \forall v \in (0,1)$$
$$F^{-1}(v) = G^{-1}(v) + c$$

where c is a constant and hence concludes the proof. $\quad\square$

3. Properties of Inaccuracy Measure

In this section, we find the bounds of inaccuracy measure (2.3) for order statistics in terms of entropy (1.2). Also, we find the average value of the derived measure.

Theorem 3.1. *For any random variable X with entropy $H(X) < \infty$.*

(i) *If B_i is the ith term of the binomial probability $B(n-1,p_i), p_i = \frac{i-1}{n-1}$, then*

$$nB_i(H(X)+I(A)) \leqslant I_n(f_{i:n},f) \leqslant nB_i[H(X)+I(\bar{A})] \tag{3.1}$$

where $I(A) = \int_A f(x)\log f(x)dx$ and $A = \{x; f(x) \leqslant 1\}$, $\bar{A} = \{x; f(x) > 1\}$.

(ii) *If $M = f(m) < \infty$, where m is the mode of the distribution, then*

$$-\log M \leqslant I_n(f_{i:n},f) \leqslant nB_i[H(X)+\log M] - \log M. \tag{3.2}$$

Proof. The entropy $H(X_{i:n})$ of ith order statistics is bounded as, [8].

$$H_n(W_i) + nB_i(H(X)+I(A)) \leqslant H(X_{i:n}) \leqslant H_n(W_i) + nB_i[H(X)+I(\bar{A})] \tag{3.3}$$

where $H_n(W_i)$ is given by (1.9).
Adding (2.2) and (3.3), we get (3.1).
To prove (ii), we will use result due to Ebrahimi *et al.* (2004) given by

$$H_n(W_i) - \log M \leqslant H(X_{i:n}) \leqslant H_n(W_i) - \log M + nB_i[H(X)+\log M]. \tag{3.4}$$

Adding (2.2) and (3.4), we get (3.2). □

Example 3.1. Let X be a random variable following exponential distribution with p.d.f. $f(x) = \theta e^{-\theta x}$, $x \geqslant 0$, $\theta > 0$. Then, $F(x) = 1 - e^{-\theta x}$.
For $i = 1$, that is the case of sample minima, we have

$$I_n(f_{1:n},f) = -E_{g_1}[\log(f(F^{-1}(W_1)))] = \frac{1}{n} - \log\theta. \tag{3.5}$$

Note that

(i) For a fixed value of n, inaccuracy of sample minimum for exponential distribution decreases with increasing value of θ. Figure 1 shows decrease in inaccuracy for different values of n.
(ii) Similarly, if we keep θ fixed then inaccuracy decreases with increase in sample size. Figure 2 shows decrease in inaccuracy for different values of θ.

For $i = n$, that is the case of sample maxima

$$I_n(f_{n:n},f) = -E_{g_n}[\log(f(F^{-1}(W_n)))] = \gamma + \psi(n) - \log\theta + \frac{1}{n}. \tag{3.6}$$

where $\psi(1) = -\gamma = 0.5772$ is Euler's constant and we use $\psi(n+1) = \psi(n) + \frac{1}{n}$.
Note that

(i) For a fixed value of n, inaccuracy of sample maximum decreases with increasing value of parameter θ.
(ii) $I_n(f_{n:n},f) - I_n(f_{1:n},f) = \gamma + \psi(n) \geqslant 0$, equality holds when $n = 1$. Hence, for exponential distribution we can conclude that inaccuracy about the maximum is always more than the minimum.

Inaccuracy

Fig. 1.

Inaccuracy
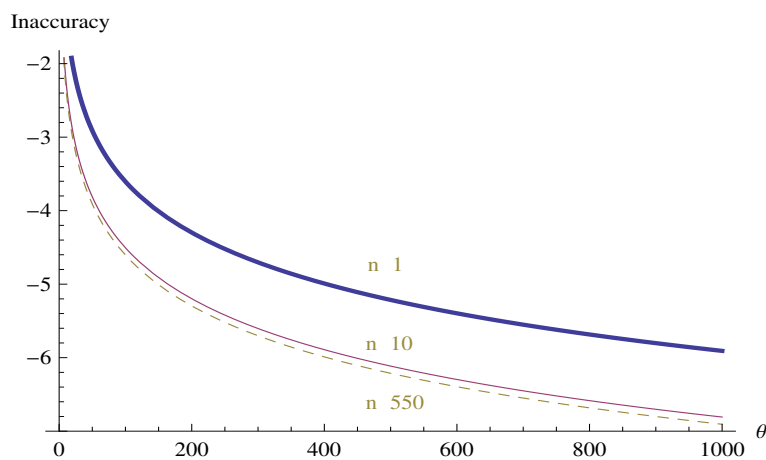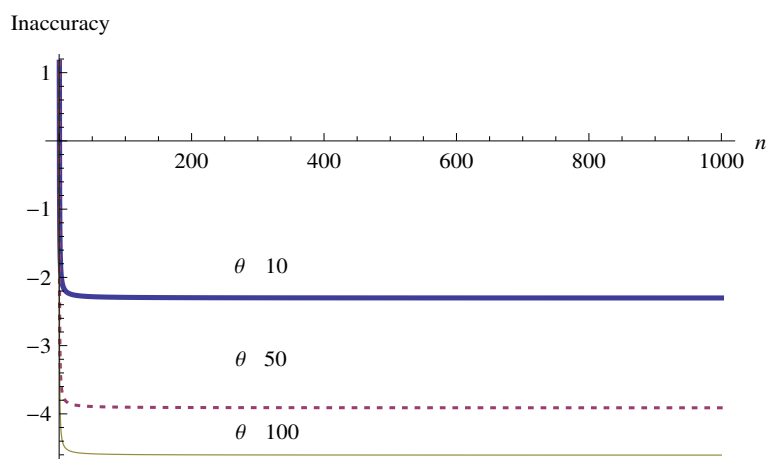
Fig. 2.

Remark 3.1. For exponential distribution with parameter θ we have $M = \theta$ and $H(X) = 1 - \log \theta$. Using (3.2), we have

$$-\log \theta \leqslant I_n(f_{i:n}, f) \leqslant nB_i - \log \theta. \tag{3.7}$$

For $i = 1$, (3.7) becomes

$$-\log \theta \leqslant I_n(f_{1:n}, f) \leqslant n - \log \theta. \tag{3.8}$$

where as

$$I_n(f_{1:n}, f) = \frac{1}{n} - \log \theta. \tag{3.9}$$

The difference between the actual value of $I_n(f_{1:n}, f)$ and the lower bound calculated in (3.8) is $\frac{1}{n}$ which tends to 0 as $n \to \infty$. Therefore, for exponential distribution, lower bound is useful when sample size is large.

Theorem 3.2. *The average value of inaccuracy measure is entropy of the parent random variable X, that is*

$$\frac{1}{n}\sum_{i=1}^{n} I_n(f_{i:n}, f) = H(X).\tag{3.10}$$

Proof. Consider

$$
\begin{aligned}
-\sum_{i=1}^{n}\int f_{i:n}(y)\log f(y)dy &= -\sum_{i=1}^{n}\int \frac{1}{B(i,n-i+1)}(F(y))^{i-1}(1-F(y))^{n-i}f(y)\log f(y)dy\\
&= -\sum_{i=1}^{n}\int g_i(F(y))f(y)\log f(y)dy\\
&= -\int \sum_{i=1}^{n} nq_{i-1}f(y)\log f(y)dy\\
&= nH(X),
\end{aligned}
$$

where

$$g_i(w) = \frac{1}{B(i,n-i+1)}w^{i-1}(1-w)^{n-i}, \quad 0 \leqslant w \leqslant 1,$$

is the p.d.f. of ith order statistics from standard uniform distribution, and q_{i-1} with $\sum_{i=1}^{n} q_{i-1} = 1$ denotes the $(i-1)^{\text{th}}$ term of $B(n-1, p)$, the Binomial variate with parameters $(n-1)$ and $p = F(x)$. Hence, the desired result (3.10) follows. $\qquad\square$

Example 3.2. Let X be a random variable having exponential distribution with p.d.f. $f(x) = \theta e^{-\theta x}$, $\theta > 0$, $x \geqslant 0$. Then,

$$f_{i:n}(y) = \frac{1}{B(i,n-i+1)}F(y)^{i-1}(1-F(y))^{n-i}f(y).\tag{3.11}$$

For $i = 1, 2$ and $n = 2$, using (2.4)

$$I_2(f_{1:2}, f) = -\log\theta - \frac{1}{2}$$

and

$$I_2(f_{2:2}, f) = -\log\theta + \frac{3}{2}.$$

Hence,

$$\frac{1}{2}\left(I_2(f_{1:2}, f) + I_2(f_{2:2}, f)\right) = 1 - \log\theta.\tag{3.12}$$

Also, using (1.2) we have

$$H(X) = 1 - \log\theta.\tag{3.13}$$

which is equal to average inaccuracy as calculated in (3.12).

4. Conclusion

The proposed measure of inaccuracy between the ith order statistics and parent random variable characterizes the distribution function of parent random variable uniquely and its average value is the entropy of the parent random variable.

Acknowledgement

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An Optimal Fuzzy Filter for Gaussian Noise in Color Images Using Bacterial Foraging Algorithm

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Abstract— this paper presents an optimal fuzzy filter for Gaussian noise in color images using Bacterial Foraging Algorithm (BFA) and cosine similarity. The filter makes use of the relationship between different color components of a pixel to remove the noise from the color images. The adaptive cosine similarity between the central pixel and the neighboring pixels is estimated using color pairs red-green, red-blue and green-blue for noise removal. The membership function Large is defined and used to fuzzify similarity of each color component. Mean Square Error is used as an objective function for the bacterial foraging algorithm to learn the parameters of membership function Large. The correction term for the Gaussian filter is calculated using weighted average of the weights of all the neighboring pixels. The proposed Gaussian filter is found to be effective in eliminating noise from color images with the significant improvement in image quality. The experimental result on several color images proves the efficacy of the proposed fuzzy filter.

Keywords— *Fuzzy, Gaussian noise, Cosine similarity, Color-pair and BFA.*

I. INTRODUCTION

The noise removal has been an important aspect of image processing. Noise free image is primary requirement for many applications such as object detection, segmentation, biometrics etc. Noise may get added in the image during acquisition by camera sensors and transmission in the channel etc. Two additive noises, Gaussian and Impulse has been major concern in image processing applications. The Gaussian noise among two, is more difficult to remove because of its nature. There are several works, in the field of noise reduction reported, in the literature. Tuan-Anh Nguyen *et al.* [1] proposed spatially adaptive de-noising algorithm, with noise detection and removal steps. The denoising is obtained by using three defined terms "Local weighted mean, local weighted activity and local maximum". Russo [2] introduced a multi-pass fuzzy filter fashion, each having its own fuzzy operator to cope with noise. D. Androutsos, *et al.* [3] described the fuzzy adaptive filters for multichannel signals, the filters utilizes fuzzy transformation of the angles between vectors to incorporate local feature information in the image. Fuzzy filters are easy to realize by means of simple fuzzy rules that characterize a particular noise. Major issue with the Gaussian noise removal

is to differentiate between noise and edges, because of similar features of both. In [4], the effective fuzzy derivatives are used for differentiating the noise and edge pixels in images corrupted with Gaussian noise. Schulte *et al.* [5] consider the fuzzy distance between color pairs as a weight to perform the weighted average filtering for the removal of the Gaussian noise in color images. Russo [6] proposes a method based on noise estimation, for Gaussian noise filtering. The technique combines a nonlinear noise removal algorithm, with edge preserving feature and estimation of noise, with automatic parameter tuning. An efficient fuzzy filter for edge preservation is proposed in [7] using fuzzy technique for color images. In [8] a new "fuzzy-logic-control based filter" is presented for impulse noise removal, with detail preserving ability.

Tzu-Chao Lin [10] uses "decision-based fuzzy averaging (DFA) filter" consisting of a "D–S (Dempster–Shafer) noise detector" and a two-step noise removal technique. "The counter-intuitive problem" of Dempster's combination rule problem is solved using simple support functions. The noise removal is performed using weighted averaging. The weights are calculated using fuzzy functions and fuzzy sets. A cascaded simple filter is used to improve the final filtering performance. The peer group i.e. Group of similar pixels in an image, is another concept used in image denoising techniques. In [11] the concept of peer group is used with fuzzy concept termed as "fuzzy peer group". To define fuzzy peer group, peer groups are considered as support set. The pixel, being processed, is compared for similarity using fuzzy membership function of peer group. This fuzzy peer group concept is utilized to develop a cascaded filter consist of switching filter between fuzzy impulse filter and fuzzy mean filter based on peer groups. Because both the steps are using fuzzy peer groups, it results in saving of computational power.

Hanagaki and Osana in [12] proposes a method based on similarity of pixels. It considers the detection of noisy pixel and artifacts by "self-organizing map with refractoriness". In [13], fuzzy logic is used to realize the noise detection and removal using a relative pixel similarity based algorithm. The evolutionary optimization technique, bacterial foraging algorithm proposed in Passino [15], Liu and Passino [16]. Foraging behavior of bacterium showed a potential to be

utilized as an optimization algorithm. The bacterium tries to optimize the food search maximum with time i.e. "maximize the energy obtained per unit time spent during foraging". Here the objective function is defined according to the optimization problem, which reflect index of food available in the region. Recently the bacterial foraging algorithm has find many applications in various field of image processing [17-19] i.e. enhancement and edge detection etc. In [17] Madasu Hanmandlu et al. presented a novel approach to enhance the color images using a fuzzifier and bacterial foraging algorithm for optimization of parameters used. A new approach for edge detection is proposed by Verma et al. [18], by combining two evolutionary algorithm bacteria foraging algorithm (BFA)and Ant colony optimization (ACO). They utilize the forging behavior of BFA and probabilistic derivative technique of Ant Colony Systems to develop a modified algorithm. Biswas et al. [20-21] proposed another combination of bacterial foraging optimization algorithm with Differential Evolution optimization technique. Dasgupta et al. [22] developed an algorithm which adopted the bacterial foraging optimization to obtain the optimize results. Here a new fuzzy objective is defined to represent the edge map for an image, which is minimized with BFA for automatic detection of circles in the image. The authors in [23] compared and analyzed the movement of bacterium (Chemotactic) of a one dimensional bacterial foraging with the classical Gradient Descent Algorithm (GDA). This study shows that when bacterium reaches to the region where optimum point is located, it will have sustained oscillation as food profile is flat in nature in this location. Datta et al. [24] proposed an approach based on bacterial foraging to optimize the weights of linear array of antenna. Here both amplitude and phase of weights are optimized with BFA. The objective function of BFA is realized such that to obtain the maximum array factor for any desired direction and leaving a zero value in specific direction. Kim et al. [25] proposed an approach, where genetic algorithm is utilized to modify bacterial foraging algorithm (BFA) for improved results of the optimization problems.

In this paper, we have extended our previous work [29] on noise reduction in color images, where Euclidian distance is used as a measure of similarity. The similarity is calculated by obtaining the Euclidian distance between color pairs (red-green, red-blue and blue-green) of central pixel and neighborhood pixel. In proposed approach, cosine similarity is calculated between the color pairs of the central pixel and the neighboring pixels to estimate the similarity between these pixels. Membership function large is defined, to fuzzify all the three color components. Mean Square Error between approximated image and original image, is selected as an objective function. The BFA is used to optimize this objective function, which in turn results in automatic learning of parameters of the membership function "Large".

Organization of the paper is as follows: Section II presents the fuzzy filter based on the cosine similarity for Gaussian noise reduction. Objective function and its optimization using the bacterial foraging are discussed in section III. Algorithm for the proposed filter is given in section 4. Results and their analysis are discussed in Section 5. Finally, conclusions are drawn in Section 6.

II. FUZZY FILTER FOR NOISE REMOVAL

A noisy image, affected with Gaussian noise, in RGB color space with Cartesian co-ordinates (x, y, z) is expressed [29] as:

$$f(x, y, z) = I(x, y, z) + \eta(x, y, z) \tag{1}$$

Where $f(x, y, z)$ is the resultant noisy color image with Gaussian noise, $I(x, y, z)$ is original uncorrupted color image and $\eta(x, y, z)$ represents the signal independent additive random Gaussian noise, in the RGB color space. The x and y represents the space location of the image pixel in 2-D space and z =1,2,3 represents the red, green and blue (RGB) color components respectively.

The most accepted methods of Gaussian noise reduction, in the literature utilizes the weighted average of neighborhood pixel values to replace the corrupted value of the central pixel value [2]. The point of research is, how to select/obtain these weights using the local property of image, so that it can give best approximated value of correct intensity. One of the approaches utilized in weight selection is similarity of central pixel with local pixels. We use the color pairs to assign weights to the neighborhood pixels; it leads to a reduction in the undesired artifacts. Adaptive fuzzy cosine similarity between the color pairs gives similarity between the central pixel and the neighborhood. This Adaptive fuzzy similarity helps in preserving edges by way of giving less weight to the noisy pixels and more weight to the similar pixels. Therefore, if the adaptive fuzzy similarity value is more than more weight is assigned and vice-versa.

A. Cosine Similarity

The Cosine similarity is a well-known concept, which gives a criterion to measure the similarity between two vectors. The cosine of the angle between the vectors is calculated to measure similarity. The extent of similarity is reflected by the cosine value. As the cosine value approaches to one, similarity also approaches to maximum because the value of cosine function is equal to 1as the angle between is 0, for other values it is less than 1. The value of cosine of the angle between two vectors gives the degree of similarity between to vectors, more precisely similarity in the direction of vectors.

The cosine value of angle between two vectors is calculated by using the Dot Product formula:

$$A.B = \|A\| \|B\| \cos\theta \tag{2}$$

Given two vectors A and B having n dimension in the vector space, the cosine similarity is given as

$$\cos\theta = \frac{A.B}{\|A\|\|B\|} = \frac{\sum_{i=1}^{n} A_i \times B_i}{\sqrt{\sum_{i=0}^{n}(A_i)^2} \times \sqrt{\sum_{i=0}^{n}(B_i)^2}} \tag{3}$$

The similarity measure can be determined by various combination of the Euclidean distance and cosine similarity. The cosine similarity can be illustrated as measure of relative extents of similarity of various dimensions. Maximum similarity between two vectors is obtained when all the

dimension of a vector are same. Cosine similarity and Euclidean distance represents almost similar information, where Euclidean distance measures an actual distance between the two points, and cosine can gives the measure of their apparent distance, viewed from the origin. Adaptive fuzzy similarity is found between each color pair of the central pixel and that of the neighborhood pixels. Color pairs are denoted in terms of the image function $'f'$ as follows [38]:

$$\text{Red-Green} \quad (f(x,y,1), f(x,y,2))$$

$$\text{Red-Blue} \quad (f(x,y,1), f(x,y,3))$$

$$\text{Green-Blue} \quad (f(x,y,2), f(x,y,3)) \qquad (4)$$

Adaptive similarity between a color pair of central pixel and that of neighborhood pixel, say between red-green pairs is found from:

$$S_{rg}(x+i, y+j) = \frac{f(i,j,1) \times f(x,y,1) + f(i,j,2) \times f(x,y,2)}{(f(i,j,1)^2 + f(i,j,2)^2)^{1/2} \times (f(x,y,1)^2 + f(x,y,2)^2)^{1/2}} \qquad (5)$$

Where $f(i,j)$ represents neighboring pixels and $f(x,y)$ is the central pixel for the window of size $k \times k$. Similarly, we can find $S_{rb}(x+i, y+j)$ and $S_{gb}(x+i, y+j)$ for adaptive similarity between the red blue and green blue components. The adaptive fuzzy similarity between the color pairs is obtained by fuzzifying the adaptive similarity using the membership function 'Large' to be introduced in the next section.

B. The Filter Structure

In the proposed method the weighted average of the neighboring pixels in the window of interest is calculated. The weights to the neighboring pixels are determined according to the following fuzzy rules.

For the Red component

IF $S_{rg}(x+i, y+j)$ is large AND $S_{rb}(x+i, y+j)$ is large THEN weight $W(x+i, y+j, 1)$ is a large. $\qquad (6)$

For the Green component

IF $S_{rg}(x+i, y+j)$ is large AND $S_{gb}(x+i, y+j)$ is large THEN weight $W(x+i, y+j, 2)$ is a large. $\qquad (7)$

For the Blue component

IF $S_{rb}(x+i, y+j)$ is large AND $S_{gb}(x+i, y+j)$ is large THEN weight $W(x+i, y+j, 3)$ is a large. $\qquad (8)$

To express the degree to which an adaptive similarity is Large, the adaptive similarities are fuzzified using the membership function Large, defined as:

$$\mu_l = \begin{cases} e^{\frac{(\lambda-b)^2}{2c^2}}, & \lambda \geq t \\ 0, & \lambda < t \end{cases} \qquad (9)$$

This membership function for the set "Large" is shown in Figure 1. The parameter 't' is the minimum similarity between a color pair of a central pixel and that of the neighborhood in a window. The values for b and c in the above function are discussed in section 3.
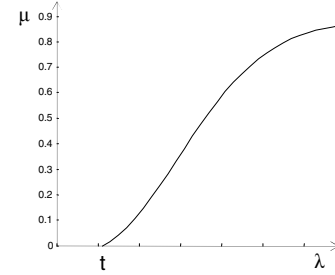
Fig. 1. The membership Function for "Large"

The above fuzzy rules are implemented by calculating the adaptive fuzzy similarity using the membership function "Large". For example, fuzzy adaptive similarity between the red-green color pairs of a pixel at (x,y) and a neighboring pixel at $(x+i, y+j)$ is represented as: $\mu_{rg}(S_{rg}(x+i, y+j))$ where, μ_{rg} is the membership function of the red-green color pair defined in equation (9). The weights for a neighboring pixel at the location $((x+i, y+j)$ corresponding to red, green and blue components are derived from fuzzy rules as:

$$W(x+i,y+j,1) = \max\{\mu_{rg}(S_{rg}(x+i,y+j)), \mu_{rb}(S_{rb}(x+i,y+j))\}$$

$$W(x+i,y+j,2) = \max\{\mu_{rg}(S_{rg}(x+i,y+j)), \mu_{gb}(S_{gb}(x+i,y+j))\} \qquad (10)$$

$$W(x+i,y+j,3) = \max\{\mu_{gb}(S_{gb}(x+i,y+j)), \mu_{rb}(S_{rb}(x+i,y+j))\}$$

The weights for red, green and blue components follow similarly and the final corrected value of a pixel at location (x,y) for the red component is given by:

$$I(x,y,1) = \frac{\sum_{i=-k}^{k} \sum_{j=-k}^{k} W(x+i,y+j,1) \times f(x+i,y+j,1)}{\sum_{i=-k}^{k} \sum_{j=-k}^{k} W(x+i,y+j,1)} \qquad (11)$$

Where k is the size of the window, similarly, we can find $I(x,y,2)$ and $I(x,y,3)$ for green and blue components respectively.

III. PARAMETER OPTIMIZATION

The filtering action of the Gaussian filter is dependent on two parameters b and c. In this approach, bacterial foraging is used for optimization/learning of these parameter values. The search space of bacteria foraging technique is two dimensional and the movement of bacteria finds the minimum value of Mean Square Error. Parameter training with the help of

bacterial foraging gives different values of parameters for different noise concentration level this is in contrast with the given constant values for these parameters. Mean Square Error is given as

$$MSE(I,f) = \frac{\sum_{z=1}^{3}\sum_{y=1}^{M}\sum_{x=1}^{N}(I(x,y,z)-f(x,y,z))^2}{3 \times M \times N} \qquad (12)$$

Where, I is the original test image and f is the filtered image of $M \times N$ size. MSE gives the measure of similarity between two images. By minimizing MSE with the help of BFA optimization technique, we are reducing the mean square error between the noisy image and the de-noised image and obtain the optimized values for the unknown parameters b and c to get the best possible results. Results are discussed in the next section.

Optimization problem is to find minima of mean square error therefore MSE is used as the food function for bacterial foraging. The objective function in our problem is given as

$$J = MSE(I,f) \qquad (13)$$

The cell-to-cell attractant function of BF optimization algorithm is used to obtain high density food area, which is less important in this scenario; hence it is not used here.

A. Initialization of Parameters

The main parameters involved in this approach, to be optimized are b and c present in fuzzy membership function. In calculation of MSE value these parameters are related to objective function J. The other set of parameter to be initialized are parameters related to the BF algorithm [15]. Parameters related to BFA optimization are initialize here and the initialization of parameters 'b' and 'c' is discussed in the next section.

The dimension of search space p =2, the bacteria population S is taken 10, number of chemotactic step before reproduction N_c =4, the bacteria split ratio $S_r = S/2$ swimming length= 4, number of reproduction steps N_{re} =2, number of elimination and dispersion events N_{ed} =2, and the probability of elimination/dispersion event P_{ed} =0.25.

The movement of bacteria is given by following equation:

$$\theta^i(j+1,k,l) = \theta^i(j+1,k,l) + C(i)\frac{\Delta(i)}{\sqrt{\Delta^T(i)\Delta(i)}} \qquad (14)$$

Where $\theta^i(j,k,l)$ is position of ith bacterium in j^{th} chemotaxis, k^{th} reproduction and l^{th} elimination-dispersion step. $C(i)$ is step size of bacteria movement and the direction movement is decided by vector $\Delta(i)$.

IV. RESULT AND DISSCUSSION

A color image consisting of an $M \times N \times 3$ array of pixel at locations (x,y) may be viewed as a "stack" of three scale images corresponding to RGB components. The color images "Lena", "Parrots", and "Flower" of size 256 $\times$ 256 with the Gaussian noise is considered as test images. The original images are shown in Figure 2.

Fig. 2. Orignal Image (a)Lena, (b)Parrots, and (c)Flower

The mean square error (MSE) is selected as the measure of performance as defined above (12). Another measure of performance is peak signal to noise ratio (PSNR) given as:

$$PSNR(I,f) = 10\log\left(\frac{1}{MSE(I,f)}\right) \qquad (15)$$

Higher the PSNR value, better the de-noised image. Experiments are performed using different sizes of windows and the results for these experiments are shows that the window size of 3×3 is the most suitable. The performance of Gaussian noise filter is evaluated over the four test colour images with $\sigma = 10$, 20 and 30. The parameters b=0.2, c=0.9 are taken as the initial values to the Bacterial foraging algorithm.

TABLE I. OPTIMIZE VALUES OF PARAMETERS

Variance	Initial Values			Optimize Values		
(σ)	b	C	MSE	b	c	MSE
10	0.2	0.9	14.23	0.2921	0.4382	08.823
20	0.2	0.9	36.52	0.3390	0.5049	18.564
30	0.2	0.9	54.31	0.0608	0.3097	27.968

It shows that there is a great difference between the values of the membership function parameters and MSE before and after the optimisation and hence the results. The results of the proposed approach are compared in terms of MSE with methods developed by Om Prakash Verma *et al.* (FFNRCI) [29], Tzu-Chao Lin, Decision-based fuzzy image restoration for noise reduction based on evidence theory (DBFIR) [12], Restoration of images corrupted by mixed Gaussian-impulse noise via l_1–l_0 minimization (RICMG) [13], Fuzzy Peer Groups for Reducing Mixed Gaussian-Impulse Noise From Color Images [14] (FPGA), Spatially Adaptive De-noising Algorithm for a Single Image Corrupted by Gaussian Noise(SADA)[15].

TABLE II.   COMPARISION OF PSNR VALUES LENA WITH 10% NOISE, PARROTS WITH 20% NOISE AND FLOWERS WITH 30%

Filter	Lena	Parrots	Flower
Noisy	31.94	29.05	28.59
FFNRIC	36.22	32.50	30.37
FPGA	35.78	32.11	29.47
DBFIR	35.20	31.02	29.45
RICMG	35.73	31.01	28.65
SADA	35.72	32.54	28.43
Proposed	**38.64**	**34.60**	**31.28**

Comparison of PSNR values resulting from the application of the proposed filter and the other methods in Table II show the superiority of the proposed filter over the other in the reduction of Gaussian noise. The results of de-noising of test images are shown in fig. 4.
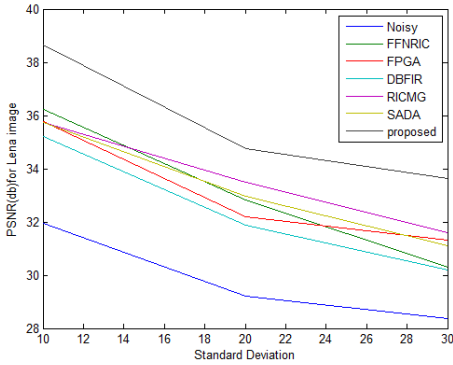

Fig. 3.   Comarision of PSNR(db) for Lena image at different noise

The undesirable effect of a Gaussian filter is that it blurs the edges. This process results in an image with reduced "sharp" transitions.

Fig. 4. Noisy images with 30% Gaussian noise and denoised images with proposed method.

The above result shows that prosed filter is better from many existing filters. Fig. 3 shows the comparison of PSNR values for different filter for Lena image with 30% Gaussian noise. The images in Fig. 4 also show visual difference between resulting images from different filters.

V.   CONCLUSION

The removal of Gaussian noise is accomplished via fuzzy adaptive similarity between the color components of a pixel of interest and the neighbourhood pixel. The Adaptive fuzzy similarity between colour pairs approach produces a de-noised image with all the significant details preserved. It was shown that this filter is capable of reducing Gaussian noise up to $\sigma = 30$. This is observed that the proposed filter produces the better texture than the previous works. The use of the adaptive fuzzy similarity between colour components in the RGB space is resulted in better results.

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Compressed Air Retrofit Kit for Existing Motor Vehicles

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Abstract—Keeping in view the climate change, the dependence on petroleum reserves as the primary energy source, and volatile fuel prices, it is imperative to explore possible opportunities in unconventional alternative-fuel technologies. One of the choices available is the Compressed Air Vehicle (CAV), or air car, powered by a pneumatic motor and on-board high-pressure gas tank. While proponents claim CAVs offer environmental and economic benefits like zero emissions (in fact, the exhaust air is cleaner than the ambient air because of the filters used) and the cold exhaust being used for the air conditioning system, the technology has not been subject to more rigorous analysis. Also, in a compressed air engine, air alone can be used as the fuel, or it can be used in amalgamation with traditional fuels or electricity. Just using air is the most suitable option because it drastically reduces weight of the vehicle and improves the efficiency.

Developing a whole vehicle to run on pneumatic systems will prove an outright tedious and without doubt a costly affair, modification of current internal combustion engines to run on compressed air is an avenue that this paper explores.

Index Terms—Alternative fuel, Compressed Air, Small engine, Zero Emission

I. INTRODUCTION

O F all the problems generated by fossil fuel use, the most challenging will be surviving the withdrawal from that use, after worldwide oil production peaks and begins to decline.

Peak oil is the point in time when the maximum rate of petroleum extraction is reached, after which the rate of production is expected to enter terminal decline. The oil crisis will begin when demand for oil consistently begins to exceed supply. After the peak, demand and supply can no longer match. Keeping in view the discerning climate crisis, the dependence on petroleum reserves as the primary energy source, and volatile fuel prices, we have to explore possible opportunities in unconventional alternative-fuel technologies. Compressed air as an alternative fuel can offer a solution to most of the aforementioned problems.

At first glance, the idea of running a car on air seems almost too good to be true. If we can use air as fuel, why think about using anything else? Air is all around us. Air never runs out. Air is non-polluting. Best of all, air is free. Using the potential energy stored in compressed air for running engines and propelling vehicles can prove to be a clean and sustainable alternative.

Instead of going into development of a whole new pneumatic system to run on compressed air, which demands appreciable investment of capital and research, the solution proposed here is to run existing two stroke engines on air with no or minimum modification to their construction.

II. WORKING PRINCIPLE

The basic principle of the CAE is quite modest. Instead of the gases produced when a traditional fuel is burnt in the cylinder, the expanding air is used to push the piston down and the remaining functioning of the engine remains unaffected.

The source of energy in a CAE is the high-pressure compressed air tank. Unlike other fuel types, which store energy within the chemical bonds of the fuel, compressed air derives its energy from the thermodynamic work done by an expanding gas. A compressed air tank is energy storage medium similar to an electric battery, in that both are charged from an external source, and release a portion of that power to the vehicle, with the remainder lost to inefficiencies or other limitations. Since the power and range of a CAV depends on the amount of on-board energy, and since its small form factor places restrictions on the size of storage tanks, the vehicle's design requires a high energy-density fuel for acceptable performance. However, compressed air is a poor energy carrier compared to conventional fuels and rechargeable batteries. Greater energy density is possible with greater storage tank pressures but creates trade-offs in terms of losses in gas expansion.

III. DESIGN PLAN

Several key constraints are considered regarding the existing two stroke engine for characterizing the conversion of a two stroke engine into a compressed air engine. The first one is that the base technology is needed to be economically available. Secondly, the final system should not deteriorate the ability of the two stroke engine to operate in hostile conditions. The third constraint is that the simplicity of the existing two stroke engine should not be sacrificed for the attainment of the goal. Fourthly, the part of the energy consumed by the injection system of the compressed air engine should be comparable to the existing two stroke engine. Last but the most important compulsion is that the kit must be inexpensive to install, with commonly available tools and adequate expertise.

IV. CHOICE OF SYSTEM

The two stroke engines studied for the conversion into compressed air engine are: spark ignition engine and compression ignition engine.

The compression ignition (CI) engine is based on diesel cycle which uses diesel oil as fuel due to lower self-ignition temperature. A high pressure fuel pump and injector is required to inject the fuel into the chamber. For direct injection diesel engines with a displacement of 0.5 Lt. per cylinder, the compression ratio is approximately 18: 1 [3]. It has low speed (RPM) due to its heavy weight.

The spark ignition (SI) engine is based on otto cycle which uses gasoline as fuel due to high self-ignition temperature. The fuel and air mixture as a gaseous mixture is introduced in the combustion chamber during the suction stroke. A carburetor is used to mix the fuel and air mixture in desired ratio. It has the compression ratio of 10 [3]. It has high speed (RPM) due to its light weight.

The spark ignition engine is found to be more suitable because it inherits several structural features which offer high degree of customizability and tuning. It is much easier to mount and dismount the components like spark plug, carburetor and flywheel form the engine. The low weight of the moving parts offer less resistance, thus an instant torque is obtained even at low pressure of injected air.

V. ENGINE MODIFICATIONS

A. Cylinder Head

Instead of designing and casting a new cylinder head for the purpose of the injecting compressed air into the combustion chamber, the existing cylinder head could be applied to this purpose with minimum modifications. The spark plug is seated at the top of cylinder head of the engine. In general, a spark plug of two stroke SI engine has an isometric screw thread profile: M14x1.25 or M18x1.5 [4]. The spark plug is dismounted and the internal threads present on the cylinder head are machined until it is completely removed.

Thereafter, the plain cylindrical bore obtained is threaded according to profile of given adapter or reducer nipple. The adapter nipple connects the engine cylinder to the solenoid valve as shown in the figure 1.
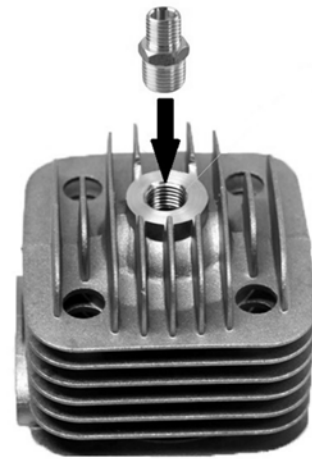
Fig. 1. Modified cylinder head ready for fitting adapter nipple.

B. Intake Port

The carburetor does not find any application in the engine running on compressed air only which is injected at the top of the combustion chamber. Therefore, it is advantageous to remove the carburetor since it will help to reduce the weight of the engine. Next to carburetor, a reed valve could be located. Its removal will eliminate the pressure force applied to piston in opposite direction during the expansion stroke. Moreover, these modifications will also facilitate the quick removal of the residual air from the combustion chamber at the end of the expansion stroke.

C. Flywheel

The existing flywheel of the two stroke SI engine is magnetized and a stator coil lies underneath the magnetized flywheel. The internal coil and magnet could interfere with the field of the external magnet which leads to malfunctioning of the magnetic sensor. Therefore, the flywheel along with the coil is removed with the help of tools. A steel disc of equivalent weight is attached to a separate fanwheel using nuts and bolts in the manner as shown in the figure 2. The steel disc and fanwheel assembly is then mounted on the crankshaft of the engine. This type of arrangement has an advantage of adding or removing additional weight later without any modification.
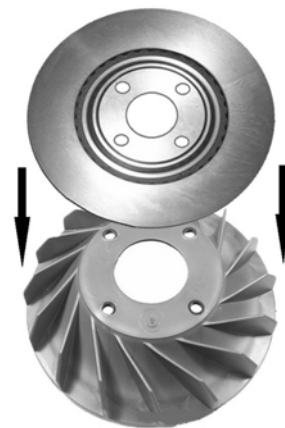
Fig. 2. Steel disc and fanwheel assembly.

VI.   ADDITIONAL COMPONENTS

A. Storage Cylinder

In order to use compressed air engine in vehicles for transportation purpose, high pressure storage cylinder is used to store the compressed air. Therefore, the storage system must be compact and lightweight. Advanced fiber-reinforced bottles are comparable to the rechargeable lead-acid battery in terms of energy density and has longer lifetime. Generally, the cylinder is fitted with stop valve. The valve also includes a pressure relief device.

B. Pressure Regulator

A pressure regulator is used to reduce the high pressure of compressed air in the storage cylinder to working pressure of the engine and solenoid valve. Proper selection is critical for a safe and effective transfer of the compressed air from the supply to the solenoid valve.

A two-stage regulator is used since reduction produces a final delivery pressure showing little effect from changes in cylinder pressure. Generally, the regulator has built-in pressure gauges; one to show inlet pressure and the other to show delivery pressure.

C. Air Filter and Lubricator

This unit usually is a combination of components that filters the air and adds lubricants for moving parts in the circuit. Compressed air contains dust, condensed water, and rust and oil sludge which must be removed to keep moving parts of the machine working properly.

Some of the components of the engine require a small amount of lubrication to extend their life and maintain torque. The air filter and then air lubricator are present in supply line of compressed air as shown in the figure 4.

D. Hoses and Fittings

Hoses are used for carrying compressed air from storage cylinder to the engine. Hoses are made from one or a combination of many different materials. Polytetrafluoroethylene (PTFE) hoses are preferred because it is chemically inert and usable at temperature ranging from -70°C up to +260°C. Hose-barb to male-pipe fitting is used to connect hose to the components like pressure regulator, air filter and lubricator and solenoid valve.

VII.   ELECTRICAL COMPONENTS

A. Reed Switch

The reed switch is an electrical switch operated by an applied magnetic field. As shown in the figure 3, reed switches comprise of two ferromagnetic reeds placed with a gap in between and hermetically sealed in a glass tube. The glass tube is filled with inert gas to prevent the activation of the contacts. The surfaces of the reed contacts are plated with rhodium.

As shown in the figure 3, reed switches are operated by the magnetic field of an energized coil or a permanent magnet which induces north (N) and south (S) poles on the reeds. The reed contacts are closed by this magnetic attractive force. When the magnetic field is removed, the reed elasticity causes the contacts to open the circuit. The reed contacts are closed by this magnetic attractive force.
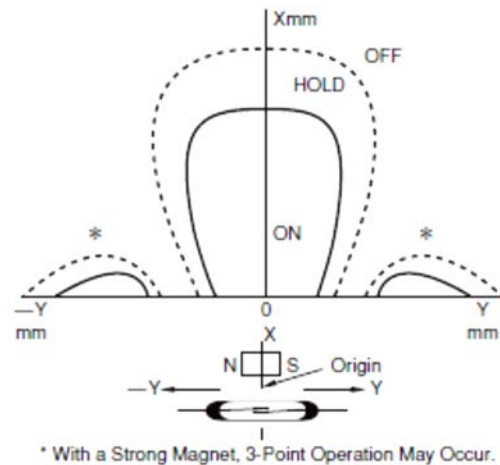
Fig. 3. Reed Switch in presence of magnetic flux.

When the magnetic field is removed, the reed elasticity causes the contacts to open the circuit. When a reed switch is operated by a permanent magnet, its ON-OFF domains will differ according to the type of the reed switch, its pull-in and drop out values, read forming conditions as well as the permanent magnet material, its shape, and magnetizing conditions.

B. Solenoid Valve

A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid. They are found in many application areas. Solenoids offer fast and safe switching, high reliability, long service life, good medium compatibility of the materials used, low control power and compact design.

Most solenoid valves operate on a digital principle. They therefore possess two distinct states, which are (1) - when the coil is activated by an electrical current, and (2) - when the valve is resting (without electricity). Valve functions are defined from the resting position. A solenoid valve is normally closed (abbreviated - NC) if there is no flow across the valve in its resting position (with no current on the solenoid contacts). The key to the operation of a proportional valve is a balance established between the forces in action on the plunger.

These balanced forces include a mechanical force provided by a spring specially developed for proportional valves and a magnetic force created by the current level passing through the coil. The spring force is proportionally opposed by the magnetic force.

Taking into account the working parameters and with an estimated range of working pressure between 0-10 bar a NC 24v DC Solenoid Valve constructed of brass was selected .The technical Specifications are given in table I.

TABLE I
TECHNICAL SPECIFICATIONS

Parameter	Specification
Supply Voltage Max	24VDC
Operating Pressure Max	10bar
Fluid Temperature Max	50°C
Material	Brass with stainless steel inner parts.
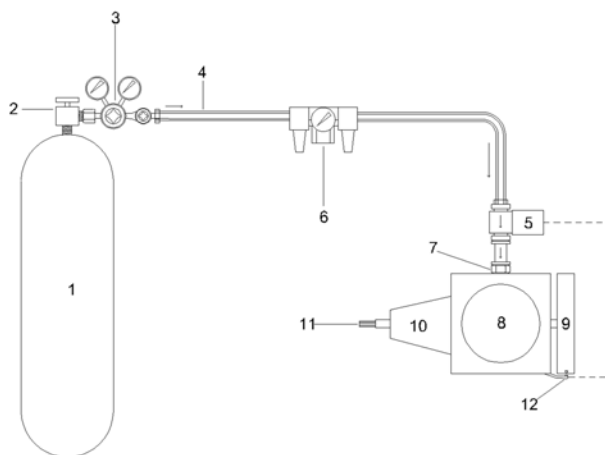
Fig. 4. Schematic diagram of compressed air engine.
1. Storage Cylinder
2. Stop Valve
3. Pressure Regulator
4. Hose
5. Solenoid Valve
6. Air Filter and Lubricator
7. Adapter Nipple
8. Two Stroke SI Engine
9. Flywheel
10. Gearbox
11. Transmission Shaft
12. Magnetic Sensor

VIII. CAE KIT OPERATION

Unlike gasoline or diesel engines, the CAE technology does not use any form of internal combustion. Compressed air (or other gases or combination of gases) is used as energy carrier and storage medium. The air is stored at pressure of around 200bar in compressed air storage cylinders. For energy carrying purpose, the pressure of the compressed air is reduced to around 10 bar or less using pressure regulator connected in front of cylinder valve. The air with reduced pressure is carried by poly-Teflon hose. The hose is then connected to the solenoid valve using barbed fitting. The air inlet timing and duration is controlled by the Solenoid valve. A small magnet is attached on the flywheel and a sensor is fitted very close the flywheel. After each revolution of the flywheel, the sensor gets activated by the magnetic field of the magnet passing nearby and sends signal to solenoid valve. The air is fed through an air injector to the engine and flows into which air expands. The air pushing down on the piston moves the crankshaft, which gives the vehicle power. The flywheel stores some energy to provide it back during the upstroke.

The process taking place inside the cylinder could be divided into four stages (in reference to the figure 5):

A. Stage 1

The Reed switch sensor detects the magnets attached to the flywheel and the signal is transmitted to the solenoid valve. As a result compressed air at 10bar or less is injected at TDC by injector at the cylinder head. The compressed air is injected till 10-15 degree after TDC. The injected air immediately acquires the passage above the piston.

B. Stage 2

As the magnet moves away from the Reed switch, the signal transmission is discontinued and hence, the solenoid valve closes, disrupting the flow of air in to the engine. The compressed air in passage in the cylinder then starts to expand and forces the piston down. The piston moves the crankshaft which powers the vehicle, reducing the air pressure inside the cylinder.

C. Stage 3

At about 35 degree before BDC, both the exhaust and transfer ports are exposed to the chamber having reduced air pressure (still greater than the atmospheric pressure). The pressure is relieved and chamber's pressure becomes equals to the atmospheric pressure.

D. Stage 4

From 35 degree after BDC, the air remaining in chamber at atmospheric pressure is compressed by the upward movement of the piston and the cycle is repeated.
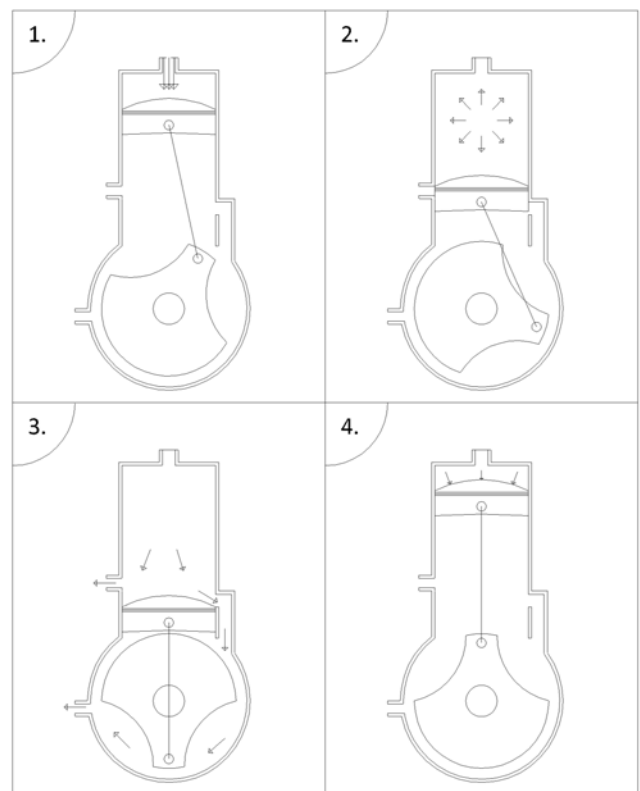
Fig 5. Different stages in CAE working cycle.

IX. RESULTS AND FINDINGS

The significant part of experimentation was concentrated on two aspects:
1) Running the engine at different pressures and observing the differences in speed (RPM) and,
2) Varying the injection timing by some degrees before or after TDC by moving the timing magnets along the rim of the flywheel.

A. Analysis of results

The engine was successfully tested at majorly two pressures. At a lower ~10 bar with a lower capacity (max. 10 bar) two-way NC solenoid valve and a higher ~25 bar with a higher capacity (max. 30 bar) three-way NC solenoid valve. Both valves had a similar delay period of about 20ms. At each of these pressures, the position of the timing magnets was varied, hence varying the injection time which had significant effect on the engine speed. Few of the observations are tabulated in table II.

TABLE II
VARIATION OF RPM WITH THE CHANGE IN PRESSURE AND
INJECTION ANGLE

Work Pressure	Injection Angle	RPM (Maximum)
10 bar	10° before TDC	715
	At TDC	845
	5° after TDC	910
	10° after TDC	993
	15° after TDC	964
25 bar	10° before TDC	1191
	At TDC	1332
	5° after TDC	1450
	10° after TDC	1483
	15° after TDC	1472

B. Utility of results

The study of the flywheel rotation pattern helps in coming to the following conclusions:
1) The optimum point of injection is about 10-15degree after TDC.
2) The non-availability of standard parts severely restricted the maximum achieved speed (RPM) of the engine. The solenoid valves used had a delay time of ~20ms. If a valve with delay time of the order of ~2ms was to be used, theoretically, the maximum speed can be increased to about 5 times that of what was observed here.
3) The low speed calls for incorporation of a CVT (Continuous Variable Transmission) in place of a normal gear box for real world utilization.

Taking into totality the amount of time, effort and capital input in the project, it can be safely inferred that yes, this is a technology that does hold up to its promise of replacing fossil fuels as the energy source to power our automobiles but not at this point of time. The technology is in its infancy and demands full scale research and investment for its full scale.

X. MERITS & DEMERITS

Some advantages and drawbacks of the system are quite apparent even from a layman point of view like the kit enables to look beyond fossil fuels for the daily transportation fuel needs and the vehicles employing the kit losing some power and range. But some points are not so obvious and this calls for a clear listing that follows.

A. Merits of the system

1) Much like electrical vehicles, the system would ultimately be powered through the electrical grid, which makes it easier to focus on reducing pollution from one source.
2) Transportation of the fuel would not be required due to drawing power off the electrical grid. This presents significant cost benefits. Also, pollution created during fuel transportation would be eliminated.
3) Air, on its own, is non-flammable. Hence high degree of safety is maintained.
4) The mechanical design of the engine is simple, robust and already proven for fossil fuels that produce significantly tougher operating conditions.
5) Low manufacture cost of the kit as well as easy maintenance.
6) Compressed-air tanks can be disposed of or recycled with less pollution than batteries.
7) Compressed-air system components are unconstrained by the degradation problems associated with current battery systems.
8) The tank may be refilled more often and in less time than batteries can be recharged, with re-fuelling rates comparable to liquid fuels if a full-fledged system exists.

B. Demerits of the system

1) When air expands, as it would in the engine, it cools dramatically (Charles law) and must be heated to ambient temperature using a heat exchanger similar to the intercooler used for internal combustion engines. This might be problematic if the kit is employed on a full scale automobile.
2) Refueling the compressed air container using a home or low-end conventional air compressor may take as long as 4 hours (although the specialized equipment at service stations may fill the tanks in only minutes).
3) Tanks get very hot when filled rapidly. SCUBA tanks are sometimes immersed in water to cool them down when they are being filled. That would not be possible with tanks in a vehicle and thus it would either take a long time to fill the tanks, or they would have to take less than a full charge, since heat drives up the pressure.
4) The limited storage capacity of the tanks will severely hinder the distance possible to cover with even a fully charged cylinder.

XI. CONCLUSION

This kit basically represents the idea about providing an alternative to the current energy scenario by modifying existing vehicles rather than altogether manufacturing new, more efficient ones, and doing so in an affordable and economical way.

The CAV is aimed to open new avenues to explore in the area of fuels as needless to say, conventional sources of energy are limited and due to that, the price of petroleum products also continues rise by the day. Also, while considering alternate fuels, some factors are to be considered like availability, economy, and environment friendliness etc., based on that compressed air technology is the best technology and demands more attention as it tends to take the engine to zero pollution running on a fuel that is

freely available. Even though the vehicles running on the CAV kit seem to compare poorly to gasoline and electric vehicles in range and power & their applications severely constrained due to their limited driving range, it may be an ideal mode of transportation once enough research and analysis are put in the field.

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Control of Aircraft Landing Using Fuzzy Logic

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Abstract: Simulation of the final descent and landing approach of an aircraft has been carried out. Two state variables for this simulation are considered as height above ground and vertical velocity of the aircraft. The control output has been taken as force which alter its height and velocity. The descent profile of aircraft has been plotted and analysed.

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I. INTRODUCTION

Fuzzy logic is a superset of conventional (Boolean) logic that has been extended to handle the concept of partial truth-truth values between "completely true" and "completely false". It was introduced by Dr. Lotfi Zadeh of UC/Berkeley in the 1960's as a mean to model the uncertainty of natural language [1].With fuzzy logic, the first step is to understand and characterize the system behaviour by using our knowledge and experience. The second step is to directly design the control algorithm using fuzzy rules, which describes the principles of the controller's regulation in terms of the relationship between its inputs and outputs The last step is to simulate and debug the design.

The fuzzy control is a model free approach. It does not require a mathematical model of the system under control. Fuzzy controllers are supposed to work in situations where there is a large uncertainty or unknown variation in system parameters. Fuzzy control is a potentially powerful approach that can capture human experience and expertise in ntrolling complex processes here by circumventing many of the shortcomings of hard-algorithmic control [2,3,4]. Thus, the fuzzy logic has emerged as one of the active area of research activity, particularly in control applications , where the mathematical model is not available and data available are imprecise.Today's aircraft designs rely heavily on automatic control system to monitor and control many of aircraft's subsystems. The development of automatic control system has played an important role in the growth of civil and military aviation. The architecture of the flight control system, essential for all flight operations, has significantly changed throughout the years[9].

This paper presents the automation in control of aircraft landing with fuzzy logic. Simulation of the final descent and landing approach of an aircraft has been carried out. Two state variables [5] for this simulation are considered as height above ground and vertical velocity of the aircraft. The control ouput has been taken as force here that when applied to the aircraft, will alter its height and velocity. Control equations are derived, then the membership functions for the height, velocity and control force have been constructed. Finally IF-THEN rules have been simulated. Complete software is developed to control descent and landing of aircraft [10].

II.   AIRCRAFT LANDING MECHANISM

The desired descent profile of aircraft is shown in Fig.1. The downward   velocity is proportional to the square of height. Thus, at higher altitudes, a large downward velocity is desired. As the height (altitude), diminishes the downward velocity get smaller and smaller. In the limit, as the height becomes vanishingly small, downward velocity also goes to zero. In this way, the aircraft will descend from altitude promptly but will touch down very gently to avoid damage.
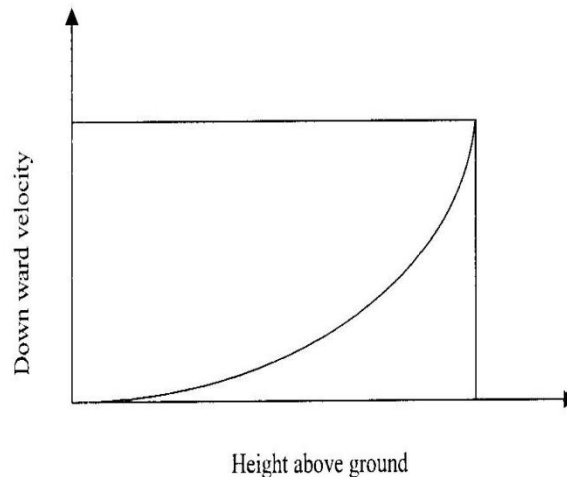
Fig 1 The desired profile of down ward velocity vs. Altitutde

III. PROBLEM FORMULATION

Two state variables [5] for this simulation are considered as height above ground and vertical velocity of the aircraft. The control ouput has been taken as force here that when applied to the aircraft, will alter its height and velocity. Two control equations indicating new downward velocity and new height are derived, then the membership functions for the height, velocity and control force have been constructed.

IV. CONTROL EQUATIONS DEVELOPMENT
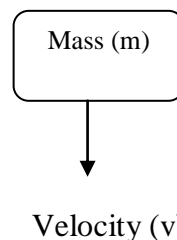
Velocity (v)
Fig. 2 Aircraft Landing Control Problem

The controlling differential equations are derived as follows:
If, mass= m,
Velocity= v
Then, momentum P = mv
If no external forces are applied, the mass will continue to travel in the same direction at the same velocity v. If a force is applied over a time Δt, a change n velocity of

$$\Delta v = \frac{f \Delta t}{m}$$

Will result,

Now, if $\Delta t = 1$ sec.

And m = 1 kg

We obtain $\Delta v = f$

Or a change in velocity is proportional to the applied force,

Let, v_i = old velocity

v_{i+1} = new velocity

h_i = old height

h_{i+1} = new height

In difference equation notation, we get,

$v_{i+1} = v_i + f_1$ (1)

$h_{i+1} = h_i + v_i(1)$ (2)

Equations (1) and (2) are two "Control Equations" which define the new values of the state variables v and h in response to control input and previous state variable values.

V.   COMPONENTS OF FUZZY LOGIC CONTROLLER (FLC)

A fuzzy controller can be designed to roughly emulate the human deductive process i.e. the process whereby we successively infer conclusion from our knowledge. Fuzzy logic controller consists of four main components as shown in Fig.3.
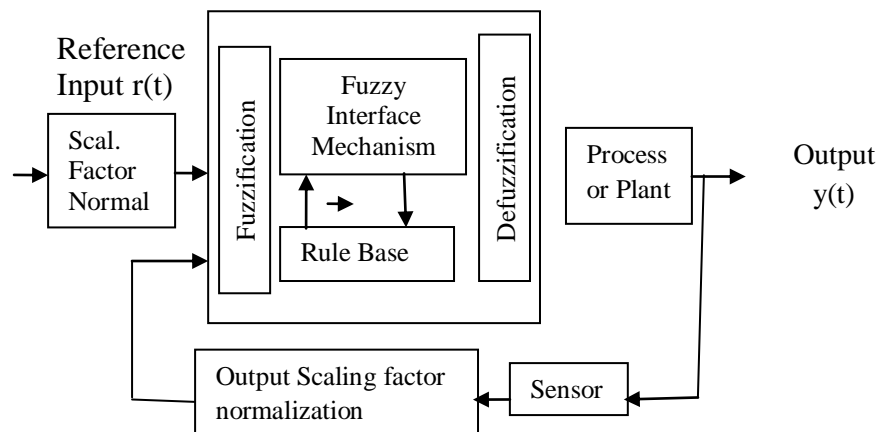
Fig. 3 Components of Fuzzy Logic Controller

VI. AIRCRAFT LANDING SYSTEM CONTROLLER

The block diagram of aircraft landing system controller is shown in Fig. 4. It consists of following main parts:

Personnel Computer

It is used to take crisp value from input analog to digital converter (ADC) and after fuzzy processing (see fig. 3), it gives crisp control output, this in turn passes through D/A converter, amplifier and transmitter to micro wave antenna.

Antenna

Antenna transmits the control signal to the aircraft, which controls the fuel injecting system, hence the accelerating and decelerating torque to maintain the velocity and height at proper values.

This antenna also receives a reflected signal which is fed to relevant transducers for height and velocity measurement which are input for the personnel computer.

Signal Conditioning Circuit
Signal received from antenna is very weak and noisy which is amplified and filtered through this circuit.
Transducers
The delayed reflected signal is used to measure the height and velocity of the aircraft by employing relevant transducers.
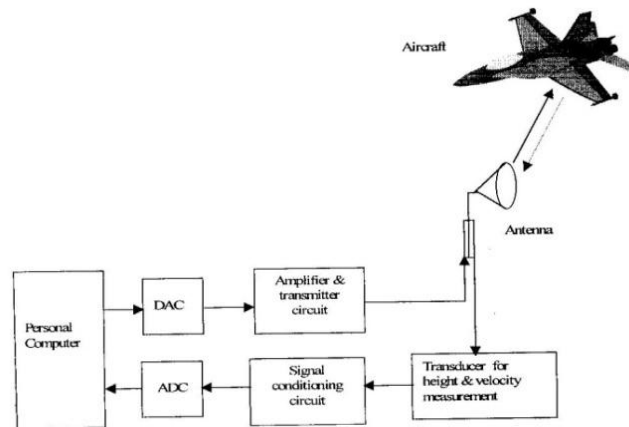
Fig. 4. Block diagram of aircraft landing system using fuzzy logic

VII.   FUZZY LOGIC CONTROL MPLEMENTATION

The control of aircraft landing system using fuzzy logic has been implemented as follows:
Steps involved in Fuzzy Logic Control
The following steps are taken for fuzzy logic control:
Step 1: Membership function for state variable height h_i
[$0 < h_i$ (m)<1000] is defined.
Step 2: Membership function for second state variable velocity v_i [$0 < v_i$ (m/s)<30] is defined.
Step 3: Membership function for the control output i.e. controlling force f [$0 < f(kg) < 30$] is defined.
Step 4**:** The rule base has been defined and summarized in to a fuzzy associative memory (FAM) table [6,7].
Inferencing
The entries of FAM table is translated into IF THEN rules as follows:
1. If height is Zero (ZO) and velocity is also Zero (ZO), then control force is also Zero (ZO).
2. If height is Zero (ZO) and velocity is in the range of Positive Small (PS), then control force is Positive Small (PS).
3. If height is Zero (ZO) and velocity is Positive Small (PS), then control force is again Positive Small (PS).
4. If height is Zero (ZO) and velocity is Positive Big (PB), then control force is Positive Big (PB).
5. If height is Positive Small (PS) and velocity is Zero (ZO), then control force is Positive Small (PS).
6. If height is Positive Small (PS) and velocity is also Positive Small (PS), then control force is Positive Medium (PM).
7. If height is Positive Small (PS) and velocity is Positive Medium (PS), then control force is Positive Medium (PM).
8. If height is Positive Small (PS) and velocity is Positive Big (PB), then control force is Positive Big (PB).

9. If height is Positive Medium (PM) and velocity is Zero (ZO), then control force is Positive Medium (PM).
10. If height is Positive Medium (PM) and velocity is Positive Small (PS), then control force is Positive Big (PB).
11. If height is Positive Medium (PM) and velocity is Positive Medium (PM), then control force is Zero (ZO).
12. If height is Positive Medium (PM) and velocity is Positive Big (PB), then control force is Positive Small (PS).
13. If height is Positive Big (PB) and velocity is Zero (ZO), then control force is Positive Medium (PM).
14. If height is Positive Big (PB) and velocity is Positive Small (PS), then control force is Positive Big (PB).
15. If height is Positive Big (PB) and velocity is Positive Medium (PM), then control force is Positive Small (PS).
16. If height is Positive Big (PB) and velocity is also Positive Big (PB), then control force is Zero (ZO).

Deffuzification of Output
In order to increase or decrease the velocity of the aircraft at different heights, one need to control the applied force on aircraft. So far several IF-THEN rules, in which It is worked on fuzzy values of the two state variables i.e. height and velocity and the fuzzy control output force, has been formed. But, the fuzzy value of control force is not required instead, a crisp value of this controlling ouput force, which can be applied to the aircraft physically. In fact, there are several methods of defuzzification to arrive at crisp value [8]. In this paper, height defuzzification method has been used to defuzzify the output controlling force.

VIII.   RESULTS

The simulated results of four successive cycles are tabulated below in Table 1:

Table 1: Results of four successive cycles

Cycle	Cycle 0	Cycle 1	Cycle 2	Cycle 3	Cycle 4
Height h_i (m)	200	180	165	151	136
Velocity v_i (m/s)	10	8	5	5.4	4.6
Control Force f(kg)	16.6	9.5	8.31	7.21	7.01

The descent profile of downward velocity vs height is drawn in Fig. 5
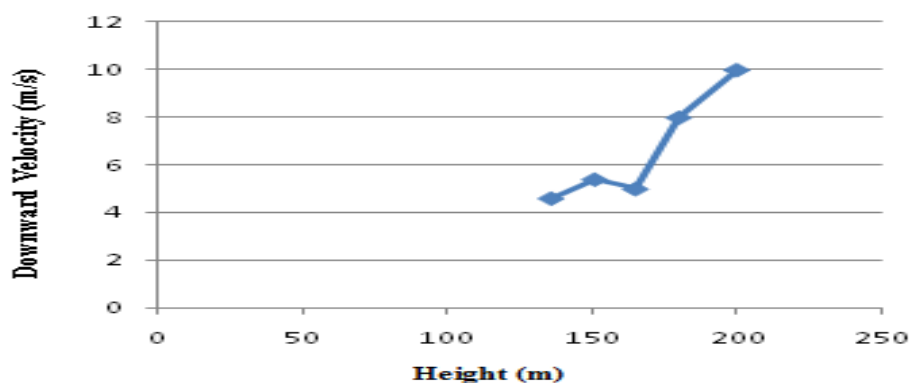
Fig.5 The descent profile of downward velocity vs height using fuzzy logic

By choosing more number of membership functions and linguistic variables for velocity, height and control force, hence more number of IF-THEN rules, a more precise control algorithm can be developed.

IX.   CONCLUSION

In present work, a fuzzy logic based control scheme for aircraft landing system has been simulated. An algorithm developed has been found capable of eliminating the hardship of conventional aircraft landing mechanism. The descent profile shown above in fig.5 appears to be a reasonable resemblance with the desired descent profile shown in fig.1.
The control scheme presented here can be considered as a step towards autonomous aircraft landing mechanism, which can successfully adapt in unknown and changing environment.

X. ACKNOWLEDGEMENT

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EFFECT OF UV-B RADIATION ON THE DEFENCE SYSTEM OF *LABEO ROHITA* (ACTINOPTERYGII: CYPRINIFORMES: CYPRINIDAE) LARVAE AND ITS MODULATION BY SEED OF DEVIL'S HORSEWHIP, *ACHYRANTHES ASPERA*

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Background. Ultraviolet (UV-B) radiation affects the immune system of fish. Dietary supplementation of natural immunostimulants may enhance the immunity of fish. The presently reported investigation evaluates the UV-B protective property of *Achyranthes aspera* seed in larvae of rohu, *Labeo rohita* (Hamilton, 1822).
Materials and methods. Larvae (1.19 ± 0.03 g) were fed four formulas of diet containing 0.0% (control), 0.1%, 0.5%, and 1.0% *Achyranthes aspera* seeds. After 51 days, larvae of each feeding treatment were divided into two groups. One groups was exposed to UV-B radiation ($80~\mu W \cdot cm^{-2}$) and the other one remained unexposed.
Results. Average weight of fish was significantly ($P < 0.05$) higher in fish fed 0.5%-seed-supplemented diet (compared to other treatments). UV-B radiation affected the growth of fish fed 0.1%-seed-supplemented- and control diets; other two treatments remained unaffected. Total serum protein-, albumin-, and globulin levels were significantly ($P < 0.05$) higher in exposed fish compared to the unexposed ones. Among the exposed groups, serum glutamic oxaloacetic transaminase and serum glutamate pyruvate transaminase levels were minimum in fish fed 1.0%-seed-supplemented diet, whereas the highest levels of myeloperoxidase, hemagglutination titre, and white blood cells were found in fish fed 0.5%-seed-supplemented diet.
Conclusion. Dietary supplementation of *A. aspera* seed at 0.5% level enhanced the growth and immunity of UV-B exposed fish.

Keywords: rohu, UV-B radiation, Achyranthes aspera seed, immunostimulation

INTRODUCTION

Solar ultraviolet B (UV-B, 280–320 nm) is a potent environmental stressor to aquatic organisms. UV-B radiation affects both wild and cultured species. The effect of UV-B on aquatic organisms depends on the capacity of the radiation to penetrate into the aquatic environment, which is determined by the depth of the water column, presence of dissolved organic carbon, and the quantity of organic and inorganic particulate matter (Häder et al. 1998, 2007, Bancroft et al. 2007). The harmful effects of UV-B include damage that compromises the physiology, biochemistry, reproduction, and growth of the exposed animals (Lesser et al. 2001, Armstrong et al. 2002, Van Uitregt et al. 2007, Nahon et al. 2009).

In fishes, UV-B radiation can induce injury to the skin, including sunburn and appearance of sunburn cells, epidermal hyperplasia, depletion of the mucus layer, or even sloughing of the epidermis solar elastosis with wrinkling, melanomata (Bullock 1988, Berghahn et al. 1993,

Little and Fabacher 1994, Blazer et al. 1997, de Oliveira Miguel et al. 2003, Sharma et al. 2005). These changes in the skin can be accompanied by infections. The skin lesions of Atlantic salmon, *Salmo salar* L., contained *Vibrio* spp., and mycobacteria (McArdle and Bullock 1987). UV-B irradiated rainbow trout, *Oncorhynchus mykiss* (Walbaum, 1792), had skin fungal pathogens (*Saprolegnia*) (see Fabacher et al. 1994). Thus the primary barrier of the defence system becomes damaged and the normal physiology of fish is affected due to the radiation. The immune system of fish can be strongly modulated by UV-B radiation (Salo et al. 2000). UV-B exposure induces pronounced immunomodulation in cyprinids (Markkula et al. 2006). The digestive physiology and immune system of catla, *Catla catla* (Hamilton, 1822), were affected by UV-B radiation (Sharma et al. 2010). Outbreak of diseases seriously affects the freshwater aquaculture industry, especially in the developing countries. The majority of the freshwater species are vulnera-

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ble to the UV-B exposure for the following reasons: animals are cultured in clear water, so UV-B radiation can easily reach them. The majority of the species breed during summer months, when highest UV indexes are recorded. Moreover, the larvae are poorly developed, the skin is less pigmented and the scales are absent. Sharma et al. (2005) reported severe damage of the skin and eye of UV-B radiated larvae of ayu, *Plecoglossus altivelis* (Temminck et Schlegel, 1846). UV-B radiation harshly damaged the gills of catla larvae (Sharma and Chakrabarti 2006). The early developmental stage is more prone to UV-B damage as these larvae are unable to recognize the harmful radiation. In a study with the orientation behaviour of larvae of red seabream, *Pagrus major* (Temminck et Schlegel, 1843), it was found that the sensitivity of the larvae towards the UV-B developed during ontogenetic development (Sharma et al. 2007).

Immunostimulants enhance immunocompetence and disease resistance in cultured fish. Fish rely more on non-specific defence mechanisms than mammals do (Anderson 1992). Microbial levan served as immunostimulant for common carp, *Cyprinus carpio* L. (see Rairakhwada et al. 2007) and juveniles of rohu, *Labeo rohita* (Hamilton, 1822) (see Gupta et al. 2008). Increased levels of lysozyme, nitroblue tetrazolium, serum protein, and albumin/globulin were found in fish fed microbial-levan supplemented diet. Kumar et al. (2007) showed that gelatinized and non-gelatinized starch served as immunomodulator for rohu. Used as a dietary supplement, some immunostimulants can increase disease resistance in fish by improving the non-specific/innate 'arm' of the immune system (Kamilya et al. 2008). This may be induced by an increase of known defensive proteins such as complement (zymosan induced) or interferon or the activation of cellular defences such as macrophages (Sakai 1999). The use of immunostimulants, as dietary supplements, can improve the innate defence of animals providing resistance to pathogens during periods of high stress (Bricknell and Dalmo 2005). In Mozambique tilapia, *Oreochromis mossambicus* (Peters, 1852), intraperitoneal administration of hot water extract of *Toona sinensis* (Plantae: Sapindales) resulted in higher survival rate of fish challenged with bacteria *Aeromonas hydrophila* compared to the control diet fed fish (Wu et al. 2010). Sheikhzadeh et al. (2011) found that decaffeinated green tea enhanced innate and specific immune responses of rainbow trout, *Oncorhynchus mykiss*. Complement and respiratory burst activity were increased by administration of inulin and *Bacillus subtilis* in gilthead seabream, *Sparus aurata* L. Higher IgM level was also recorded in treated fish compared to control ones (Cerezuela et al. 2012).

Haematological parameters are good indicators of health status of fish and therefore are important in diagnosing the structural and functional status of fish exposed to toxicant (Adhikari et al. 2004). Serum protein, albumin and globulin help to understand the nutritional status and health condition of the fish. The amino transferases, aspartate aminotransferase (SGOT), and alanine amino-transferase (SGPT) are usually found in a variety of tis-

sues viz. liver, muscle, kidney, etc. These are released into the serum in case of tissue damage. Elevated amount of these amino transferases are indicators of tissue damage; SGPT is more specific for liver. Myeloperoxidase is most abundantly expressed lysosomal protein and it is stored in azurophilic granules in neutrophils. It produces hypochlorous acid from hydrogen peroxide and chloride ion during the neutrophil's respiratory burst. It oxidizes tyrosine to tyrosyl radical using hydrogen peroxide as an oxidizing agent. Hypochlorous acid and tyrosyl radical are cytotoxic. These are used by the neutrophil to kill bacteria and other pathogens. Release of myeloperoxidase by neutrophils and monocytes during inflammation plays an important role in the innate immune response (Chakrabarti et al. 2012). White blood cells (granulocytes, monocytes, lymphocytes, and thrombocytes) play a major role in the defence mechanism of the fish. Granulocytes and monocytes act as phagocytes to salvage debris from injured tissue and lymphocytes produces antibodies (Wedemeyer and Mcleay 1981, Maheswaran et al. 2008).

The devil's horsewhip, *Achyranthes aspera*, an herb belonging to the family Amaranthaceae is widely available in India. This plant has showed immunostimulatory effect in carps (Rao and Chakrabarti 2005a, Chakrabarti and Rao 2012). Among the different parts of the plant, the seed and root possess greater stimulatory activity.

Rohu, *Labeo rohita* (Family: Cyprinidae), is an omnivorous water-column feeder, contributing considerably to the Indian aquaculture production. Disease problem is also reported in this important species. This investigation was aimed to study the impact of UV-B radiation on immune system of rohu, *Labeo rohita* larvae and to assess the UV-B remedial measures of the *Achyranthes aspera* seed.

MATERIALS AND METHODS

Culture of fish and exposure to UV-B radiation. Larvae of one of the Indian major carps—rohu, *Labeo rohita*—were obtained from the Chatterrjee Brother's fish farm, Mogra, West Bengal. The larvae weighed 1.19 ± 0.03 g and were produced by induced breeding. Larvae were acclimatized in tank (500 L), maintained in the wet laboratory for 48 h, and then introduced into glass aquaria (each 15 L). The stocking density was 15 larvae per aquarium. Larvae were fed four different types of diets for 51 days; then divided into two groups, one group was exposed to UV-B radiation (80 µW · cm^{-2}) and the other remained unexposed. Three replicates were used for each treatment. We measured the ambient UV-B level in Delhi, India (28°38′ N, 77°13′ E) as 80 µW · cm^{-2} in October 2012 using Radiometer PMA 2100 (Version 1.21, Solar Light Company, Glenside PA 19038, USA). The intensity used to be much higher during April–June. Therefore, we have selected the lower dose for the presently reported study. The duration of UV-B exposure was 24 days and the total duration of experiment was 75 days.

Dechlorinated, transparent water was used and the depth of water in the aquarium was 20 cm. Water temper-

ature and pH ranged from 30 to 31°C and 7.5 to 8.1, respectively throughout the study period. Dissolved oxygen level was maintained above 5 mg · L^{-1} with the help of aerator. The source of UV-B (280–320 nm) was a Philips tube light TL 20/12 RS made in Holland, suspended above each aquarium. Aquaria were covered with black plastic sheets to shield outside light. All tubes were pre-burned for 100 h to give a stable output. The spectral output of the tubes, as defined by the manufacturer has maximum emission at 313 nm, with negligible energy above 320 (Bertoni and Callieri 1999). UV-B tubes were covered with cellulose acetate, which absorbs wavelength < 280 nm. Fish were exposed everyday at a fixed time (1220 h) for 10 min. In our earlier study, we have found the harmful effect of UV-B radiation in carp, *Catla catla*, after 5, 10, and 15 min of exposure (Sharma and Chakrabarti 2006). We have selected the moderate exposure duration 10 min. Both these treated and control groups were kept under full-spectrum bulb (Philips 20 W) without UV components from 6000 h to 1800 h (photoperiod of 12 h : 12 h).

Preparation of diet and feeding of fish. Experimental diets (40% protein) were prepared using 0.1%, 0.5%, and 1.0% *Achyranthes aspera* seed along with other feed ingredients: dry fish powder, wheat flour, cod liver oil, and vitamin-mineral premix. Control diet was prepared using the same ingredients, except the seed (Table 1). Three replicates were used for each feeding regime. Feed was given at the rate of 5% of body weight daily twice at 9000 h and 1700 h throughout the study period.

Sampling. Fish were anaesthetized with MS-222 (Sigma, USA) and blood sample was collected from the caudal vein of individual fish using syringe containing ethylene diamine tetraacetic acid (EDTA). Blood samples collected from 4 fish of each aquarium were pooled. There were 3 pooled samples for each feeding regime. Samples were allowed to clot and stored in a refrigerator at 4°C overnight. The clot was then spun down at 2000 rpm for 10 min; then the serum was stored in sterile Eppendrof tube at –20°C until used for assay. Weight of individual fish was recorded.

Biochemical assay. Total serum protein, albumin, and globulin fraction were measured following the method of Lowry et al. (1951) and the absorbance was recorded at 750 nm using Microplate Reader (BioTek, Synergy HT, New York, USA).

Hemagglutination assay was conducted to determine the antigen-specific antibody response. The chicken blood (c-RBC) was collected in Alsever's solution (1 : 3) and stored overnight at 4°C. The cells were washed in PBS (phosphate buffer saline, pH 7.5) and resuspended in 20% (v/v) PBS. Fifty μL serum of control and test fish of each group was serially diluted in PBS in 96-well round-bottomed microplate. Equal volume of c-RBC (2%) was added to all wells and kept for 1 h at room temperature; then overnight at 4°C. The reciprocal of the highest dilution that gave agglutination was measured as the hemagglutination antibody titre.

Table 1
Composition of diets fed to rohu, *Labeo rohita*, during the experiment

Ingredient [g kg^{-1}]	Control diet	Experimental diet		
		0.1%	0.5%	1.0%
Dry fish powder	583.3	583.3	583.3	583.3
Wheat flour	402.7	401.7	397.7	392.7
Cod liver oil	10.0	10.0	10.0	10.0
Vitamin-mineral premix	4.0	4.0	4.0	4.0
Achyranthes aspera seed	0.0	1.0	5.0	10.0

Both serum glutamic oxaloacetic transminase (SGOT) and serum glutamate pyruvate transminase (SGPT) were determined using diagnostic kits (Siemens Healthcare Diagnostics Ltd., Baroda, India). Absorbance was recorded at 340 nm. Myeloperoxidase activity was measured according to Quade and Roth (1997). The optical density was measured at 450 nm in Microplate Reader.

Total white blood cells (WBC) were counted using an improved Neubauer-ruled hemocytometer (Tripathi et al. 2004). The blood sample was diluted (1 : 20) in Turk's fluid. The fluid was allowed to stand in the pipette for 8–10 min before charging into the Neubauer's chamber. Total WBC count [μL^{-1}] was performed by counting all WBCs in the 4 corners of primary squares.

$$WBC = n \times 20 \times 0.4^{-1}$$

where: n = number of WBCs observed in the 4 primary squares, 20 = dilution factor, and 0.4 = volume of fluid in 4 WBC squares.

Cells were counted in both chambers of the hemocytometer (×40 objective) and the number was averaged to produce the raw WBC count to reduce analytical variation.

Specific growth rate (SGR). The specific growth rate was calculated using the formula:

$$SGR = 100 \, [\ln W_f - \ln W_i] \cdot t^{-1}$$

where: W_i and W_f were the initial and final body weight [g] and t, the time in days.

Food conversion ratio (FCR). The food conversion ratio was calculated according to the following formula:

$$FCR = FC \cdot WG^{-1}$$

where: WG = wet weight gain, FC = dry feed consumed [g].

In a pilot study, the feed consumption rate of individual fish (5% of body weight) was determined and the same feeding scheme was followed throughout the study period.

Statistical analysis. Data were compiled as mean ± standard error (SE). All data were analyzed by using one-way analysis of variance (ANOVA) and Duncan's multiple range test, DMR (Montgomery 1984). Statistical significance was accepted at $P < 0.05$ level.

Ethical issues. The presently reported study has been carried out in accordance with the country's regulations on experiments on animals.

RESULTS

Growth performance of fish. Average weight was significantly ($P < 0.05$) higher in both UV-B exposed (3.86 ± 0.13 g) and unexposed rohu (3.78 ± 0.3 g) fed 0.5%-seed-supplemented diet than in fish of other treatments. This was followed by unexposed and exposed fish fed 1.0%-seed-supplemented diet. There was no significant ($P > 0.05$) difference between the exposed and unexposed fish fed 0.5%-seed-supplemented diet. Similar trend was found in fish fed 1.0%-seed-supplemented diet (Table 2). The specific growth rate was significantly ($P < 0.05$) higher in both UV-B exposed and unexposed rohu groups fed 0.5%-seed-supplemented diet then in fish of other treatments (Table 2). Significantly ($P < 0.05$) lower FCR was observed in fish fed 0.5%-seed-supplemented diet compared to others (Table 2). There was, however, no significant ($P > 0.05$) difference between exposed and unexposed fish in this treatment.

Biochemical assay. Total serum protein level was significantly ($P < 0.05$) higher in UV-B exposed group compared to its counterpart of UV-B unexposed group regardless of feeding scheme, except for 1.0%-seed-supplemented diet fed fish (Table 2). In this treatment, total serum protein level (91.23 ± 4.1 mg · mL^{-1}) was significantly

($P < 0.05$) higher in UV-B unexposed group compared to the UV-B irradiated one (85.19 ± 0.06 mg · mL^{-1}). Serum protein level was minimum in unexposed control group (75.94 ± 5.63 mg · mL^{-1}).

Serum albumin level was significantly ($P < 0.05$) higher in UV-B irradiated group fed 1.0%-seed-supplemented diet compared to others. Albumin level was minimum in UV-B unexposed and exposed groups fed control diet. Serum globulin level was significantly ($P < 0.05$) higher in UV-B exposed fish fed 0.5%- and 1.0%-seed-supplemented diets compared to others. Like albumin, the globulin level was also minimum in control diet fed fish (Table 2).

Significantly ($P < 0.05$) higher SGOT level was found in UV-B exposed fish fed control diet (217 ± 33.37 U · L^{-1}) compared to the other groups. Among the exposed groups, minimum SGOT was found in rohu fed 1.0%-seed-supplemented diet. Though the SGOT level was significantly ($P < 0.05$) higher in each feeding scheme of exposed group compared to the respective feeding scheme of unexposed group, but there was no significant ($P > 0.05$) difference in SGOT level between exposed (123.7 ± 1.05 U · L^{-1}) and unexposed (122.80 ± 10.663 U · L^{-1}) groups of rohu fed 1.0%-seed-supplemented diet (Fig. 1a).

Similar trend was also found with SGPT. Significantly

Table 2

Effect of *Achyranthes aspera* seeds on the UV-B exposed and unexposed rohu, *Labeo rohita*

| Parameter | Experimental diet | | | | | | Control | |
| | 0.1% | | 0.5% | | 1.0% | | | |
	Exposed	Unexposed	Exposed	Unexposed	Exposed	Unexposed	Exposed	Unexposed
W [g]	2.36 ± 0.07^d	2.95 ± 0.11^c	3.86 ± 0.13^a	3.78 ± 0.30^a	3.16 ± 0.22^b	3.36 ± 0.06^b	2.27 ± 0.26^d	3.05 ± 0.26^c
SGR [%]	0.91 ± 0.04^d	1.21 ± 0.05^c	1.57 ± 0.05^a	1.53 ± 0.10^a	1.30 ± 0.09^b	1.38 ± 0.02^b	0.84 ± 0.16^d	1.14 ± 0.34^c
FCR	3.84 ± 0.22^b	2.55 ± 0.17^c	1.67 ± 0.08^e	1.76 ± 0.19^e	2.32 ± 0.26^d	2.06 ± 0.05^d	4.73 ± 1.26^a	2.8 ± 0.12^c
T [mg·mL^{-1}]	83.38 ± 1.34^c	77.33 ± 1.12^d	87.41 ± 1.3^b	86.67 ± 2.97^b	85.19 ± 0.59^b	91.23 ± 4.19^a	83 ± 2.03^c	75.94 ± 5.63^d
A [mg·mL^{-1}]	66.34 ± 4.83^b	62.65 ± 6.32^c	$67.06 \pm 3.57b$	$57.31 \pm 1.26d$	$70.74 \pm 0.32a$	$56.72 \pm 7.27e$	$56.69 \pm 8.33e$	$56.25 \pm 4.05e$
G [mg·mL^{-1}]	16.86 ± 1.79^b	15.31 ± 0.66^b	22.16 ± 2.11^a	15.23 ± 0.93^b	23.36 ± 3.83^a	15.59 ± 3.50^b	14.98 ± 1.56^c	14.10 ± 1.78^c

W = mean weight (± SE); T = total serum protein; A = albumin; G = globulin; Each replicate composed of four fish. Three replicates were used for each treatment; Means sharing different letters in the same row are significantly *(P < 0.05)* different.
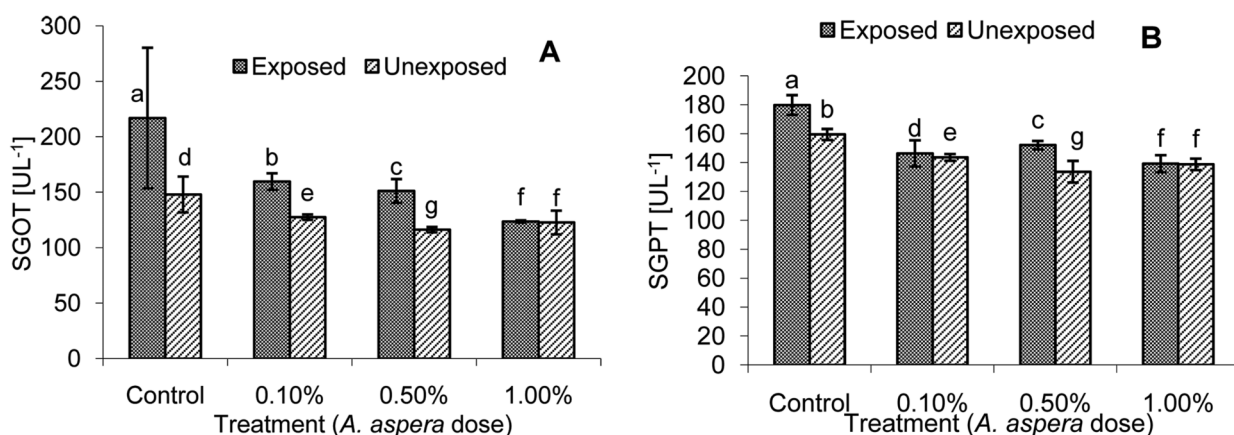
Fig. 1. Effect of dietary supplementation of *Achyranthes aspera* seed on (**A**) serum glutamic oxaloacetic transminase (SGOT) and (**B**) serum glutamate pyruvate transminase (SGPT) levels of ultraviolet exposed- (UV-B) and unexposed rohu, *Labeo rohita*; each replicate composed of four fish; three replicates were used for each treatment. Bars with different superscripts are significantly ($P < 0.05$) different; U = international unit

(P < 0.05) higher SGPT level was observed in exposed rohu fed control diet (179.922 ± 6.85 U · L^{-1}) compared to others (Fig. 1b). Among the exposed groups, minimum SGPT was found in 1.0%-seed-supplemented diet fed fish. Though the SGPT level was significantly (P < 0.05) higher in UV-B irradiated fish of each feeding scheme compared to their unexposed counterparts, but there was no significant (P > 0.05) difference between the UV-B exposed (139.12 ± 6 U · L^{-1}) and unexposed (138.88 ± 4 U · L^{-1}) groups fed 1.0%-seed-supplemented diet.

Significantly (P < 0.05) higher myeloperoxidase level was found in UV-B unexposed fish compared to UV-B exposed fish regardless of feeding regime (Fig. 2). Highest myeloperoxidase level was found in unexposed fish fed 0.5%-seed-supplemented diet (3.137 ± 0.0783, λ 450 nm). Among the exposed fish, the highest level was found in fish fed 0.5%-seed-supplemented diet (2.127 ± 0.0127, λ 450 nm), but there was no significant (P > 0.05) difference between fish fed 0.5% and 1.0%-seed-supplemented diets.

The hemagglutination antibody titre level was significantly (P < 0.05) higher in UV-B unexposed fish of each feeding scheme compared to their UV-B exposed counterparts (Fig. 3). Highest hemagglutination antibody titre level was observed in unexposed rohu fed 1.0%-seed-supplemented diet (256 ± 128). Among the exposed groups, the highest level was found in fish fed 0.5%-seed-supplemented diet. The level was minimum in exposed (7 ± 1) groups fed control diet.

WBC count was significantly (P < 0.05) higher in UV-B unexposed fish of each feeding scheme compared to their UV-B exposed counterparts. The highest value was recorded in unexposed fish fed 1.0%-seed-supplemented diet (675 267 ± 8577 μL^{-1}). Among the UV-B irradiated fish, the highest number of WBC was found in fish fed 0.5%-seed-supplemented diet (451 533 ± 4628 μL^{-1}). The number of WBC was the lowest in exposed group fed control diet (Fig. 4).

DISCUSSION

UV-B radiation affected the growth of rohu fed 0.1%-seed-supplemented- and control diets, but the supplementation of *Achyranthes aspera* seed at 0.5% and 1.0% levels helped the fish to overcome the harmful effect of UV-B radiation. This is clear from the presently reported study as there is no significant difference in the average weight of exposed and unexposed rohu of these two feeding schemes. Supplementation of seed enhanced the growth of even UV-B irradiated rohu. Food was also efficiently utilized in seed-supplemented diet fed fish compared to control group. This is evident from the lower values of FCR in the majority of treatment groups. A similar result was also reported by Rao et al. (2006). UV-B irradiation affected the FCR and consequently resulted into poor growth. The nutritional value of *Achyranthes aspera* seed plays a significant role. Previous studies showed that a number of oleanolic acids, bisdesmosidic-triterpenoid-based saponins, ecdysterone, and various amino acids were present in the seed (Hariharan and
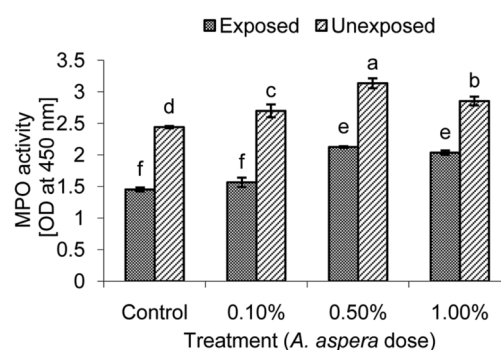
Fig. 2. Effect of dietary supplementation of *Achyranthes aspera* seed on the myeloperoxidase (MPO) level in ultraviolet-exposed- (UV-B) and unexposed rohu, *Labeo rohita*; each replicate composed of four fish; three replicates were used for each treatment. Bars with different superscripts are significantly (P < 0.05) different; OD = optical density
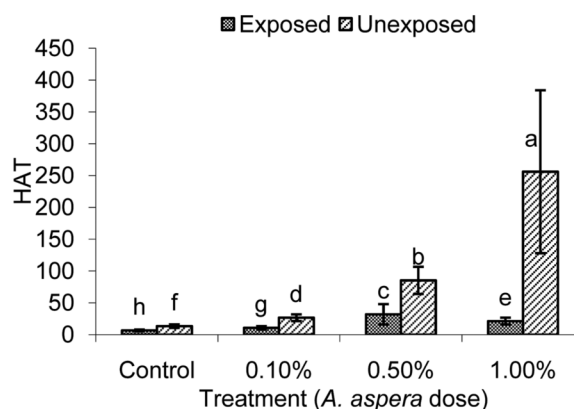
Fig. 3. Effect of dietary supplementation of *Achyranthes aspera* seed on hemagglutination antibody titre (HAT) in ultraviolet exposed- (UV-B) and unexposed rohu, *Labeo rohita;* each replicate composed of four fish; three replicates were used for each treatment; Bars with different superscripts are significantly (P < 0.05) different

Fig. 4. Effect of dietary supplementation of *Achyranthes aspera* seed on abundance of white blood cell count (WBC) (per 1 μL) in ultraviolet exposed- (UV-B) and unexposed rohu, *Labeo rohita*; each replicate composed of four fish; three replicates were used for each treatment; Bars with different superscripts are significantly (P < 0.05) different

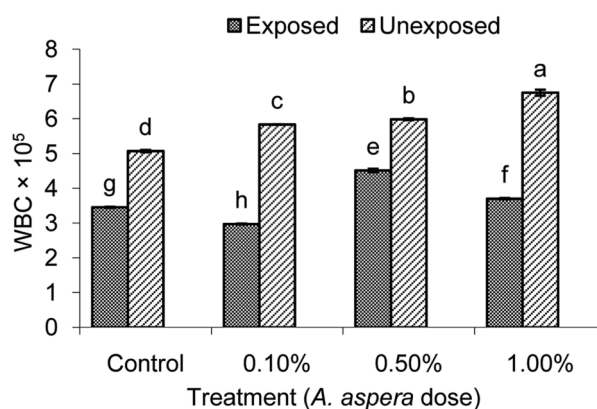Rangaswami 1970, Banerji et al. 1971, Varuna et al. 2010). Chakrabati et al. (2012) reported the presence of ecdysterone in the seeds of *Achyranthes aspera* which was likely to enhance the growth of fish. Ecdysteron is reported to have pronounced growth-promoting effect due to high rate of protein synthesis (Goerlick-Feldman et al. 2008).

The most important character of an UV sunscreen is that the compound should absorb a fraction of the incident radiation high enough to provide a meaningful benefit to the organisms. This fraction is the sunscreen factor. The second condition is that the presence of the compound in the organisms should be correlated with enhanced fitness under UV radiation, i.e., growth rate enhanced or survival rate increased compared with that of the same organisms when lack the compound (Garcia-Pichel et al. 1993).

Exposure of fish to UV-B induced the production of more protein, which is evident from the higher values of total protein, albumin, and globulin in the exposed fish compared to the unexposed fish of the same feeding regime. When organism are stressed by UV-B radiation there is up-regulation of the constitutive heat shock chaperons to produce newly formed HSPs which can be detected in the cell at concentration two or three times those of the constitutive chaperons as well as in tissue fluid (Chiang et al. 1989, Locke 1997). The presently reported investigation confirms this.

Higher levels of SGOT and SGPT are the indicators of tissue damage. In this study, the photoprotective property of seed was evident as minimum SGOT and SGPT levels were documented in 0.5% and 1.0% seed-supplemented diets fed fish. A dose-dependent expression was also recorded. This confirms the earlier findings (Rao and Chakrabarti 2005a, b, Chakrabarti and Srivastava 2012). Supplementation of seed influenced the immune system of rohu larvae. A direct relation was found between the amount of seed in the diet of fish (up to 0.5%) and myeloperoxidase level in both UV-B exposed and unexposed groups. Myeloperoxidase showed phagocytic, chemotactic, and bactericidal properties in fish neutrophils. Reduced activity with UV-B radiated fish showed the effect of stress. Significantly higher myeloperoxidase level was reported in immunostimulant (lactoferrin, β-1,3 glucan, levamisole, and vitamin C) fed Philippine catfish, *Clarias batrachus* (L.) (see Kumari and Sahoo 2006).

The antigen-specific antibody response was measured as hemagglutination antibody titre. A direct relation was found between the amount of seed in the diet and hemagglutination titre level. The seeds of *Achyranthes aspera* enhanced the hemagglutination antibody titre level in catla (Rao and Chakrabarti 2005a) and common carp (Chakrabarti et al. 2012).

Significantly higher level of WBC was recorded in UV-B unexposed fish compared to UV-B exposed fish regardless of feeding regime. The reduction in number of white blood cell is a result of elevated phagocytic activity in affected tissues such as gills, liver and kidneys which were damaged by the foreign substances (Gey Van Pittius unpublished[*], Van der Merwe unpublished[*], Wepener unpublished[*]). The white blood cells leave the circulating blood to protect the body by moving to the infected tissues. Seeds of *Achyranthes aspera* promoted the increased number of WBC in the fish. Chakrabarti et al. (2012) reported the presence of two essential fatty acids linolenic acid and oleic acid in the seeds of *Achyranthes aspera* which probably stimulated the immune system of carp.

CONCLUSIONS

Exposure of fish to UV-B radiation resulted into elevated protein-, SGOT- and SGPT levels in fish. Simultaneously it resulted into reduced levels of myeloperoxidase and hemagglutination titre and white blood cells count. Poor physiological and immunological systems make the fish more prone to disease. Supplementation of seed of *Achyranthes aspera* at 0.5% level in diet of larvae showed promising results to overcome the problem of UV-B radiation in aquatic system. This may serve as natural immunostimulant for fish.

ACKNOWLEDGEMENTS

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Experimental Studies on a Scraped Surface Ice Slurry Generator

Rajinder Singh, Surendra Singh Kachhwaha

Abstract- In the present experimental study a scraped surface ice slurry generator has been designed, developed and fabricated successfully with a focus on collection of experimental data related to ice slurry production using 10%, 20% and 30% concentrations of antifreezes (PG and MEG). Three distinct stages- chilling, nucleation and stable ice slurry generation period were observed through historical time dependence curves. The minimum ice slurry temperatures achieved are -11.0 ^{0}C and -11.9 ^{0}C respectively for 30 % concentration of PG and MEG. It was further observed that the freezing temperature reduces with increase in antifreeze mass fraction for PG and MEG. Using the experimental data and the present manufacturing technique opens further possibility for development of a higher capacity ice slurry generation machine suitable for industrial application.

Index Terms- Ice Slurry, Scraped Surface, Ice Slurry Generator, Antifreezes.

I. INTRODUCTION

During the last couple of decades, some widely used conventional refrigerants have been identified as harmful for greenhouse substances and also contribute ozone depletion. Therefore, refrigeration industry has been continuously working to develop alternative refrigerants having good physical and thermodynamic characteristics besides less adverse effects on the environment. Simultaneously, the research work has also been done to reduce the amount of refrigerant installations by the use of secondary refrigeration loops. The heat transfer fluid in these loops is generally water or sometimes an aqueous solution which can be replaced by diphasic secondary refrigerants such as ice slurries to improve system efficiencies.

 The ice slurry is normally the ice crystals distributed in water or an aqueous solution where different substances are added to achieve reduction in freezing point, viscosity, corrosion behaviour, agglomeration and increase in heat carrying capacity and thermal conductivity of the fluid phase. Ice slurry has a great potential for the future due to wide range of industrial applications, ranging from comfort cooling and commercial refrigeration to industrial production processes and medicine. An important application [1] of an ice slurry system is in the milk production where high peak loads are to be adjusted.

Ice slurry is a phase-changing secondary fluid consisting of both a liquid state and a solid–state fraction (composed of fine ice particles). The main purpose of using ice slurry is to take advantage of the stored cooling energy (in terms of latent heat) in the ice particles (0.1 to 1 mm size) during melting. Sodium chloride, ethanol, ethylene glycol and propylene glycol are the four most commonly used freezing point depressants [2] used by the refrigeration industry. Depending on the type of additive and additive concentration, the operating temperature [3] for ice slurry can be chosen between 0 to -35ºC.

The time required for ice to cover the unscraped cooling surface; the thermal response of the supercooled solution at the onset of phase change; the heat transfer coefficient on the scraped surface with/without phase change, and the growth kinetics of ice film spreading along the cooling surface was exhaustively studied by Qin et al. [4]. Continuous heat extraction is important for the process of freeze concentration of aqueous solutions, in which water is removed as solid ice. Three typical stages of heat-transfer patterns [5], namely, chilling, nucleation, and crystallization were identified during the process of freeze concentration in a scraped surface heat exchanger. Using the Laplace and inverse transform, and incorporating the initial condition of ice nucleation, an analytical solution was obtained by Qin et al. [6]. Heat transfer phenomena in two types of eutectic crystallizers have been analyzed by Vaessen et al. [7]. Both increasing and decreasing heat transfer rates have been observed in crystallizing conditions at increasing scraping rates. Differences are attributed to geometrical crystallizer characteristics and solid content [8].

 For ice slurries to become more widely accepted, however, more engineering information is required on fluid flow and heat transfer characteristics. An experimental study [9] was carried out on a scraped surface heat exchanger used for freezing of water–ethanol mixture and aqueous sucrose solution. The influence of various parameters on heat transfer intensity was established. The heat transfer coefficient and the power consumption of a laboratory scraped-surface heat exchanger (SSHE) were measured when it was used for freezing a 10 wt. % sugar solution. Experimental results [10] show that the heat transfer coefficient with phase change (ice formation) was about three to five times greater than that without phase change. Effect of poly vinyl alcohol

(PVA) in inhibiting an increase in ice crystal size in isothermal ice slurries was investigated by Inada and Modak [11]. Using PVA, which exhibits thermal hysteresis, is a novel technique to completely inhibit the increase in ice crystal size in isothermal ice slurries. A new type of sensor for in-line measurements of antifreeze mass fraction in aqueous solutions is described by Ayel et al. [12]. Its principles of operation are based on the exploitation of the temperature rise that accompanies the freezing of an undercooled solution. Latent heat of fusion of ice in aqueous solutions was investigated by Kumano et al. [13] in order to understand the characteristics of ice slurries used in ice thermal energy storage systems.

The study by Matsumotoa et al [14] focuses on an emulsion as a new thermal storage material for ice storage. The results indicated that one emulsion was a W/O type emulsion, while the other was an O/W type. Finally, adaptability of the two emulsions to ice storage was discussed, it was concluded that a high performance ice slurry could be formed by the W/O type emulsion. Study by Guilpart et al. [15] compares the performance of several commonly used organic and inorganic ice slurry secondary refrigerants. This study was based on thermo physical assessments carried out at different operating temperatures. For ice slurry applications there is a need for accurate freezing point data and for more basic thermo physical property data at low concentrations [16]. An analytical model has been developed by Hawlader et al. [17] to predict the growth of ice around the injected super cooled coolant droplets, which involves phase change and heat transfer between layers. Theoretical and experimental work on a novel ice slurry producing system utilizing inner waste heat was proposed by Li et al [18]. This system consists of two major processes: an evaporative super cooling process and a liquid dehumidification process. Lu and Tassou [19] investigated several types of phase change materials for the preparation of PCM slurries which have potential for cooling applications.

Heat transfer from a jacketed wall of a scraped-surface heat exchanger (SSHE) numerically simulated by Baccar and Abid. [20] to analyse the hydrodynamic and thermal behaviour under various operating and geometrical conditions using three-dimensional form of the Navier-Stokes and energy equations. Results show that geometrical and operating parameters can strongly affect the performance of a heat exchanger. An increase in the number of scrapers contributes to a higher frequency of the scraped film which would improve heat transfer performance. With more than four blades, radial dispersion decreases and a rigid-body rotation takes place. The growth pattern related to the potential for crystal growth as well as the crystal surface topography have been studied by Grandum et al [21].The crystal shape and size were found to be strongly dependent on the super cooling in the crystal's surrounding liquid in between a transition temperature. An experimental investigation of a scraped surface heat exchanger (SSHE) was undertaken by Dumont et al. [22] using visual observations and the electrochemical technique in order to study the transition between laminar and vortex flows and to evaluate the wall shear rates. It was established that flow patterns in a SSHE are noticeably different from those observed in an annular space in the same conditions. A bubbling device was applied by Zhang et al. [23] to an experimental dynamic ice making system to suppress ice adhesion to the cooling wall. The experimental dynamic ice making system employed an air compressor to create air bubbles, and for the sake of this purpose, its ice slurry generator was set up vertically. It was concluded that the air bubbles are effective to suppress ice adhesion to the cooling wall; however, the air blowing rate of the air compressor should be optimized. Lasvignottes et al. [24] demonstrated the feasibility to produce ice slurry from super cooled water. This technology which does not use extra mechanical energy source to operate is a promising alternative to the actual technologies. However the design must be very accurate to control the super cooled degree at the outside of the evaporator.

A functional fluid was made by adding a small amount of additive to a water silicone-oil mixture with 90 vol % water content, and the functional fluid was transformed into an ice slurry by cooling while stirring. The new ice formation system, proposed by Matsumotoa et al [25] for ice storage based on the results of previous studies, demonstrated that the ice slurry could be formed continuously for 10 h. Experiments were carried out, varying operating conditions, and an optimal operating condition was determined to improve performance of the present system.

A physical model to investigate the non-isothermal freezing kinetic in ice slurry systems was built by Kousksou et al [26]. Matsumoto et al [27] had proposed application of ice slurry to a cold storage of foods for widely using the ice slurry. A new ice slurry utilizing the food additive trehalose was tested using the "harvest method".

Heat transfer in presence of a high viscosity fluid may be substantially enhanced using heat exchangers supported by a mechanical agitation system that can also "scrape" the exchange surface. In this case, heat transfer efficiency depends strongly on exchanger and agitator geometries, agitation methods as well as fluid characteristics and heat transfer conditions [28].The study performed by Yataghene et al [29] is focused on

experimental analysis of the flow patterns inside SSHE under isothermal and continuous flow conditions. Experimental flow pattern analyses are the basis for further experimental explorations of mixing and heat exchange mechanism. Thongwik et al [30] studied the heat transfer phenomenon of melting slurry ice on external surface of a copper helical coil. The experimental results show that, with small coil diameter, high mass flow rate of circulating water and low ice fraction, high heat transfer coefficient of the slurry ice at the warm helical coil surface is obtained.

Most crystallization models for ice slurries are based on the equilibrium thermodynamic approach. Che´gnimonhan et al [31] presented results of simulations grounded on classical nucleation theory and crystal growth included in global Nakamuratype kinetics coupled with the one-dimensional nonlinear heat equation, another way to model the phase change.

Ice storage is a potential energy saving method for air conditioning systems and is an ideal material for ice storage. The conventional ice slurry producing method using super cooled water suffers from the instability of ice block and depends heavily on electric power. A novel ice slurry producing system utilizing inner waste heat was proposed by Li et al. [32]. Compared with the conventional system, this new system can alleviate the burden on electric power and raise the efficiency. The basic crystallization principles and heat transfer mechanisms in current ice generators are not yet fully understood. To elucidate the heat transfer mechanisms, heat transfer measurements are presented by Stamatiou et al [33] in a prototype compact ice generator. Turbulent fluid flow and related solid particle behavior in the direct vicinity of the heat exchanging surface of a scraped heat exchanger crystallizer was studied by Pascuala et al [34]. The main goal was the design of scraper geometries that enhance heat transfer by perturbing the thermal boundary layer, and effectively scrape off particles that nucleate, grow and adhere onto the heat exchanger surface. The Ultrasonic Doppler Method (UDM) has been applied by Vuarnoz et al. [35] to the process of ice slurry generation by direct injection of a refrigerant into an aqueous solution. The main objective of this work has been to investigate the fluid dynamic behavior of evaporating refrigerant drops in an immiscible fluid and the approach taken has been to evaluate how suitable the UDM technique is for such investigations.

Pronk et al [36] performed a dynamic simulation of an experimental set-up in order to predict heat transfer coefficients in a fluidized bed ice slurry generator. A comparison between experiments and results from simulations pointed out that both models overestimate heat transfer coefficients and that crystallization does not affect the heat transfer process significantly. A possible explanation for the latter phenomenon is that the crystallization takes place in the bulk of the fluidized bed instead of near the wall. A super-cooling ice slurry generator type was experimentally tested and compared by Mouneer et al [37] with a traditional scraped surface type. A new method of ice slurry generation without the deposition of an ice layer on a cooled surface was developed by Koji et al. [38].

The recent review of the literature (as mentioned above) shows that there are broadly six methods used for ice slurry generation namely: (i) mechanical scraper method (also known as harvest method) (ii) fluidized bed method, (iii) direct injection method, (iv) vacuum freezing method, (v) oscillatory moving cooled wall method, and (vi) super-cooling water. The investment and operating costs of each of these methods is an important parameter during system selection procedure. In the mechanical scraper method the refrigerant evaporates in a double-wall cylinder. Through the inside space, bounded by the inner cylinder, the water or aqueous solution flows and the ice crystals are created. A rotary sharp edged scraper scrapes the ice growing on the cooling surface. The scraped surface generator has a large surface for the ice crystal creation per unit volume of ice slurry generator. In the fluidized bed method, the ice slurry generation process is performed using liquid–solid fluidized bed heat exchangers. In the direct injection method, the refrigerant is directly injected into the water domain. Liquid droplets of refrigerant enter through nozzles, normally at the bottom of the generator, and start to evaporate. The growing droplet/bubbles, moving upwards by buoyancy rise to the top of the water containing column. Vacuum freezing method has been investigated by ethanol solution and pure water. In the oscillatory moving cooled wall method, an oscillatory motion is applied to the cooled surfaces on which the ice layers are formed, and removed by the vibration generated during the oscillatory motion. In the super-cooling water method, the ice slurry is produced with low ice concentration by using a typical design of shell and tube type, but the initiation of the freezing should be controlled to adjust the produced ice concentration without system blockage. In the developing countries a widespread utilization of ice slurry systems for industrial applications has not taken place yet which is mainly attributed to the high investment costs of commercially available (only imported) ice slurry generators. The objectives of this study are design and fabrication of a small scale scraped surface ice slurry generator test rig through commonly used manufacturing processes employed by small and medium scale industries and collection of experimental data to understand ice crystallization mechanism in the

microscopic scale, and heat transfer and fluid mechanics involving agitation and phase change in the macro scale for ice slurry production using Propylene Glycol (PG) and Mono Ethylene Glycol (MEG) water based solution at different solute concentrations. Experimental data have been collected on a prototype to explore the possibility for development of a future large capacity ice slurry generation machine.

II. EXPERIMENTAL SETUP AND PROCEDURE

In the present experimental study 'scraped surface ice slurry generator' of 5 liter capacity has been designed, developed and fabricated [refer Fig.1 (a) to (c)]. Experiments were carried out to collect the performance data for ice slurry production.

A. *Working Principle and Specifications of Scraped Surface Ice Slurry Generator*
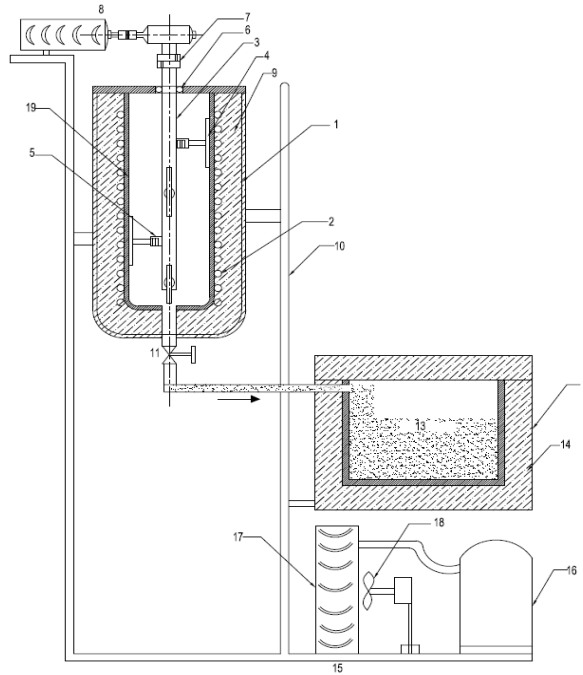
Fig.1 (a) Schematic diagram of Ice Slurry System

1 = Ice Slurry Generator	14 = Insulation
2 = Evaporator Coil	15 = Condensing Unit
3 = Scraper Shaft	16 = Compressor
4 = Scraper Blade	17 = Condenser
5 = Spring	18 = Condenser Fan
6 = Bearing	19 = Inner Shell
7 = Coupling	20 = Soldering
8 = Motor	21 = Refrigerant In
9 = Insulation	22 = Refrigerant Out
10 = Frame	23 = Ice Slurry Out
11= Valve	24 = Ice Slurry Pump
12 = Ice Slurry Tank	25 = Cooling Load
13 = Ice Slurry	

The scraped surface ice slurry generator consists of a circular shell-and-tube type heat exchanger (Figure 2), where outer shell side is cooled by an evaporating refrigerant and inside surface is scraped by spring loaded rotating blades (Figure 3) to prevent any deposition of ice crystals on the cooled surface. This scraping action is required to prevent the formation of an ice layer on the inner walls of ice generator, which would otherwise introduce an additional thermal resistance and could seriously lower the heat transfer. The continuous accumulation of the ice layer on the ice generator walls would eventually block
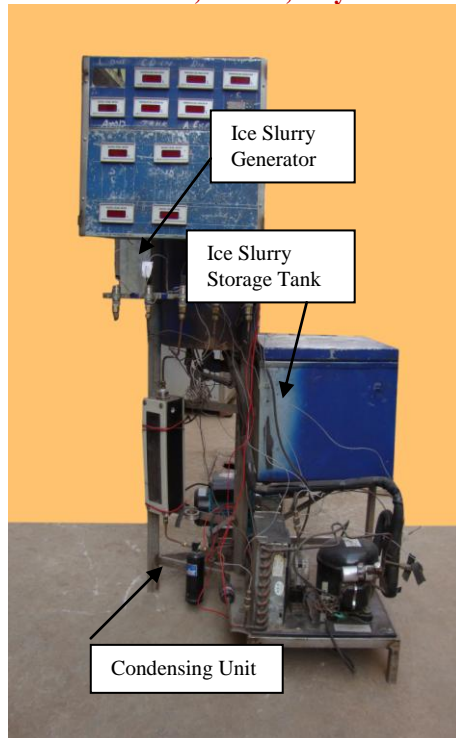
Fig.1 (b) Photograph of Ice Slurry System

Fig.1 (c) Photograph of Ice Slurry

Rotation of the scraper blades and cause freezing up of the ice slurry generator. Depressants are added to depress the freezing point of the solution to prevent the freeze-up of the ice generator walls and alternatively provide impact on the temperature driving force for heat transfer. Turbulence is mechanically induced into the ice slurry flow by the action of the rotating scarper blades mounted in the centre of the heat exchanger, thus greatly increasing the heat transfer rates and facilitating the production of a homogeneous ice slurry mixture. Table 1(a) and (b) summarizes the specifications of the present ice slurry generator manufactured for laboratory purpose. Ice slurry generator is manufactured using stainless steel (SS304) tube. Stainless steel is the preferred material of construction because it offers good thermal properties, strength and corrosion resistance. Extruded materials can also be used to minimize the overall cost.
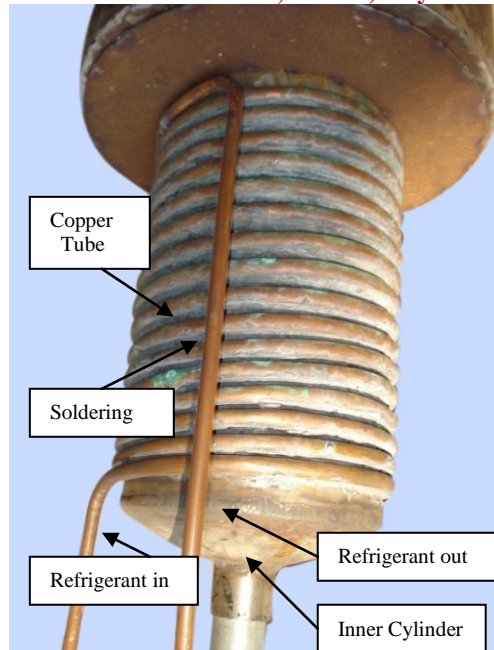
Fig.2 Photograph of coil of shell and coil type evaporator
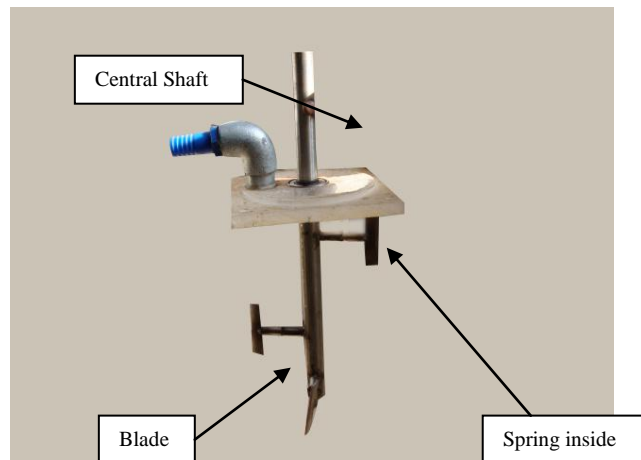
Fig.3 Photograph of Scraper blade assembly

Table 1(a): Specifications of ice slurry generator (including primary and secondary circuit components)

S. No.	Name of the component	Specifications(material/size)
1	Compressor	1/6 horse power
2	Condenser	Air cooled fin and coil type
3	Capillary tube	0.031 inch size
4	Evaporator	Circular shell and coil type of 3/8 inch coil
5	Inner cylinder	150 mm inner diameter (SS 304)
6	Scraper blade assembly	SS 304

| 7 | Ice slurry tank | 300 cubic mm (SS 304) |
| 8 | Ice slurry circulation pump | (SS 304), 1/4 horse power |

Table 1(b): Technical specifications of ice slurry generator

Specifications	The present design
Ice slurry side	
Tube Material	304-Grade Stainless Steel
Evaporator type arrangement	Vertical
Freezing point depressant	Propylene glycol, mono ethylene glycol
Crystal size (mm)	0.2- 0.3
Inner tube diameter (m)	0.15
Tube length (m)	0.30
Heat transfer area (m^2)	0.1414
Agitation mechanism	SS 304 scraper blades 7.5 cm (L), 1.85 cm (W)
Agitation speed (rpm)	24
Refrigerant side	
Evaporator type	Circular shell and coil type of 3/8 inch coil
Refrigerant type	R134a

The stainless steel (SS 304) cylinder (150 mm inner diameter, 3 mm thickness and 300 mm length) is used as the main body for ice slurry generator. A copper tube (0.93 cm diameter) was wrapped in a spiral coil shape (16 numbers of turns) around the outer surface of the main cylinder (Figure 3). This copper tube is soldered with the outer periphery of the cylinder for proper contact to enhance the heat transfer effect. The total 40 feet length of copper tube was consumed. This type of copper coil configuration (evaporator) ensures proper turbulence for the primary refrigerant (R134a). Around the copper tube coil, polyurethane foam insulation of 7.5 cm thickness is provided and inserted between the inner and outer cylinders. The insulating material is compatible with the temperature of the cooling medium to minimize any heat gains from the surroundings. The two concentric cylinders are connected by welded neck flanged ends. The scraper blade assembly used in the present work consisted of four staggered spring loaded blades attached to the 25 mm diameter scraper shaft located centrally in the inner cylinder. Each blade is 75 mm long in the axial direction and 18.5 mm wide in the radial direction. An electric speed motor is mounted at the top of ice slurry generator to rotate the scraper shaft. The scraper blade assembly is coupled to electric motor (1 hp, 1425 rpm) via a reducing gear box of ratio 1:60 to provide rotational speed of 24 rpm to the scraper shaft. The rotational speed of the scraping mechanism was kept constant in all experimental observations presented herein this research which is the minimum speed with the lowest internal thermal resistance of ice layer formed.

B. *Experimental Setup*

A schematic diagram of the experimental apparatus is presented in Fig. 4. The present condensing refrigeration unit consisting of a compressor (1/6 hp, 1-φ, 230V, 50 Hz), air cooled condenser (fin and coil type 220 ×230 mm, 2 row deep, 3/8 inch diameter copper tubes, 6 fins per inch, fan 1300 rpm) and capillary tube (5/16 inch size having two 7 feet long passage) and measurement facilities. Ice slurry tank (300 mm×300 mm×300 mm size, insulated with 60 mm thick polyurethane foam) is connected with ice slurry generator through a ice slurry circulation pump (1/4 hp). This unit supplies the refrigerant to the coil of the ice slurry generator (referred as evaporator in the refrigeration cycle in Fig.4) where evaporating refrigerant at lower pressure
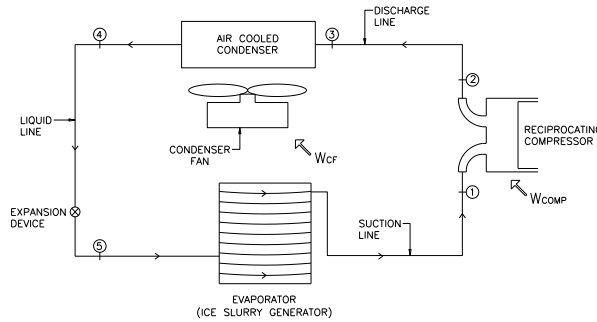
Fig 4 (a) Schematic of Direct-expansion, single-stage mechanical vapor compression refrigeration system of scraped surface ice slurry generator
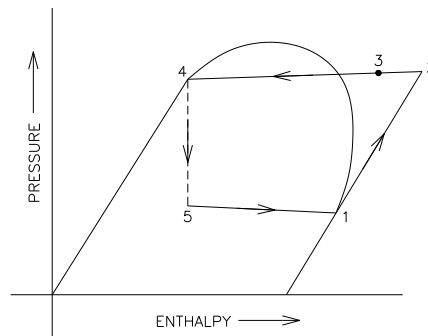
Fig.4 (b) Pressure-enthalpy diagram

Withdraws heat from the binary solution which is finally converted into ice slurry inside the generator. At the exit of the evaporator, a refrigerant vapor of enough superheat is generated from this indirect heat exchange process, recompressed and recompensed at high pressure to complete the refrigeration cycle. During the experimentation, ice slurries are made of an aqueous solutions of propylene glycol [PG] and mono ethylene glycol [MEG] having the initial weight concentration of 10%, 20%, and 30%, respectively.

C. *Measurements and Data Collection*

The temperatures at condenser inlet and outlet, compressor suction and discharge, ice slurry tank and ice slurry in the ice slurry generator were measured by resistance-temperature detectors with a range of -50 ºC to 0 ºC to 99 ºC and accuracy of 0.01 K. The pressures of primary refrigerant at condenser inlet and outlet, compressor suction and discharge, expansion outlet were measured using pressure transmitters with a range of 0 to 20 bar having accuracy of 0.01 bar. Mass flow rate of primary refrigerant was measured using rotameter. Propylene Glycol (PG) and Mono Ethylene Glycol (MEG) were used as additives **an** air-cooled, direct-expansion, single-stage mechanical vapor compression refrigeration system with R134a as primary refrigerant is used for scraped surface ice slurry generator. A pressure-enthalpy diagram of this system is shown in Fig. 4 (b). Table 2 (a) and Table 2 (b) summarizes the measured operating thermodynamic properties at inlet and outlet of various primary refrigerant components.

Table 2(a) Measured Thermodynamic Properties (MEG as Antifreeze in Ice Slurry Generator)

State	Pressure (kPa)			Temperature (°C)		
	10%	20%	30%	10%	20%	30%
1. Compressor suction	100	083	068	-6.9	-8.9	-12.0
2. Compressor discharge	1051	1005	985	46.7	45.7	42.1
3. Condenser inlet	1014	971	946	46.6	44.9	41.6
4. Condenser outlet	1005	961	939	36.3	35.5	35.4

2319-5967

5. After expansion	108	091	077	-7.0	-9.5	-12.1
6. Ice slurry temperature				-3.4	-7.1	-11.9

Table 2(b) Measured Thermodynamic Properties (PG as Antifreeze in Ice Slurry Generator)

State	Pressure (kPa)			Temperature (°C)		
	10%	**20%**	**30%**	**10%**	**20%**	**30%**
1. Compressor suction	104	082	062	-5.0	-8.7	-11.2
2. Compressor discharge	1045	1006	972	45.9	43.0	41.2
3. Condenser inlet	1010	972	935	45.8	42.6	40.9
4. Condenser outlet	999	962	929	35.7	35.3	35.2
5. After expansion	112	091	071	-6.8	-9.1	-11.5
6. Ice slurry temperature				-2.9	-6.4	-11.0

III. RESULTS AND DISCUSSIONS

The aqueous solution of antifreezes, Propylene Glycol (PG) and Mono Ethylene Glycol (MEG) with water at weight percentages 10%, 20% and 30% of antifreezes were used in the freezing process. The coolant temperatures were measured with resistance-temperature detectors. Recorded temperatures of aqueous solution of antifreezes, refrigerant temperatures at evaporator inlet and outlet, refrigerant temperatures at condenser inlet and outlet at different concentrations are plotted (Figures. 5 to 7 for PG and Figures 8 to 10 for MEG) with respect to freezing time of ice slurry for PG and MEG, respectively. From the present experimental ice slurry generation data it can be observed that ice slurry generation process can be divided into three stages- cool down or chilling period, nucleation or unstable ice slurry generation period and stable ice slurry generation period. The first stage (cool down period) starts t_0 to t_1, where t_0 is the starting time of the experiment and t_1 is the time at the end of the chilling period which is the on-set of the super-cooling phenomenon. During the chilling period volumetric ice concentration is zero. As observed in Figures 5 to 7, the freezing temperature reduces with increase in antifreeze mass fraction for PG and MEG solution initially chilled continuously without phase change in stage 1. First phase time duration is 1500, 1600 and 2000 seconds respectively for 10%, 20% and 30% concentration of PG. Similar trend was observed for MEG (Figures 8 to 10) but first phase time duration was relatively higher as compared to PG. During this stage the average evaporator temperature decreases sharply which causes increase in the refrigeration capacity and compressor work. Therefore, the condenser inlet temperature increases due to higher heat rejection quantity. The second stage (nucleation period) starts from t_1 to t_2, where the ice seeds after the super cooling phenomenon is observed and the volumetric ice concentration increases till its maximum value at the end of this period (at t_2). In stage 2, nucleation of ice particles occurs and it is characterized by 0.5 to 1^0C jump in temperature of the process fluid due to the release of the fusion heat of ice. Finally the third stage (ice slurry generation period) starts from t_2 to the end of the experiment, at t_f. During this stage the ice concentration is maintained constant at its maximum value. During stage 3 the heat transfer is affected by the release of the latent heat of water freezing. With antifreeze PG, the lowest ice slurry temperatures achieved are -3.1 ^{0}C, -6.4 ^{0}C and -11.0 ^{0}C at 10%, 20% and 30% concentrations respectively, whereas with antifreeze MEG, lowest ice slurry temperatures achieved are -3.4 ^{0}C, -7.3 ^{0}C and -11.9 ^{0}C at 10%, 20% and 30% concentrations respectively.
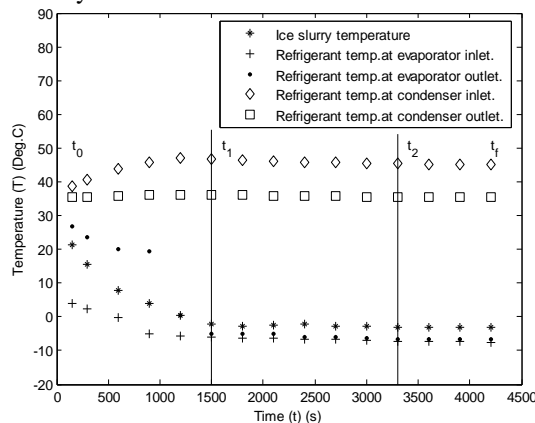
Fig.5. Freezing temperature vs time for PG at 10 % concentration
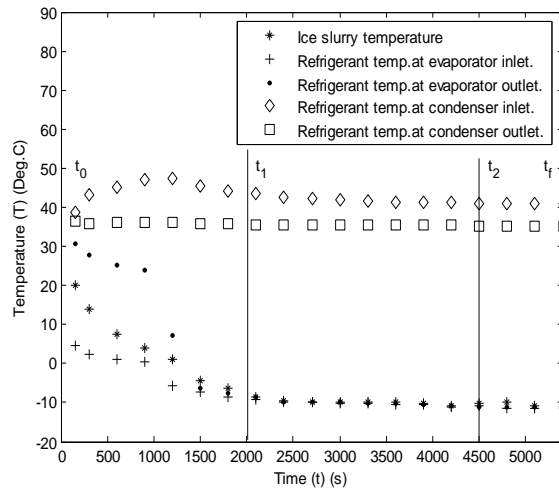
Fig.6. Freezing temperature vs time for PG at 20 % concentration

Freezing temperatures vs. antifreeze mass fraction is shown in Fig. 11. Here, freezing temperature is inversely proportional to antifreeze mass fraction. When water freezes out after the temperature of the liquid mixture has passed below the freezing point, the concentration of the additive increases in the liquid-phase. The increased additive concentration implies that the freezing point of the remaining liquid-phase is further lowered and in order to freeze out more ice the temperature of the mixture has to be further lowered below the current freezing point of the liquid. The result is that the fluid has a freezing range rather than a definitive freezing point. Thus by plotting the freezing point as a function of the additive concentration, one obtains a freezing point curve as a function of the additive mass concentration of different freezing point depressants (Figure 11). The lowering of the temperature of the ice slurry is independent of the effect of the latent heat from the phase change, but dependent on the sensible heat of the mixture. Since it is the advantage of the latent heat in ice slurry that is desired, one desires a liquid mixture where the latent heat dominates. To minimize the influence of the sensible heat, a fluid with a relatively low first derivative of the freezing point curve (flat freezing point curve) is to be preferred.
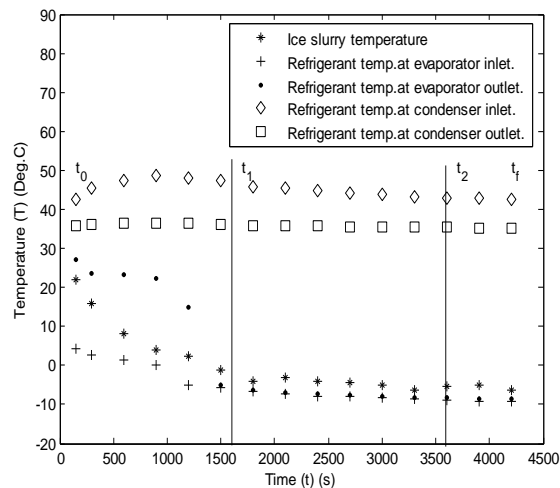
Fig.7. Freezing temperature vs time for PG at 30 % concentration
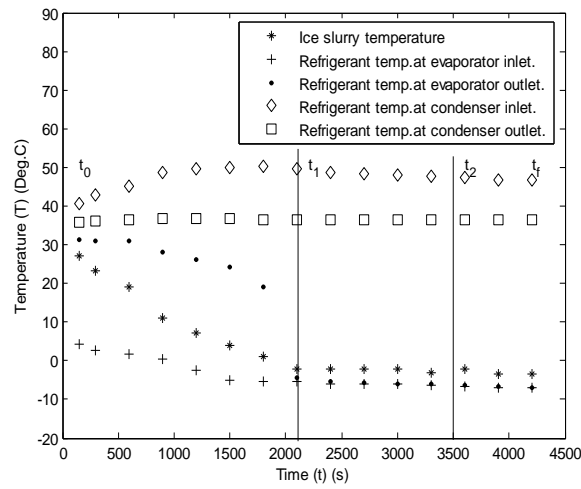
Fig.8. Freezing temperature vs time for MEG at 10 % concentration
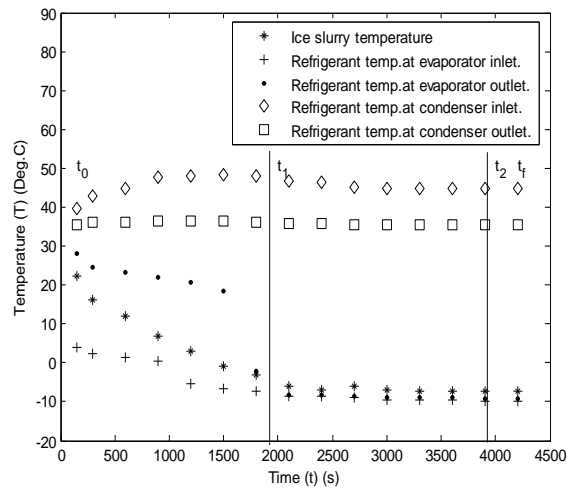
Fig.9. Freezing temperature vs time for MEG at 20 % concentration
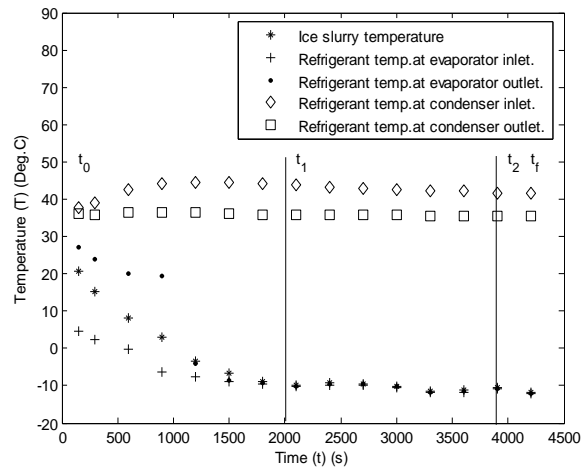
Fig.10. Freezing temperature vs time for MEG at 30 % concentration
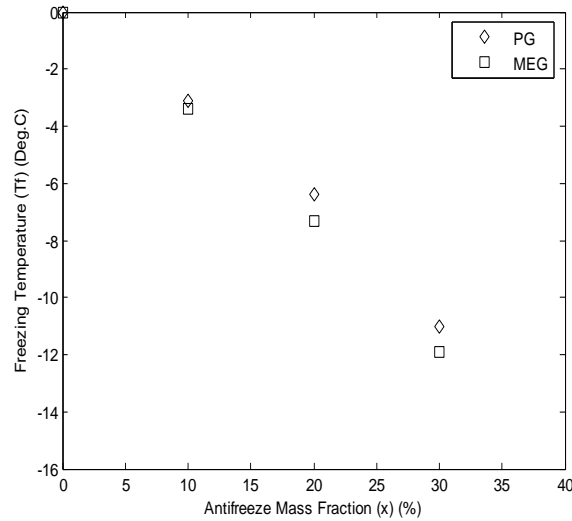
Fig.11. Freezing curve of water-PG and water- MEG mixture

Table 3 Thermodynamic heat and work calculations of Ice Slurry Generation System

	Concentration of PG			Concentration of MEG		
	10%	20%	30%	10%	20%	30%
Refrigerating Effect, $N = h_1 - h_5$ (W)	281.54	278.39	275.75	277.65	277.65	274.25
Compressor Work, $W = h_2 - h_1$ (W)	58.10	60.18	61.74	61.49	63.23	63.80
Coefficient of Performance (COP=N/W)	4.84	4.62	4.46	4.55	4.38	4.29
Heat Rejected in Condenser, $Qc = h_2 - h_4$ (W)	339.65	338.57	337.49	339.15	340.8419	338.05

Using the experimental data given in Table 2 (a) and Table 2 (b) thermodynamic heat and work calculations of Ice Slurry Generation System is shown in Table 3. For different concentrations of additives PG and MEG the COP of the system is between 4.29 to 4.84.

III. CONCLUSION

Following conclusions can be draw from the present research study:

1. A small scale scraped surface ice slurry generator test rig through commonly used cost effective manufacturing processes (employed by small and medium scale industries) is successfully fabricated for collection of ice slurry data. The present manufacturing technique can be extended for a higher capacity ice slurry generation machine suitable for industrial application.

2. Three distinct stages- cool down or chilling period, nucleation or unstable ice slurry generation period and stable ice slurry generation period were observed through historical time dependence curves.

3. The minimum ice slurry temperatures achieved are -3.1 ^{0}C, -6.4 ^{0}C and -11.0 ^{0}C at 10%, 20% and 30% PG concentrations, whereas with antifreeze MEG, lowest ice slurry temperatures achieved are -3.4 ^{0}C, -7.3 ^{0}C and -11.9 ^{0}C at 10%, 20% and 30% concentrations respectively.
4. It is observed that the freezing temperature reduces with increase in antifreeze mass fraction for PG and MEG.

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2. 'Heat Transfer and Pressure Drop Analysis in a Plate Heat Exchanger' in Proceedings of the 20th National and 9th International Conference ISHMT-ASME heat and Mass Transfer January 4-6, 2010, Mumbai, India.

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PAPER PRESENTED IN CONFEREHCE

!. Heat Transfer and Pressure Drop Analysis in a Plate Heat Exchanger' in 20th National and 9th International Conference ISHMT-ASME heat and Mass Transfer January 4-6, 2010, Mumbai, India.

2. 'Experimental Performance of an Indigenously Developed Scraped Surface Ice Slurry Generator for Refrigeration and Air-conditioning industry in 5th International Conference On Energy Research & Development (ICERD-5), 9-11 April,2012, State Of Kuwait.

RESEARCH WORK:

Working on a Research Project in the field of Ice Slurry Refrigeration System, the latest technology in Refrigeration and Air Conditioning field towards Energy Saving. funded by AICTE at Delhi College of Engineering, Delhi. Designing Ice Slurry generation machine (Theoretical design as well as the practical manufacture of machine). This machine will be used to produce Ice Slurry (small Ice Crystals). The Ice Slurry will be mixed with Chilled water and used for Central Air Conditioning plants. This will save energy in the Central Air Conditioning plants. Finally it is proposed to find out energy saving by flowing Ice Slurry water (A mixture of Ice Slurry and Chilled water) through Heat Exchanger by comparing the same by flowing only chilled water through the Heat Exchanger.

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PATENTS

1, 'Efficient Split Desert Cooler'-Published in Indian Patent Office, Application Number: 1997/DEL/2012.
2, 'Scraped Surface Ice Slurry Generator/Machine'-Published in Indian Patent Office, Application Number:
     513/DEL/2012.

ACHIEVEMENTS: AWARDS

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Implementation of Intelligent Controller for Single Phase Grid Connected PWM Inverter

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Abstract—Development of distributed generation system has resulted due to the ever growing demand of electrical energy. The main objective is coordinating the DG to the utility grid. PWM based Voltage Source inverters are mostly meant for synchronizing the utility grid to the distributed generation system. Following objectives are meant to be achieved for a grid connected PWM inverter in order to meet the growing energy demand:1) To ensure grid stability 2) Active and reactive power control through voltage and frequency control 3) Power quality improvement (i.e. harmonic elimination) etc. This paper will implement different control techniques for grid inverters systems. In this Fuzzy logic controller (FLC) is proposed to enhance the power quality by diminishing current error. An analysis of hysteresis controller is studied for providing control of a grid connected inverter. The hysteresis controller along with PI controller and Fuzzy logic controller is analysed for controlling the harmonic content in current. The studied system is modelled and simulated in the MATLAB/Simulink environment and the results obtained from hysteresis and fuzzy logic controllers are compared with conventional PI Controller.

IndexTerms—Grid, THD, Fuzzy, PIC, Hysteresis

I. INTRODUCTION

Distributed generation (DG) systems becomes more prominent in the world electricity market due to the increased demand for electric power generation, the deregulation of the electric power industry and the requirements to reduce the Greenhouse Gas Emissions etc.[1]. To meet the future energy demand of electricity Distributed Generations are the viable option as because it can provide a 1) secure and diversified energy options, 2) increase the generation and transmission efficiency, 3) reduce the emissions of greenhouse gases, and 4) improve the power quality and system stability. Inspite of the several advantages, the main technical challenge is the synchronization of the DGs with the utility grid according to the grid code requirements [2]. In most of the cases power electronics converter, especially current controlled PWM-VSI are used for the integration of the DGs with utility grid. The main objectives of the control of grid connected PWM-VSI are: 1) to ensure grid stability 2) active and reactive power control through voltage and frequency control 3) power quality improvement (i.e. harmonic elimination) etc.

Distributed generation systems and their interconnection should meet certain requirements and specifications when interconnecting with existing electric power systems (EPS). For an inverter-based distributed generator, the power quality largely depends on the inverter controller's performance. Pulse width modulation (PWM) is the most popular control technique for grid-connected inverters. As compared with the open loop voltage PWM converters, the current-controlled PWM has several advantages such as fast dynamic response, inherent over-current protection, good dc link utilization, peak current protection etc.[3]. Among the various PWM techniques, the hysteresis band current

control is used very often because of its simplicity of implementation. Also, besides fast response current loop, the method does not need any knowledge of load parameters. There are many researches in implementation hysteresis current control, for example in [4]-[7], but many have yet to implement together with the grid. For quick current controllability, unconditioned stability, good current tracking accuracy and easy implementation, the hysteresis band current control (HBCC) technique has the highest rate among other current control methods such as sinusoidal PWM. However, the bandwidth of the hysteresis current controller determines the allowable current shaping error. By changing the bandwidth, the user can control the average switching frequency of the grid connected inverter and evaluate the performance for different values of hysteresis bandwidth [5]. Inverters in DG applications constantly experience a wide range of dc input voltage variations, where the output voltage needs to be boosted up to a level compatible with ac grid [6].

The objective of this paper is to present an intelligent controller for a single phase grid connected PWM Inverter. The improvement in power quality is achieved by reducing the harmonic content in the current and compared by implementing two control schemes.

    i)   PI controller
    ii)   Fuzzy Logic Controller

A hysteresis controller is used in coordination with Fuzzy and PI controllers. The analysis of hysteresis along with these controllers is verified. The work is implemented in MATLAB/Simulink.

II. MODELING OF GRID

The number of distributed generation (DG) units, including both renewable and non-renewable sources, for small rural communities not connected to the grid and for small power resources (up to 1000 kW) connected to the utility network has grown in the last years. There has been an increase in the number of sources that are natural DC sources, for instance fuel cells and photovoltaic arrays, or whose AC frequency is either not constant or is much higher than the grid frequency, for instance micro gas-turbines. These generators necessarily require a DC/AC converter to be connected to the grid. Although some generators can be connected directly to the electric power grid, such as wind power driven asynchronous induction generators, there is a trend to adopt power electronics based interfaces which convert the power firstly to DC and then use an inverter to deliver the power to the 50Hz AC grid. It is well-known that for systems efficiency increasing, the inverter is the answer of the problem. By its control, the inverter can ensure the efficient operation and the accomplishment of the energy quality requirements related to the harmonics level.
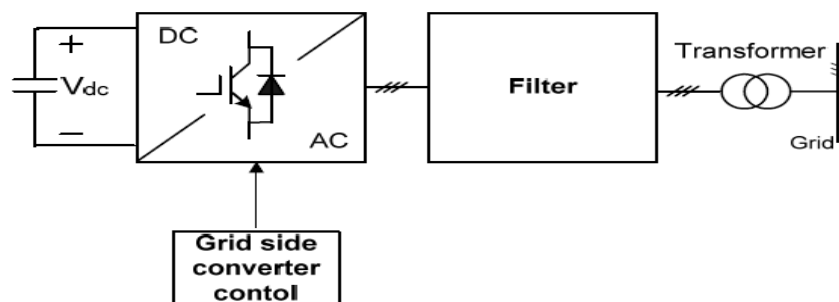
Fig.1. Layout of the model system

Power quality is important because many electric devices and appliances are designed to function at a specific voltage and frequency. In North America, AC (alternating current) power is delivered at 120 and 240 Volts and 60 Hz (cycles/second). If power is not delivered properly, it may result in appliance malfunction or damage. In the worst situation, fire hazard is a possibility.

A. Distributed Generation System

Distributed generation (or DG) generally refers to small-scale (typically 1 kW – 50 MW) electric power generators that produce electricity at a site close to customers or that are tied to an electric distribution system. Distributed generators include, but are not limited to synchronous generators,

induction generators, reciprocating engines, micro turbines (combustion turbines that run on high-energy fossil fuels such as oil, propane, natural gas, gasoline or diesel), combustion gas turbines, fuel cells, solar photo voltaic, and wind turbines.

B. Integration of DG System with the grid

For reasons of reliability, distributed generation resources would be interconnected to the same transmission grid as central stations. Various technical and economic issues occur in the integration of these resources into a grid. Technical problems arise in the areas of power quality, voltage stability, harmonics, reliability, protection, and control. Behaviour of protective devices on the grid must be examined for all combinations of distributed and central station generation. A large scale deployment of distributed generation may affect grid-wide functions such as frequency control and allocation of reserves.

III. CONTROLLER DESIGN

A. Hysteresis Controller

In this circuit single phase load is connected to the PWM voltage source inverter. The load currents ia, is compared with the reference currents $ia*$ and error signals are passed through hysteresis band to generate the firing pulses, which are operated to produce output voltage in manner to reduce the current error.
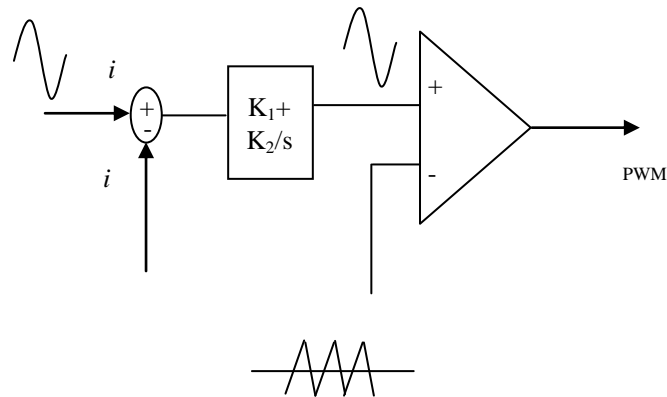
Fig.2. PWM obtained from hysteresis current control

B. PI Controller

In control engineering, a PI Controller (proportional-integral controller) is a feedback controller which drives the plant to be controlled by a weighted sum of the error (difference between the output and desired set-point) and the integral of that value. It is a special case of the PID controller in which the derivative (D) part of the error is not used.

The PI controller is mathematically denoted as:

$$P_{out} - P_O = K_P \left(e(t) + \frac{1}{T_i} \int e\, dt \right) \qquad (1)$$

The transfer function of a PI controller is:

$$H(s) = K_P \left(1 + \frac{1}{T_i s} \right) \qquad (2)$$

Where K_P the high frequency is gain of the controller and T_I is the integral time constant. Integral control action added to the proportional controller converts the original system into high order. Hence the control system may become unstable for a large value of K_p since roots of the characteristic eqn.

may have positive real part. In this control, proportional control action tends to stabilize the system, while the integral control action tends to eliminate or reduce steady-state error in response to various inputs. As the value of T_i is increased,

- Overshoot tends to be smaller
- Speed of the response tends to be slower.

C. Fuzzy Logic Controller

Fuzzy logic controller is used as an intelligent controller as one of methods used to control grid voltage and grid current. To eliminate the uneven switching frequency which cause noise, at the same time current error will be produced which produces more harmonic distortion in the output current the drawbacks of hysteresis current controller can be eliminated by Fuzzy Logic Controller.

Here the membership function is chosen as triangular as shown in fig. 3. The input is taken as error (e) and the change in error (Δe)

A 7*7 membership function having 49 rules are taken into account, shown in table 1. The rule base contains linguistic rules that are provided by experts. It is also possible to extract rules from numeric data. Once the rules have been established, the FIS can be viewed as a system that maps an input vector to an output vector.

TABLE I. RULE BASE
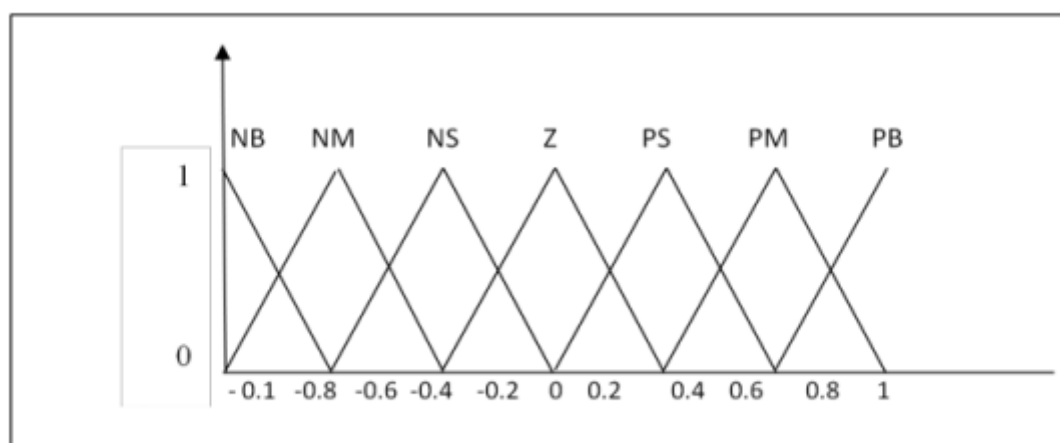
Fig.3 Membership function

NB	NB	NB	NB	NB	NM	NS	Z
NM	NB	NB	NB	NM	NS	Z	PS
NS	NB	NB	NM	NS	Z	PS	PM
Z	NB	NM	NS	Z	PS	PM	PB
PS	NM	NS	Z	PS	PM	PB	PB
PM	NS	Z	PS	PM	PB	PB	PB
PB	Z	PS	PM	PB	PB	PB	PB

IV. RESULTS

A. Analysis using Hysteresis Controller

In Fig. 4, the grid voltage, source current and load current is shown for a grid connected PWM inverter when controlled using a Hysteresis controller only. The source current shows higher content of harmonics. Our these results also match with the results obtained by Satyaranjan Jena et al [8].
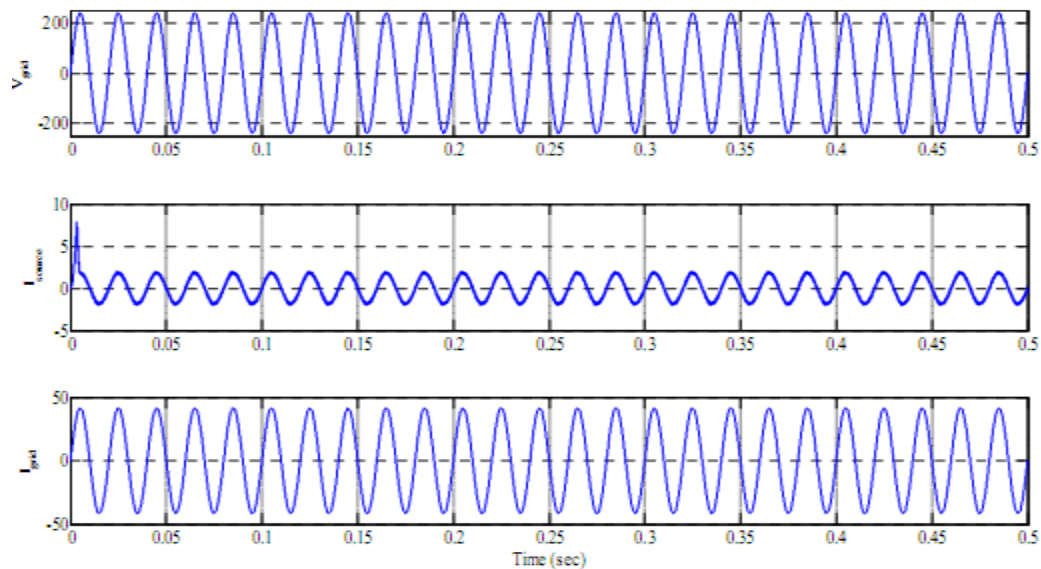
Fig.4 Grid voltage, source current and load current is shown for a grid connected PWM inverter when controlled using a Hysteresis controller
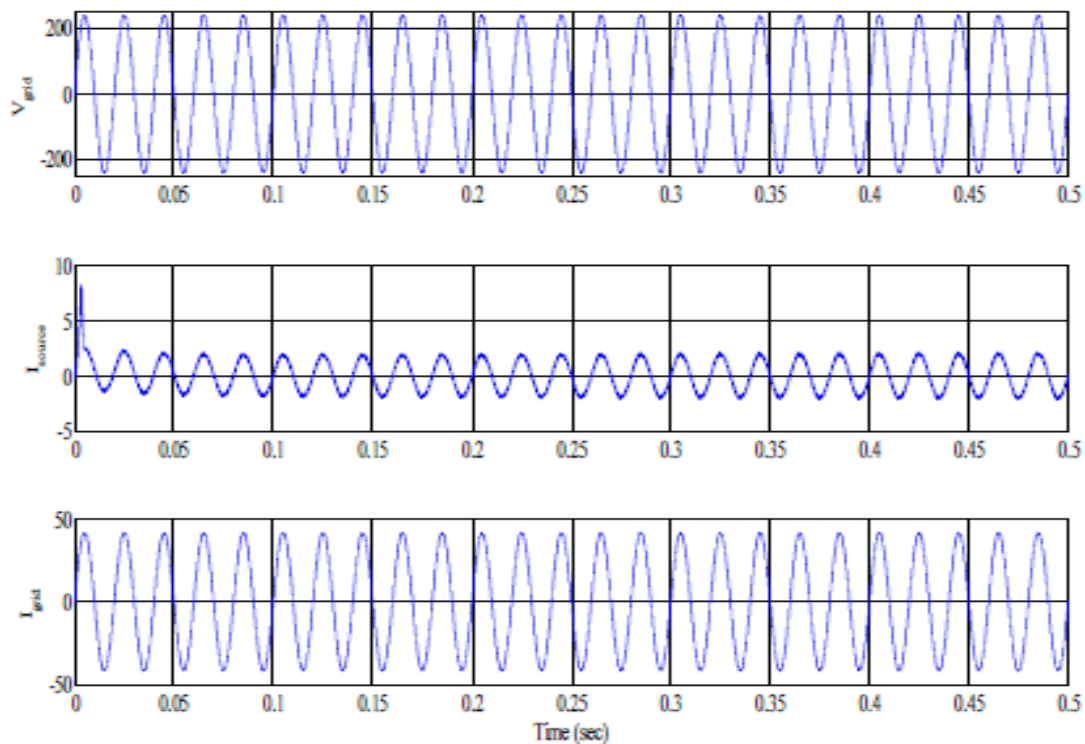
Fig.5 Grid voltage, source current and load current is shown for a grid connected PWM inverter when controlled using a PI controller

B. Analysis using PI Controller

In Fig. 5, the grid voltage, source current and load current is shown for a grid connected PWM inverter when controlled using a PI controller. The DC link to the Voltage Source inverter is fed through a diode bridge rectifier, where the source voltage is 415 V and grid voltage is 240 V. The source current can be observed, having been generated from Hysteresis controlled inverter, has a value of 2 Amps. The load current is very high about 40 Amps because of loading. The PI controller is tuned resulting in efficient control of the source current. Our these results also match with the results obtained by Satyaranjan Jena et al [8].
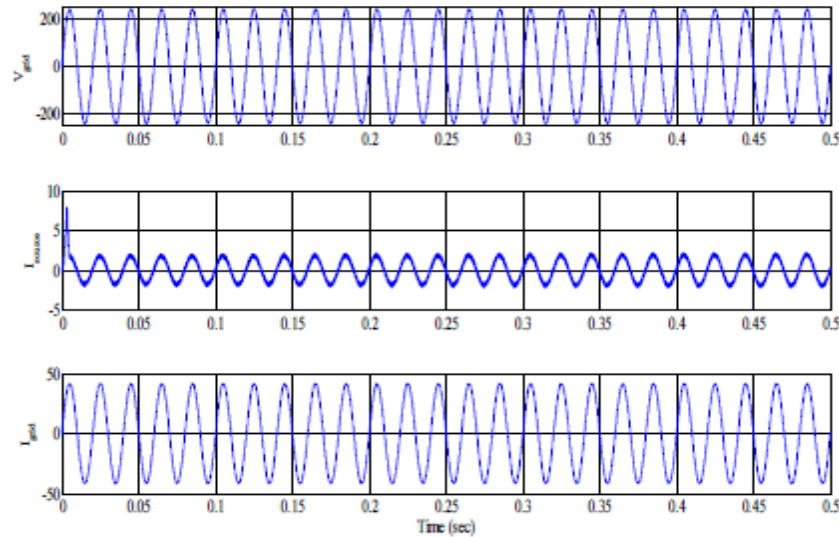
Fig.6 Grid voltage, source current and load current is shown for a grid connected PWM inverter when controlled using an FLC

C. Analysis using FLC

In Fig. 6, the grid voltage, source current and load current is shown for a grid connected PWM inverter when controlled using a FLC. The source current can be observed, having been pgenerated from Hysteresis controlled inverter, has a value of 2 Amps, having smoother and quicker response than Hysteresis Controller and Hysteresis plus PI controller. The load current is very high about 40 Amps because of loading. The FLC parameters are tuned resulting in efficient control of the source current. Our these results also match with the results obtained by Satyaranjan Jena et al [8].
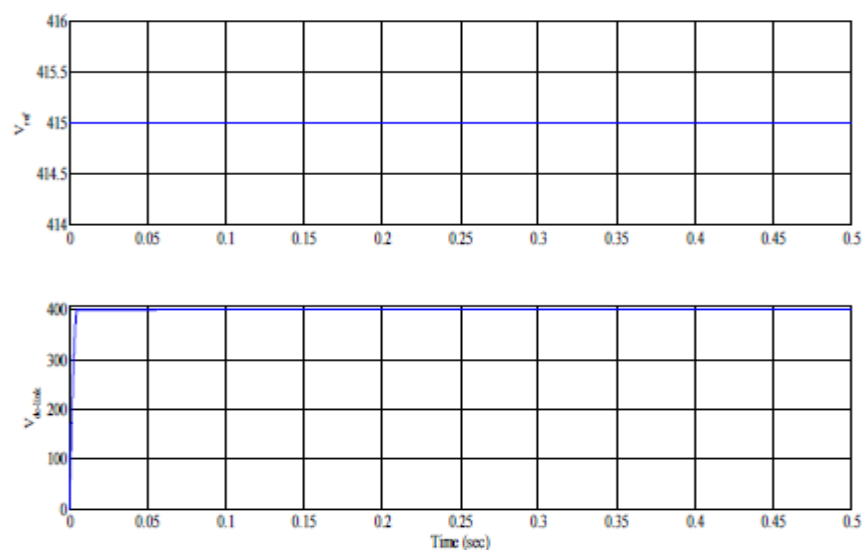
Fig.7 Reference voltage and source voltage

In Fig. 7, the reference voltage and the source voltage is shown. The reference was set at 415 V and the output from the capacitor is set to 400 V.

A) when $V_{grid}>V_{source}$
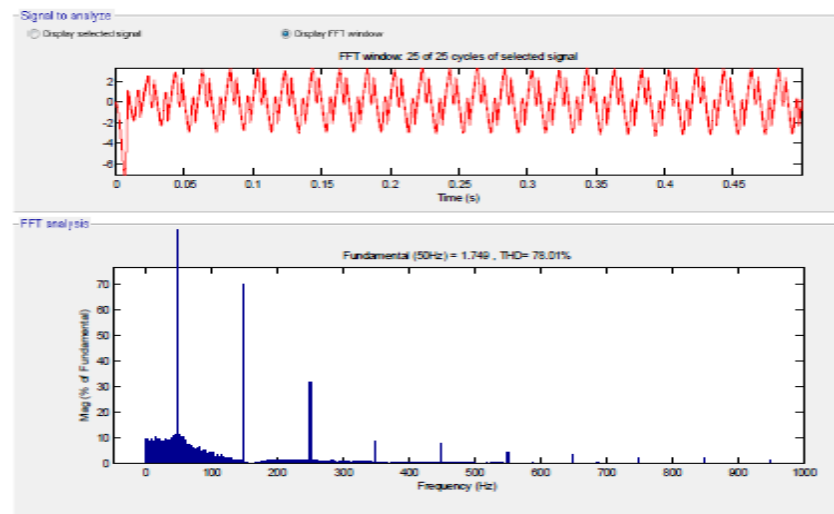
Fig.8 THD for grid connected inverter for $V_{grid}>V_{source}$

It can be seen from Fig. 8, for this case, the THD is very high, about 78%. In this case the harmonics are huge and distortion in current can be observed. So it is necessary that the proper values of grid voltage and source voltage are maintained.
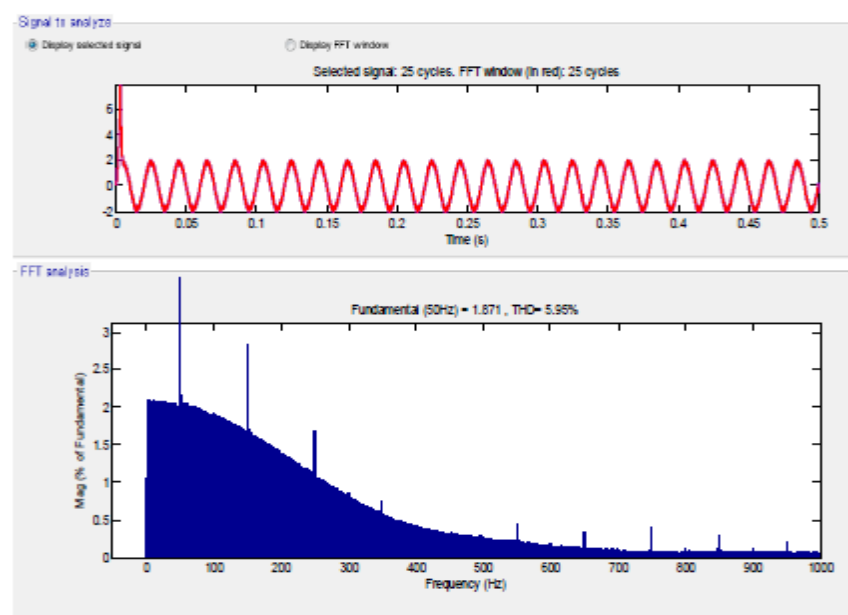
Fig.9 THD for grid connected inverter with hysteresis controller

B) THD of grid connected PWM inverter for hysteresis controller

In Fig. 9, the THD of grid connected PWM inverter is given. The hysteresis controller is able to reduce the current harmonics. The THD of a hysteresis only controller is about 5.95%.

C) When $V_{grid}<V_{source}$ controlled using Fuzzy plus Hysteresis controller

In this case, the THD is less about 4.75%, which is well below the IEEE recommended 5%. The harmonics are reduced. The magnitude of the harmonics can be seen from Fig. 10 and compared with Fig. 9. Also noting the harmonics in case of a hysteresis only controller, it can be observed that the Fuzzy Logic controller has resulted in better control of current as the harmonics have reduced.
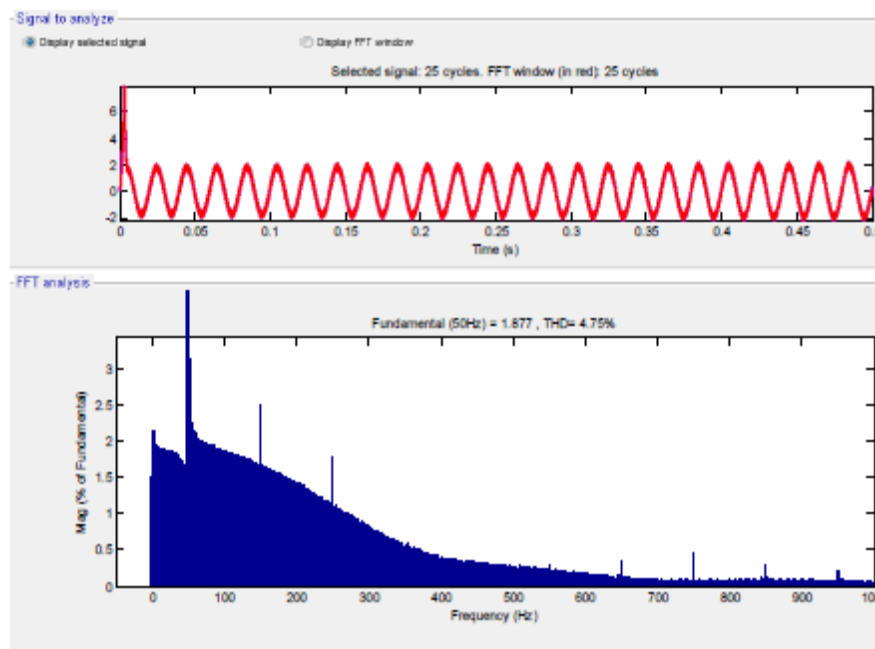
Fig.10 THD for grid connected inverter for $V_{grid}<V_{source}$

Fig.10 THD for grid connected inverter for $V_{grid}<V_{source}$

V. CONCLUSION

A detailed simulation study of a grid connected PWM inverter controlled through two control techniques in MATLAB/Simulink has been carried out is performed to understand the physical behavior of the system. The tuning of PI controller and FLC controller were carried out through simulation study and the necessary tuning parameters were determined. The performance of the controllers is observed in improving the power quality by reducing the harmonic content in the current. A grid connected PWM voltage source inverter using PI controller and Fuzzy logic controller along with hysteresis controller in the control loop is presented through this work and for the same simulation in MATLAB/Simulink is carried out. From this study we observed that, fuzzy logic controller with hysteresis current controller is able to enhance the power quality of the grid system as it has the capability to reduce the switching frequency even if the band width is increased without any significant increase in the current error. The THD obtained for intelligent controller is less than the Hysteresis Controller.

VI. ACKNOWLEDGEMENT

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APPENDIX
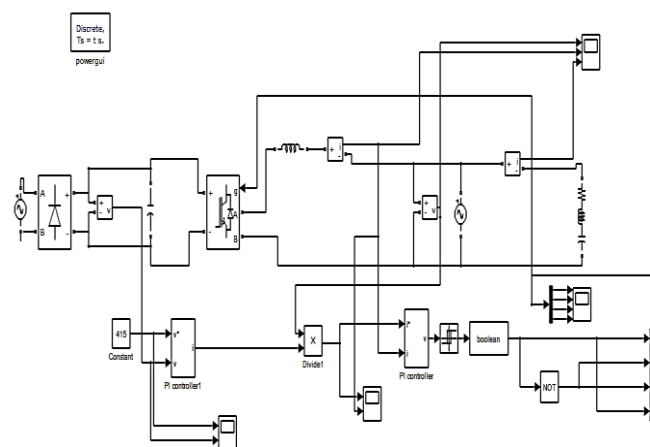
Fig.11 MATLAB Model of Control Strategy for Grid Connected Inverter using PI controller
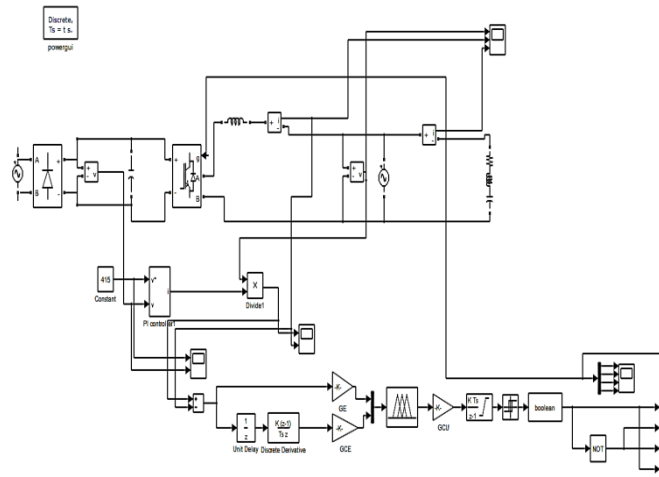
Fig.12 MATLAB Model of Control Strategy for Grid Connected Inverter using FLC

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From the Editor-In-Chief's Desk

We draw immense pleasure in presenting the first issue of International Journal of Research in Management & Social Science to provide a platform that stimulates and guides the intellectual quest of scholars. Under invulnerable patronage, with invaluable support of panel of referees and propitious contribution by authors, we are able to release the first issue of the journal and have applied for ISSN no at NISCAIR, New Delhi.

The articles presented in this issue address a variety of contemporary issues. The focus areas include: Financial Management, Consumer Behaviour and Satisfaction, Brand Strategies, Corporate Social Responsibility and Green Marketing. The topics related to financial management are mainly related to Taxonomy of Apparel Export, Investment choice of Individual Investors, Long term co integration of Stocks Traded and Impact of Profitability on working capital management.

We would like to express our gratitude to our esteemed contributors for their scholarly contributions to the Journal. Appreciation is due to the Editorial Advisory Board, the panel of Referees and the Management of the Institute for their constant guidance and support. Many faculty members from the Institute provided the necessary editorial support that resulted in enhanced reader friendliness of various articles, we are extremely thankful to all of them. We are also thankful to those who facilitated the designing of this Journal.

We shall continue our endeavor to harness the intellectual capital of scholars and practitioners of Management and Social Sciences and present to our valuable readers.

We have tried our best to put together all the articles, coherently. Suggestions from our readers for adding further value to our Journal are however, solicited.

Dr. Tazyn Rahman
Editor - In - Chief

CONTENTS

Research Papers

TAXONOMY OF APPAREL EXPORTS: INDIA VERSUS OTHER ASIAN EXPORTERS

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ABSTRACT

This paper focuses on a taxonomic investigation of apparel trade. Identification of the leading importers of garments in the world (at present USA), identification of major global apparel exporters, determining export routes to USA, checking position of India as an apparel exporting competitor to US, analyzing functional competency of garment exporting countries on apparel value chain and matching country specific competencies with their respective rank and market share in export to USA are the stages of taxonomic investigation. Asian countries like India, China, Bangladesh, Indonesia and Vietnam being major exporters of apparel to USA were found to have different positions in the value chain. This was found to have a close linkage with their share in the exports. India leads the other Asian countries except China in terms of value chain components being able to cover the whole of it. For comprehensive value chain advantage it faces stiff competition from China.

Keywords: World apparel trade, Asian garment exporters, taxonomy of garment exports, apparel value chain

INTRODUCTION

The exports basket of textile industry consists of a wide range of items comprising of readymade garments (RMG), cotton textiles, handloom textiles, man-made fiber textiles, wool and woolen goods, silk, jute and handicrafts including carpets. Among these, apparel is one of the oldest and largest export industries in the world. It includes manufacturing of readymade garments, women wear, shawls, menswear, ethnic garment, saris, shirts, leather garment, children clothing, t-shirts, silk garments, jeans, skirts and garment accessories. It is also one of the most global industries because most nations produce for the international textile and apparel market. The Multi-Fiber Arrangement (MFA), which established quotas and preferential tariffs on apparel and textile items imported by the United States, Canada, and many European nations since the early 1970s, was phased out by the World Trade Organization (WTO) between 1995 and 2005 via its Agreement on Textiles and Clothing. The concern of many poor and small developing economies that relied on apparel exports was that they would be pushed out of the global trading system by much larger, low-cost rivals, such as China, India, and Bangladesh. Moreover, the global recession that lasted for almost five years hit the apparel industry especially hard, leading to factory shutdowns, sharp increases in unemployment, and growing concerns over social unrest as displaced workers sought new jobs. These two crises have badly affected India too. Thus, as the world enters the new decade of revival from global crisis it becomes important to study the prominent players in the global apparel market and the position of India in it.

OBJECTIVE

Apparel industry is a typical industry where a complete process of production of the final product is not culminated by one single production unit, but is rather divided into various functions. A single garment exporting country may have expertise in one or more than one functional capability. Therefore, the objective of the current paper is to make a taxonomic investigation of textile trade by (1) identifying the leading importers of apparel in the world, (2) identifying who the major global apparel exporters, (3)

determining the number exporters to the world's largest importer, (4) checking the position of India as a apparel exporting competitor to the world's largest apparel importer, (5) studying the functional competency of apparel exporting countries on the apparel value chain and (6) matching country specific competency/ies with their respective rank and market share in export to the world's largest apparel importer.

LITERATURE REVIEW

For any country to try its hand at international trade, garment and apparel industry is often treated as a guinea pig, due to its low fixed costs and emphasis on labor-intensive manufacturing (Adhikari and Weeratunge, 2006; Gereffi, 1999). Apparel is one of the most protected of all industries, ranging from agricultural subsidies on input materials (cotton, wool, rayon) to a long history of quotas under the General Agreement on Tariff and Trade within the Multi-Fibre Arrangement(MFA) and its successor pact under the WTO, the Agreement on Textiles and Clothing (ATC) (Adhikari and Yamamoto, 2007). US, EU and Japan being the top three global apparel consumers in the world (Gereffi and Frederick, 2010), the MFA/ATC restricted exports to these markets by imposing country limits (quotas) on the volume of certain imported products. This step protected the US and EU garment manufacturers from highly competitive suppliers such as China (Thoburn, 2009).

The apparel supply chain is marked by substantial country specialization. While, higher income nations predominate in more capital-intensive segments, lower income countries dominate labor-intensive segments (Kilduff and Ting, 2006). Clothing assembly processes are sub-contracted to low-wage developing countries of Asian Pacific region and those countries that had unused export quotas, such as Bangladesh, Sri Lanka, and Vietnam (Gereffi, 1999; Audet, 2004). India is one of these countries where labor is cheap and easily available. Thus, India has become one of the major players in Asian Pacific and South Asian region in garment and apparel international trade. Therefore, the current paper focuses on examining the status of India as a garment and apparel exporting country.

RESEARCH METHODOLOGY

This analysis will be done by first identifying and shortlisting the top three garment importers of the world by comparing a country's garment import share to the world garment trade. Then the country that has maximum share has been identified as the world's leading garment importer. In the process, though EU has been identified as the world's leading garment importer, maximum garment exports of India are made to US. Therefore, a list of countries that export clothing and garment to US, which is also identified as world's second largest leading garment importer has been made. Then a further short listing the top five exporters with focus on South Asian countries has been done. These countries are bound to have some functional capability/ies in the apparel value chain. Therefore, a cross analysis of country expertise in garment trade has been done by comparing its functional capability in the apparel value chain to the country's respective market share and rank in being one of the exporters to the world's garment importing leader. To summarize, the paper is divided into three sections. The first section gives the details of the leading garment importers of the world. Sections two covers firstly, information regarding leading exporters of the world. Then a comparison of rank of these exporters to the world's largest or second largest garment importer, US is done. Further, the second section also highlights the position of India in the top 15 countries that export commodities to US, and India being one of them. On this basis, growth rate of Indian garment export is viewed and it is compared with that of leading Asian garment exporters like China, Bangladesh, Vietnam, Indoensia and Thailand. Finally, the third and the last section of this research paper, analyses and discusses the importance of value chain in promoting garment exports in comparison to reducing manufacturing cost and other factors affecting garment exports of a country. The terms apparel, garment and clothing have been used interchangeably in this paper.

Section 1
This section gives the details of the leading garment importers of the world.

Leading garment importers of the world
There are many countries that participate in textile and clothing trade at global level. However, EU, US and Japan are the countries that have major share in global garment trade. Table 1 shows the amount of import of top 10 importing countries of the world and their growth in share in world imports.

Table 1: Import Of Apparel By World Leading Apparel Importers															
Import Value in US $ Million and Share in World Imports in %															
Country	1980	1990	1995		2000		2005		2007		2008		2009		
	%	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	
World			162.9		208.9		291.2		291.2		375.6		337.4		
EU-27	-	-	74.2	45.5	83.2	39.8	131.5	45.2	165	56.7	179.9	47.3	160.1	48.5	
United States	16.4	24	41.4	25.4	67.1	32.1	80.1	27.5	84.9	29.2	82.5	22	72	21.8	
Japan	3.6	7.8	18.8	11.5	19.7	9.4	22.5	7.7	24	8.24	25.9	6.9	26	7.7	
Russian Federation	-	-	-	-	2.7	1.3	7.9	2.7	14.5	4.98	21.4	5.7	7.3	2.2	
Canada	-	-	2.7	1.7	3.7	1.8	6	2.1	7.8	2.68	8.5	2.3	8	2.3	
Switzerland	3.4	3.1	3.8	2.3	3.2	1.5	4.5	1.5	5.2	1.79	5.8	1.5	5.2	1.6	
UAE	0.6	0.5	1.3	0.8	-	0.4	1.8	0.6	5	1.72	5.5	1.5	3	0.8	
Australia	0.8	0.6	1.3	0.8	1.9	0.9	3.1	1.1	3.7	1.27	4.3	1.1	4.1	1.2	
Korea			1.1	0.7	1.3	0.6	2.9	1	4.3	1.48	4.2	1.1	3.4	1	
Norway			1.4	0.9	1.3	0.6	1.8	0.6	2.3	0.79	2.7	0.7	2.2	0.7	

Source: WTO 2010, Table II.71, Clothing imports of selected economies, 1990-2009

Table1 highlights that EU (27) has always been on the top list of world garment importers followed with US and Japan. Table 2 demonstrates growth in textile and clothing imports of US in 210-11.

Table 2: US Clothing Imports in 2010-11				
(Imports in US $ millions)				
Item	2011			2010
	May	April	Year-to-date	Year-to-date
Clothing	6669	6132	31733	27664

Textile Yarn Fabric	2135	1944	9527	8514
Total imports	190,730	180,530	886,400	745,855

Source: Exhibit 15 http://www.census.gov/foreign-trade/Press-Release/current_press_release/ft900.pdf

In 2009, North America was the only destination in the world where clothing was one of the top three import product groups in world's total merchandise trade (Source: WTO Secretariat). Neither, Europe, Japan or Middle East had garment or clothing in first three ranks of total merchandise exports. Table 2 shows approximately 15% growth of clothing imports by US in the current year, thus supporting the argument of US being the world leader in garment imports.

Section 2
Sections two covers firstly, information regarding leading exporters of the world. Then a comparison of rank of these exporters to the world's largest or second largest garment importer, US is done. Further, the second section also highlights the position of India in the top 15 countries that export commodities to US, and India being one of them. On this basis, growth rate of Indian garment export is viewed and it is compared with that of leading Asian garment exporters like China, Bangladesh, Vietnam, Indoensia and Thailand.

Leading garment exporters of the world
The removal of quotas on January 1, 2005 marked the end of over 30 years of restricted access to the markets of the European Union and North America. Retailers and other buyers became free to source textiles and apparel in any amount from any country, subject only to a system of tariffs and a narrow set of transitional safeguards that expired at the end of 2008. This caused a tremendous flux in the global geography of apparel production and trade, and a restructuring of firm strategies seeking to realign their production and sourcing networks to accommodate new economic and political realities (Gereffi, 2004; Rasmussen, 2008; Tewari, 2006). After the phase out of MFA and during the post ATC period, a considerable appreciation of readymade garment exports was seen in South Africa, Singapore, Australia, Malaysia, Kuwait and Brazil. However, South Asian countries like China, Bangladesh, India, Vietnam, Indonesia Thailand and Pakistan are the ones that rule the global garment export market and give a stiff competition to EU, US and Mexico. Table 2 supports these facts by demonstrating a decadal growth in the share of the leading garment exporters of the world.

Table 3: World's Leading Garments Exporters, 1995-2010																
(Value in US$ Millions, share in world exports in %)																
Country	1980	1990		1995		2000		2005		2007		2008		2009		2010
	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value
World		108.1		158.4		197.7		277.1		347.1		365		315.6		-
China	4	9.7	8.9	24	15.2	36.1	18.2	74.2	26.8	115.5		120.4	33.2	107.3	34	44485
Bangladesh	0	0.6		-	-	5.1	2.6	6.9	2.5	8.9	2.56	10.9	3	107.3	3.4	-
EU	-	-	-	48.5	31	56.2	29		31	105	30.37	114	31	96.8	31	-
Turkey	0.3	3.3	-	6.1	3.9	6.5	3.3	-	4.3	13.9	4	13.6	3.8	11.6	-	-
India	1.7	2.5	2	4.1	2.6	14.3	3	8.6	3.1	9.9	2.85	11.5	3	11.5	3.6	5827
Viet Nam	-	-	-	-	-	1.8	0.9	4.7	1.7	7.4	2.1	8.7	2.5	8.6	2.7	-
Indonesia	0.2	1.6	2	3.4	2.1	4.7	2.4	5	1.8	5.9	1.7	6.3	1.7	5.9	1.9	-

US	3.1	2.6	2	6.7	4.2	8.6	4.4		1.8	4.3	1.24	4.5	1.2	4.2	1.3	
Mexico	0	0.6	0.5	2.7	1.7		4.4		2.6	5.1		4.9	1.4	4.2	1.3	
Thailand	0.7	-	2.6	5	3.2	3.8	1.9	4.1	1.5	4.1		4.2	1.2	3.7	1.2	-

Source: Table II.69, (WTO, 2010); Leading exporters and importers of clothing, 2009, 2010 data is from
http://otexa.ita.doc.gov/tbrimp.htm

Table 3 emphasizes the position of China as the leading Asian garment exporter of the world. However, India has also gained a prominent position in this competitive race. From 1980, for almost two decades, India enjoyed the position of being top third global garment exporter. Then in the following decade its postion fell to number five. This was the time when World Trade Organization (WTO) phased out the quotas and preferential tariffs established under Multi Fiber Arrangement (MFA) through its Agreement on Textile and Clothing (ATC). This was the time when small countries like Thailand and Turkey with its low manufacturing cost power climbed the ladder up. But post 2000, India again gained it position back to number four and since then has remained the top five garment exporting country of the world. From Asian countries, it has great threat from China and Bangladesh as far as the export volume and share in world garment export is concerned.

But in a more focused way, the worries of India, China and Bangladesh would be to remain the top exporter of US, which is the single largest importer of textile and clothing (T&C) items. During the first 11 months of calendar year 2010, US observed a positive growth of 15.30% in its imports of T&C from the world and 18.10% from India, during the first 11 months of calendar year 2010. US being a leading importer of garments, it is necessary to know the competing countries that export goods to US. Table 4 shows the list of countries that have been the top 5 exporters to US in the last decade.

Table 4: Top 5 Clothing Suppliers for the United States, 1990-2006					
(Market Share in Parentheses)					
Year	First	Second	Third	Fourth	Fifth
1990	Hong Kong -16.10%	China -14.50%	South Korea -12.00%	Taiwan -9.70%	Philippines -4.10%
1991	Hong Kong -15.90%	China -15.00%	Taiwan -10.20%	South Korea -8.00%	Mexico -4.00%
1992	China -16.50%	Hong Kong -14.50%	Taiwan -7.90%	South Korea -6.80%	Mexico -4.40%
1993	China -18.00%	Hong Kong -12.30%	Taiwan -6.80%	South Korea -6.30%	Mexico -4.90%
1994	China -15.80%	Hong Kong -12.30%	Taiwan -6.00%	Mexico -5.70%	South Korea -5.60%
1995	China -13.30%	Hong Kong -11.30%	Mexico -8.00%	Taiwan -5.20%	South Korea -4.60%
1996	China -14.00%	Mexico -10.20%	Hong Kong -9.80%	Taiwan -4.80%	Dominican Republic (4.3%)
1997	China -14.00%	Mexico -12.10%	Hong Kong -8.40%	Dominican Republic (4.7%)	Taiwan -4.40%
1998	Mexico -13.70%	China -12.10%	Hong Kong -8.40%	Dominican Republic (4.4%)	Taiwan -4.10%

1999	Mexico -14.80%	China -11.90%	Hong Kong -7.70%	Dominican Republic (4.4%)	Honduras -3.90%
2000	Mexico -14.70%	China -11.30%	Hong Kong -7.10%	Dominican Republic (4.1%)	Honduras -3.80%
2001	Mexico -13.80%	China -11.90%	Hong Kong -6.70%	Honduras -3.80%	India -3.60%
2002	China -13.00%	Mexico -13.00%	Hong Kong -6.20%	India -4.00%	Honduras -4.00%
2003	China -15.60%	Mexico -11.20%	Hong Kong -5.40%	India -4.00%	Honduras -3.70%
2004	China -18.10%	Mexico -10.10%	Hong Kong -5.30%	India -4.20%	Honduras -3.70%
2005	China -25.70%	Mexico -8.70%	India -5.10%	Hong Kong -4.50%	Indonesia -3.70%
2006	China -29.10%	Mexico -7.40%	India -5.30%	Indonesia -4.40%	Bangladesh -3.50%

Source: Table 7, http://www.fas.org/sgp/crs/row/RL34106.pdf

Though India has been the top five garment exporter of the world, it success in being the top five exporter for US has culminated only after the year 2000. Tables 3 and 4, show that India has vehemently revived as a garment exporter after the year 2000. Both at global as well as at US level, the contribution of India as a garment exporter has shown a strong footing after the ATC. But along with India, the event of ATC also promoted other low-cost Asian rivals like China and Bangladesh. Yet, in the year 2010, India sustained the top 15 position as exporter to US while Bangladesh has failed to earn this position. Therefore, Bangladesh is a rival for India only for garment and clothing exports while China is a threat for all merchandise. Rank of countries exporting goods imported to US shown in Table 5, supports this argument.

Table 5: Country-Wise Imports (Goods) By US, Year-to-Date December 2010			
Rank	Country	Imports (Year-to-Date)	Percent of Total Imports
---	Total, All Countries	1,912.10	100.00%
---	Total, Top 15 Countries	1,433.80	75.00%
1	China	364.9	19.10%
2	Canada	276.5	14.50%
3	Mexico	229.7	12.00%
4	Japan	120.3	6.30%
5	Federal Republic of Germany	82.7	4.30%
6	United Kingdom	49.8	2.60%
7	Korea, South	48.9	2.60%
8	France	38.6	2.00%
9	Taiwan	35.9	1.90%
10	Ireland	33.9	1.80%
11	Venezuela	32.8	1.70%

12	Saudi Arabia	31.4	1.60%
13	Nigeria	30.5	1.60%
14	India	29.5	1.50%
15	Italy	28.5	1.50%
Source: FTDWebMaster, Foreign Trade Division, U.S. Census Bureau, Washington, D.C. 20233			

Table 5 highlights that India is recognized as one of the top 15 exporters to US. Apart from other goods, India has witnessed growth of 18.10% of clothing exports to US in the current year (WTO, 2010). Thus, it is noteworthy that India plays an important role as a client of US for general as well as textile and clothing exports. This also means that India should concentrate on growth of textile and garment industry as it plays a prominent role in world exports. Table 6 shows the growth of clothing exports from India in the last six decades.

Table 6: Decadal Growth of Exports of Garments from India			
(Value in Rs. Crores, Share in %)			
YEAR	VALUE OF ALL EXPORTS	VALUE OF GARMENT EXPORTS	SHARE OF GARMENT IN EXPORTS
1960-61	632	0	0.1
1970-71	1535	30	2
1980-81	6710	565	804
1990-91	32553	4593	14.1
2003-04	-	5786.37	-
2004-05	-	6034.39	-
2005-06	-	7752.44	-
2007-08	-	36497.8	-
2008-09	-	47112.8	-
2010-11	845533.64*	47608.39*	5.63
Source: EPW, XXVIII-35 (1993), P.M.-96 * Source: textile annual report 2010-11			
2003-04 onwards: Source: Foreign Trade Statistics of India (Principle Commodities and Countries) DGCI&S, Kolkata			

India's textiles and clothing industry is one of the mainstays of the national economy. It is also one of the largest contributing sectors of India's exports worldwide. As the world's second largest producer of textile and garments, India's garment exports totaled US$ 10.70 billion during FY 2009-10, giving an inevitable market share of 3.2%. Though EU, US and Japan rule the world as garment consumers, India's major garment export destinations are US, UK and UAE. (Source: http://www.aepcindia.com/advantage-performance.asp). The Americans, EU, much of Asia and Middle East are India's clients. The Apparel sector also contributes to 7% of India's total exports recording decline of 0.35% in 2009-10 against 2008-09 due to global recession. Apparel and cotton textiles products together contribute nearly 70% of the total textiles exports. By 2010-11, Readymade Garments accounted for almost 45% of the total textiles exports. The industry supports 7 million people as a part of its workforce and aims to double this figure by 2011-12 (Source: annual report 2010-11, ministry of textile, GOI).

Table 6 shows the growth in size of garment exports made by India in the last 10 years. It shows that growth of RMG has been 11 crores in 2008-09 while it witnessed a growth of only half a crore in last year. This shows that there is a strong competition from the world as well as the other South Asian

countries as far as manufacturing garments and exports to US is concerned. While Table 4 highlighted the global clothing suppliers of US, Table 7 throws light on the competing South Asian countries that exports garments to the world. Since the current study is based on studying the taxonomy of garment exports of India, therefore, the top competitors in exporting garments to US have been demonstrated in table 7.

Table 7: Asian Leading Exporters of Garments, 2010								
(Valye in US$ billion, Share in %)								
Country	1995		2000		2005		2008	
	Value	%	Value	%	Value	%	Value	%
World	158.4		197.7		277.1		361.9	
China	24	15.2	36.1	18.2	74.2	26.8	120	33.2
Bangladesh	-	-	5.1	2.6	6.9	2.5	10.9	3
India	4.1	2.6	6	3	8.6	3.1	10.9	3
Vietnam	-	-	-	-	4.7	1.7	9	2.5
Indonesia	3.4	2.1	4.7	2.4	5	1.8	6.3	1.7
Thailand	5	3.2	3.8	1.9	4.1	1.5	4.2	1.2
Source: (WTO, 2010); Apparel exports represented by SITC 84								

Table 7 highlights that, after the year 2000, India has moved up in the competition of being a leading country for garment as well as other exports to US. However, China has remained on the top of garment exports the world over. To review this analysis, the following section discusses country competencies in apparel value chain and their performance with respect to growth in market share in garment exports to US, the world leading garment importer.

Section 3
The third and the last section of this research paper, analyses and discusses the importance of value chain in promoting garment exports in comparison to reducing manufacturing cost and other factors affecting garment exports of a country.

Global apparel global value chain
The world apparel trade is not only dependent on cost and technology, but more on its value chain. Gereffi and Frederick (2010) have done a very comprehensive study on global apparel value chain which is reproduced in Figure 1. In the apparel value chain, there are three main types of lead firms (retailers, brand marketers, and brand manufacturers), which are highlighted in Figure 1. These firms involve in various activities like design, marketing, consumer services, and logistics. Firms in various countries try to specialize in one or more than one of these activities to be a part of the apparel value chain.
Figure1: Global Apparel Value Chain
Source: Gary Gereffi and Stacey Frederick (2010), The Global Apparel Value Chain, Trade and the Crisis: Challenges and Opportunities for Developing Countries.
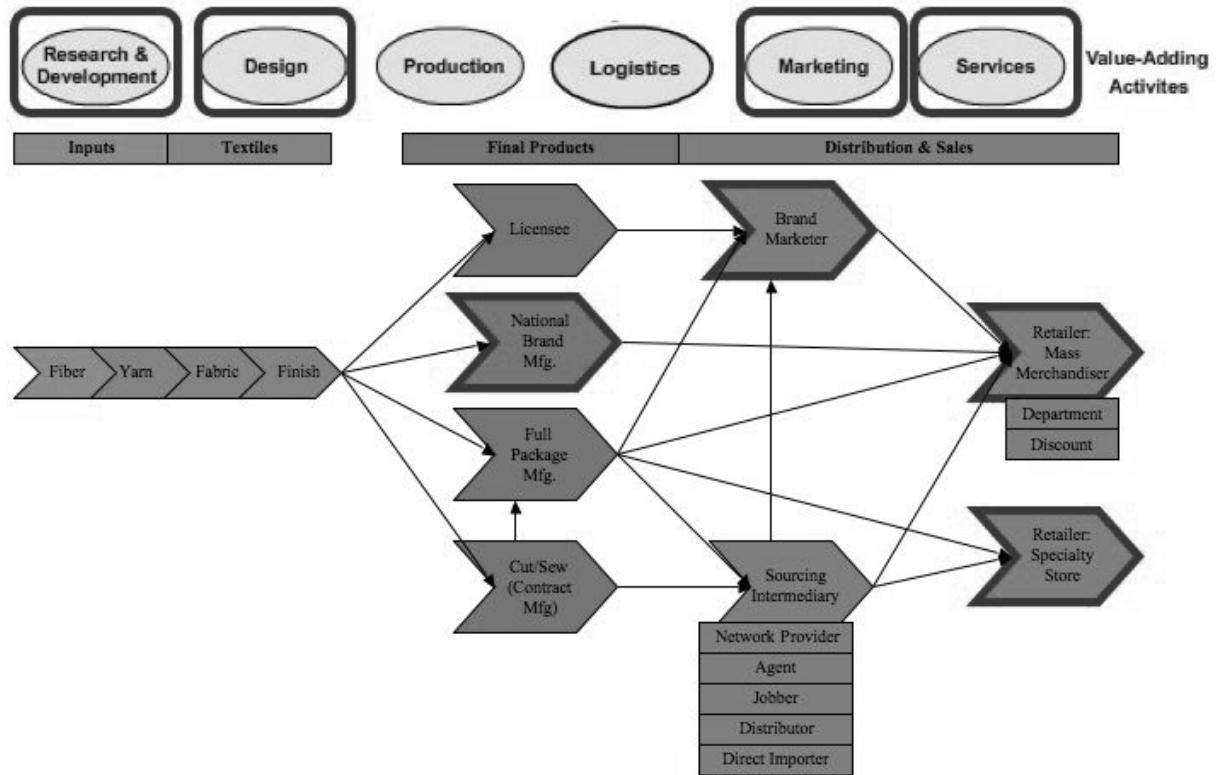
The garment manufacturing process begins with clothing design, including fabric selection and the purchase of supplies. As a concept, garment manufacturing is rather broad. The garment manufacturing process is how companies make clothes, and what transforms designers' ideas into everything from the season's newest must-have pieces to basic wardrobe staples. It incorporates essentially every element of apparel manufacturing. The point to be noted here is that no single country or manufacturer who gets themselves involved in the entire cycle of garment manufacturing process. They most of the times involve in any one of the many assemblies of the garment manufacturing process by taking contract manufacturing of that process. For example manufacturers of a particular country may only specialize in cutting or sewing activity of the entire process. This activity may be subcontracted by the garment manufacturer or some other country who may export the final product to leading garment importer. A clearer idea of garment manufacturing assembly lines and respective specializing countries can be gained from Table 8.

Table 8: Country Capabilities and Garment Manufacturing Assembly Lines			
Functional Capabilities	Supplier Tier	Recommendations; Key Facilitators	Country Examples
Cut, Make, Trim CMT (Assembly)	Marginal Supplier	Promote upstream FDI. Government and regional organizations. Lead firm to commit to long-term supply.	Cambodia, SSA, Caribbean, Vietnam
Package Contractor (OEM): Sourcing	Preferred Supplier	Invest in machinery and logistics technology. Private investment.	Bangladesh Indonesia

	Niche Supplier	-	Sri Lanka, Mexico
Full Package Provider / Original Design Manufacturing (ODM)	Strategic Supplier	Next step: enter new emerging markets as a lead firm	Turkey, EU, India, China
Service Providers	Coordinators and Foreign Investors	-	Hong Kong, South Korea, Taiwan, Singapore, Malaysia
Source: Gary Gereffi and Stacey Frederick (2010), "The Global Apparel Value Chain, Trade and the Crisis: Challenges and Opportunities for Developing Countries". The World Bank Development Research Group, Trade and Integration Team			

Table 8 shows that countries like Vietnam, Bangladesh and Indonesia specialize more in subcontracted jobs or activities of the apparel value chain. Yet their exports of garments are very high. This means they may export more of ancillary items of clothing or garment accessories like labels, collars, pockets, packaging etc. On the other hand, China and India involve in more number of activities of the apparel value chain and may also provide the full package, right from manufacturing raw material to making a complete readymade garment.

Table 9 highlights the production capabilities of these countries with their exports to US in the year 2009-10.

Table 9: US Apparel Imports from India, China, Bangladesh, Indonesia and Vietnam 2009-10													
US Apparel Imports from Selected Countries by Merged Categories, 2009-10													
Data in Dozen													
Code	Category	India		China P		Bangladesh		Indonesia		Vietnam		World	
		2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
330/630	Handkerchiefs	NA	NA	6457154	7155701	NA	NA	NA	NA	NA	NA	6993966	7473798
331/631	Gloves & Mittens	NA	NA	37629386	46932160	456433	1014927	2004591	3362650	719127	973095	54932778	71250645
334/634	Coats	280750	253728	9596500	11090756	1307776	1553542	821124	1252859	1789665	2202843	18289981	20929431
335/635	Coats	499750	455893	15857314	15985428	876836	1011561	2118900	2656522	3861761	4257410	27780394	29719405
336/636	Dresses	3472747	3985116	19166035	22634405	972460	1380357	2187141	2779949	4146602	4775676	36079851	42333017
338/339	Cotton Knit Shirts	19536710	22333897	57409307	74991312	17324679	17771693	29236995	33150923	37546697	42354308	383062771	429190972

Code	Item												
340/640	Non-Knit Shirts	2109123	2548250	9578128	12781988	7209045	9354534	2970675	3868786	2828580	3525124	34033822	42264066
341/641	Non-Knit Blouses	5371584	6277314	20158530	20776295	2498862	2949050	4693943	4938919	2239661	2629126	39993563	42632244
342/642	Skirts	1954777	1539339	6674157	7007926	1163323	809192	1536022	1865888	1592781	2143184	15842705	16321403
347/348	Cotton Trousers	6002187	5209329	47124518	61570308	26498878	29098067	9894178	11272395	14626339	16172015	175522170	196190708
349/649	Brassieres	457259	588962	25822325	31990530	2785512	3247901	4379066	4839590	157390	192452	45714304	55111313
350/650	Dressing Gowns	635124	632675	7657945	9022776	212436	190980	657594	525581	1737098	1790369	12856000	14304416
351/651	Cotton and MMF Night	1356150	1408846	19558469	21524826	1735487	1936095	671658	851633	1123855	1556594	31995100	36091766
352/652	Underwear	17863634	21643420	34481641	53118232	18408554	21332283	NA	NA	14933594	23478953	231051422	289208738
445/446	Wool Sweaters	NA	NA	1944037	2528079	32628	24309	14305	5822	NA	NA	2205589	2758726
638/639	M-MF Knit Shirts	NA	NA	22602585	28773963	714453	1496127	5227641	6035543	8734387	9812440	84642274	104140659
645/646	M-MF Sweaters	NA	NA	3010294	3232754	918526	981060	178289	162914	NA	NA	4799099	5064325
647/648	M-MF Trousers	NA	NA	11378400	15757910	3309881	4582189	4794316	5957546	5632221	7076222	50961211	61482680
845/846	Sweaters - Silk & VE	NA	NA	617313	535537	NA	NA	NA	NA	NA	NA	641535	554258

Source: Table 4.3.1(a): 4.3.1(a): Impact of Economic slowdown on Indian Textile and Clothing Industry, A Study assigned by CITI, Texprocil, AEPC and SRTEPC. June 2009.

Table 9 emphasizes that as countries such as China, Turkey, and India develop capabilities that permit vertical integration in apparel, their reliance on apparel exports tends to diminish because their upgrading

processes facilitate broader industrial diversification. This argument can be supported by looking at the high export dependence ratio of Cambodia (85%), Bangladesh (71%) and Sri Lanka (41%) (see Gereffi and Frederick, 2010). These countries concentrate on CMT and have limited full-package capabilities unlike China and India.

CONCLUSION

Analysis of table 8 and 9 emphasizes that though Vietnam is a marginal garment supplier and having an expertise of only assembly lines like cut, make and trim, it covers a share of 8.38% in 2010 in world garment exports and manufactures 20% of the total exported garment categories. Its apparel export dependence ratio is relatively low because of the importance of its agricultural exports (Gereffi and Frederick, 2010). Comparatively, countries like Bangladesh and Indonesia; exports larger garment categories because it has moved from assembly to original equipment manufacturing (OEM) production. It means these countries are evolving from being just labor intensive to being technology oriented too. This may be because countries specializing in OEM may not want to invest in design and infrastructure but just make a product according to the design specified by the buyer and sells the product under the buyer's brand name. Countries like Bangladesh and Indonesia became full range 'package suppliers' for foreign buyers like US with no control over distribution but share in world garment imports to US to be 6.7% and 5.7% respectively in 2010.

On the other hand, India has moved up the value chain. Its functional capability in an apparel value chain has moved beyond from being just a marginal supplier for assembling jobs or being a preferred supplier of foreign owners for outsourced jobs requiring uniform bulk production to becoming a strategic supplier where leading importers like US place full package orders. After the global slow-down, leading Asian apparel suppliers like China and India, began to focus more on sales to their domestic market. This step allowed them to accelerate the upgrading process associated with moving beyond assembly and full-package supply to original design manufacturing (ODM) and original brand manufacturing (OBM) (Gereffi and Frederick, 2010).

With the help of focus on garments in textile policy, government support and technology assistance too, exporters of India seem to have evolved to be original design manufacturers and strategic suppliers in the apparel value chain. The growth of share of India in world garment exporters to US from 4% in 2009 to 5% in 2010 supports the argument of upward move of India in the apparel value chain. However, though China falls in the same category as India in this value chain, its share in world garment export to US is tremendous. Both China as well as India has the capability to manufacture full package in apparel. The difference is that China has 45% foreign direct investment ownership in apparel sector and hardly 2% of state owned enterprises, while in India, there is a huge dominance of local firms. Most of the foreign firms are in the form of a joint venture. Therefore, China is largely involved in upgrading to higher-end clothing, is a primary supplier to global buyers and its major buyers have local sourcing offices. This has allowed China to be a part of OBM too. China's success in the world apparel market is also reflected in the fact (from Table 9) that it exports all the 24 categories of garment while India only deals with 12 categories. Therefore, China has shown more market share in South Asian exporting countries and also been on the top as far as world export market is concerned. Moreover, China charges a VAT of 17% at every level of the production process and the final product, but firms exporting a product can receive VAT export rebates on finished and input products. Due to decreases in export demand and increasing domestic production costs (currency and labor), China progressively increased VAT export tax rebates a total of five times for Textile and Clothing (T&C), three times in 2008 and twice in 2009. Chinese clothing manufacturers can now claim a rebate up to the 17% ceiling. Now, the government of China is targeting average textile production growth of 10% each year and export growth of 8% annually to reach US $240 billion by 2011. Therefore, in order to beat China, India has to first widen the span of categories

in which in deals for exporting and then concentrate on garment exporting policy in particular. As compared to China, India has an advantage of product diversity, huge demand in domestic market, and cost, speed and flexibility advantages as it can cater to buyers' requirements for small customized orders as well as large orders. Yet India lags behind China in garment exports due to procedural hurdles in international trade, lack of scale economies (80% of T&C units are small, cottage-like typically employing less than 11 workers with only 6% with over 49 employees), more inflation in raw material costs as compared to China, higher manufacturing cost (includes power, operating, and transactions costs) as compared to China. China's increasing manufacturing cost is limited to a couple of factors like energy and shipping, which is easier to manage than managing to reduce costs of more than two factors (Gereffi and Frederick, 2010). Moreover, the most valuable activities in the apparel value chain are not related to manufacturing only but are found in design, branding and marketing of the products. Therefore it looks easy for China to evolve in the apparel value chain and sustain its position as top garment exporter for US as well as world. Though India is in the same category of apparel value chain, its position as garment exporter in world market is still 14th, and for US it is still 3rd lead by China and Mexico.

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A STUDY OF INVESTMENT CHOICE OF INDIVIDUAL INVESTORS IN VALSAD DISTRICT

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ABSTRACT

A study of 200 respondents revealed that though majority have preferred low risk investments, considerable number have gone for high risk investments. This could be because of the awareness created among Indian individual investors regarding investment avenues and investment climate. The study also indicated that the association between profile of the respondents-age, gender, religion qualifications, income and profession, and the risk taken while making investments is not significant. The existing "Behavioral Finance" studies are very few and very little information is available about investor perceptions, preferences, attitudes and behaviour. An effort in this direction is fragmented.

Keywords: Low Risk, Investment Avenues, Behavioral Finance, Investors Perception

INTRODUCTION

Indian investors still prefer safety and liquidity to returns. The number of investors putting money in equity and mutual funds has shown a steep decline, according to a survey conducted by market regulator SEBI and NCAER in 2005. It is believed that the average Indian investor still prefers low risk, high safety and liquidity to returns. With the growing regulatory role of SEBI, growth of financial institutions, and investor education, there seems to be a change in the mindset of individual investors. The existing "Behavioral Finance" studies are very few and very little information is available about investor perceptions, preferences, attitudes and behaviour. An effort in this direction is fragmented. Investors find "Bank Fixed Deposits" the safest among all. Equity shares, Mutual Funds and Debentures were regarded unsafe. Investors rack confidence in Equity Markets. Special efforts would have to be made for creating greater investors awareness through investors, education and developing the infrastructure, which allows for easy access to the market.

REVIEW OF LITERATURE

George and Alok (2009)[i] found that older and experienced investors' intent to diversify, trade less frequently, exhibit weaker disposition effect and familiarity bias, and their trading activities are more sensitive to taxes. Sharma, Vivek; Hur, Jungshik; Lee, Heiwai (2008)[ii] designed a metric to measure the net buying and selling by institutions and individual investors and found that from the year ISSO to 2004 institutional investors were net buyers of growth stocks and net sellers of value stocks, implying that individual investors were net buyers of value stocks and net sellers of glamour stocks. Pradeep (2007)[iii] found that investors who were in the middle age group, had higher qualifications, held fewer securities in their portfolio, most invest for the long term, use all the share index to compare performance and feel that they could achieve a much higher return on their investment than previously. Bailey, Warren, Alok and David (2007)[iv] found that wealthier, more experienced investors enjoy an informational advantage and thus, are more likely to invest overseas and experience good portfolio performance; other investors appear to venture abroad for the wrong reasons. Sharma and Sharma (2004)[v] indicated that they are young, well informed, and also trade regularly. Lipe, (I998)[vi] revealed that respondents perceived different levels of variance as well as covariance of returns although they usually employed only variance in risk assessment. Most of the studies have concentrated on institutional buyers, motivational factors influencing individuals in their investment decisions and profiles of individual investors. Lppolito[vii] (1992) says that fund/scheme by investors is based on past performance of the funds and money flows into winning funds more rapidly than they flow out of losing funds. Goetzman[viii] states that there is evidence that investor psychology affect fund/scheme selection and switching. De Bondt and Thaler[ix,x] (1985) while investigating the possible psychological basis for investor behaviour, argue that mean reversion in stock prices is an evidence of investor over reaction where investors overemphasize recent firm performance in forming future expectations. Gupta L.C[xi] (1994) made a household

investor survey with the objective to provide data on the investor preferences on Mutual Funds and other financial assets. The findings of the study were more appropriate, at that time, to the policy makers and mutual funds to design the financial products for the future. Kulshreshtha[xii] (1994) offer certain guidelines to the investors in selecting the mutual fund schemes. Shanmugham[xiii] (2000) conducted a survey of individual investors to study the information sourcing by investors, their perceptions of various investment strategy dimensions and the factors motivating share investment decisions, and reports that among the various factors, psychological and sociological factors dominated the economic factors in share investment decisions. Shankar[xiv] (1996) points out that the Indian investors do view Mutual Funds as commodity products and AMCs, to capture the market should follow the consumer product distribution model. Anjan Chakraborthy and Harsh Rungta[xv] (2000) stressed the importance of brand effect in determining the competitive position of AMCs. Their study reveals that brand image factor, though cannot be easily captured by computable performance measures, influences the investors perception and hence his fund/scheme selection. Madhusudan V Jambodekar[xvi] (1996) conducted a study to assess the awareness of MFs among investors, to identify the information sources influencing the buying decision and the factors influencing the choice of a particular fund. The study reveals among other things that Income Schemes and open ended schemes are more preferred than Growth Schemes and Close Ended Schemes. During the then prevalent market conditions. Investors look for safety of Principal, Liquidity and Capital appreciation in the order of importance; Newspapers and Magazines are the first source of information through which investors get to know about MFs/Schemes and investor service is a major differentiating factor in the selection of Mutual Fund Schemes.

OBJECTIVES
The objectives of the study are as follow:
1. To identify the risk taken by individual investors while making investments.

2. To examine the association between the demographic profile of the investors and the risk taken by them.

METHODOLOGY
The present study is based on primary data collected from 200 respondents using a questionnaire. The investments are categorized as low risk, medium risk and high risk investments. The investments in post office savings, gold, land, flat, insurance and fixed deposits in nationalized banks were considered as low risk investments. The fixed deposits in other than nationalized banks, mutual funds and debentures where a higher interest can be gained were considered as medium risk investments. Shares in reputed companies, and upcoming sectors were considered as high risk investments. The investor is considered as low risk, medium risk and high risk based on the highest mean scores he/she is securing. For the purpose of finding association between the profile of the respondent and risk, chi-square has been used with the help of SPSS package.

PROFILE OF THE RESPONDENTS
Analysis of the profile indicates that the age group of above 20 years and below 30 years constitutes the largest group amongst the respondents. It accounted for 46 per cent of the sample followed by above 40 years and below 50 years category which accounts for (18.8 per cent) and above 50 years and below 60 years (f4.5 per cent) class. Classification based on gender indicates that a little more than two thirds are males. Qualification wise, the profile shows that graduates constitute the major chunk of the sample followed by post-graduates. Further, the classification indicates that professionals - graduates and post-graduates constitute a significant proportion. Profession-wise classification indicates that majority of the respondents are from the BPO industry (83 per cent). Income-wise analysis reveals that one third of the respondents has income between Rs.1,50,000 to Rs. 3,00,000. This is followed by the group with income below Rs. 1 ,50,000 group and the group with income above Rs. 3 lakhs and below Rs. 5 lakhs. Religion wise it could be observed that more than 72 per cent are Hindus, followed by Christians (16.2 per cent), Muslims (7.7 per cent) and Sikhs (3.4 per cent).

RESULTS

Table 1: Individual investor's investments

Investment Category	Frequency	Percent	Valid Percent	Cumulative Percent
Low Risk	59	50.4	50.4	50.4
Moderate Risk	15	12.8	12.8	63.2
High Risk	43	36.8	36.8	100.0
Total	117	100.0	100.0	

Source: Primary Data

Individual Investors Investments: A little over 50 per cent of the respondents h4ve made low risk investments (Table l). More than one third of the respondents have gone for high risk investments. The respondents who have gone for moderate investments constitute 12.8 per cent of the sample. Thus, it may be observed that the respondents have inclination towards either low risk or high risk instruments.

Age and Choice of Investment: It may be observed that except in the case of the group below 20 years, all other groups indicate that their preference is either low risk instruments followed by high risk instruments (Table 2). The group of respondents below 20 years of age indicated that their preferences is moderate risk (44.4 per cent) followed by high risk (33.3 per cent) instruments. Further, it may also be observed that a large number of respondents (more than 59 per cent) belonging to the age group of above 40 years have made investments in low risk investments. The chi-square value of 14.358 at 10 degrees of freedom between age and investments indicates that it is not significant as the p value is 0.157.

Gender of the Respondents and Choice of Investments: An analysis based on Gender of the respondents' shows that majority of the male members (54.3 per cent) have gone for low risk investments compared to women. It may also be observed that more number of women respondents constituting 47.2 per cent have gone for high risk investments compared to men (32.1 per cent). Regarding moderate risk investments the percentage of men is more compared to women. The chi-square test also shows that the association between gender and risk taken while investing is not significant.

Table 2: Profile of Investors

	Low Risk	Moderate Risk	High Risk	Total
Age				
Below 20 Years	22.2	44.4	33.3	100.0
Above 20 and Below 30 Years	44.4	11.1	44.4	100.0
Above 30 and Below 40 Years	50.0	8.3	41.7	100.0
Above 40 and Below 50 Years	59.1	13.6	27.3	100.0
Above 50 and Below 60 Years	70.6	5.9	23.5	100.0
Above 60 Years	66.7	0.0	33.3	100.0
Total	50.4	12.8	36.8	100.0
Chi-square		14.358		
Df		10		
P		0.157		
Gender				
Male	54.3	13.6	32.1	100.0
Female	41.7	11.1	47.2	100.0
Total	50.4	12.8	36.8	100.0
Chi-square		2.461		
Df		2		

P		0.292		
Qualification				
Below Graduation	60.9	17.4	21.7	100.0
Graduates (Professionals)	39.4	9.1	51.5	100.0
Graduate (Other than Professional)	48.1	22.2	29.6	100.0
Post-Graduates (Professionals)	61.9	4.8	33.3	100.0
Post-Graduates (Other than Professionals)	46.2	7.7	46.2	100.0
Total	50.4	12.8	36.8	100.0
Chi-square		9.962		
Df		8		
p		0.268		
Profession				
Teaching	50.0	0.0	50.0	100.0
Accounting	50.0	12.5	37.5	100.0
Software professional	40.0	0.0	60.0	100.0
Associates in BPO	51.0	14.3	34.7	100.0
Total	50.4	12.8	36.8	100.0
Chi-square		2.826		
Df		6		
p		0.83		
Income (PA)				
Below Rs.150,000	55.9	17.6	26.5	100.0
Above Rs.1500000 to RS.300,000	35.9	10.3	53.8	100.0
Above Rs.300,000 to Rs.500,000	45.8	16.7	37.5	100.0
Above Rs.500,000 to Rs.750,000	78.6	7.1	14.3	100.0
Above Rs.750,000 to Rs.900,000	66.7	0.0	33.3	100.0
Total	50.4	12.8	36.8	100.0
Chi-square		12.687		
Df		8		
p		0.123		
Religion				
Hindu	49.4	12.9	37.6	100.0
Muslim	44.4	11.1	44.4	100.0
Christian	57.9	10.5	31.6	100.0
Sikh	50.0	25.0	25.0	100.0
Total	50.4	12.8	36.8	100.0
Chi-square		1.306		
Df		6		
p		0.971		

Source: Primary Data

Qualifications of the Respondents and Choice of Investments: Investments based on the qualification of the respondents show that a vast majority of the respondents (more than 60 per cent) belonging to the category of below graduation and post graduates (professionals) have gone for low risk investments (Table 2). Majority of graduates (professionals) have gone for high risk investments. Further, it may be noted that there is no consistent pattern in investments based on the qualifications of the respondents. The chi-square test indicates that the association between qualification and investment risk is not significant.

Profession of the Respondents and Choice of Investments: The majority of respondents are working as the associates in BPO services (Table 2). It may be observed that majority have gone for low risk investments followed by high risk investments and medium risk investments. Same trend maybe observed even in other categories.

Teachers, have preferred low risk and high risk investments equally. The chi-square test indicates that the association between profession of respondents and their choice of investments is not significant.

Income of the Respondents and Choice of Investments: The table 2 shows that except the categories with income above Rs.1.5 lakhs to 3 lakhs and, above Rs.3 lakhs to 5 lakhs, in all the remaining categories a large majority of them have preferred low risk investments. In the case of the group with income of Rs. l.5lakhs to Rs.3lakhs majority of them have gone for high risk investments. The same trend of low risk investments, high risk investments and medium risk investments are continued in almost all the categories. The chi-square test indicates that the association between income level of the respondents and the risk they have taken in investments is not significant.

Religion of the Respondents and Choice of Investments: Religion wise classification of the respondents and investments indicate that in all the categories more number is going in for low risk investments (Table 2). It may be observed that this is very much prevailing among the Christian community as it is indicated by 57 .9 per cent. More than one third of the respondents in each category are going for high risk investments and approximately 10 to 12 per cent are going for medium risk investments. The chi-square value between religion and investments indicates that the association is not significant.

CONCLUSION
A little over 50 per cent of the respondents have made low risk investments. More than one third of the respondents have gone for high risk investments and the remaining has gone for medium risk. Age wise classification has shown the same trend. Gender wise it is observed that women have made moderate and high risk investments compared to men. Qualification wise classification indicated that more number of Graduates (Professionals) has gone for high risk instruments compared to others. The trend of low risk, high risk and medium risk investments are there in almost all the categories. The association between profile of the respondents-age, gender, religion qualifications, income and profession and the risk taken while making investments is not significant.

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A STUDY ABOUT THE POST – FDI IMPACT OF RETAILING ON CONSUMER & EMPLOYMENT

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ABSTRACT

The last two and half decades have seen India open up its economy in a slow but steady fashion to private as well as foreign investment. The government in a series of moves has opened up the retail sector slowly to FDI. In this study the likely impact of FDI in retailing (single and multi brand) on consumer & employment has been carried out. For this, perception of both type of respondents (i.e.-shopper & employees of retail sector) were captured using a questionnaire in major cities of Uttarakhand. The findings show that there are going to be positive impacts on consumers in terms of better service, better products where employment along with productivity is also going to enhance due to better working conditions. These findings will be of interest to retailers, manufacturers, real estate, and foreign retailers.

***Keywords**-FDI, Single-brand, Multi-brand, Service, Employment*

INTRODUCTION

The last two and half decades have seen India open up its economy in a slow but steady fashion to private as well as foreign investment. The foreign investment is governed through the FDI policy which regulates industries open to foreign investment, and also the percentage that can be held by the foreign companies. Globalization and liberalization have immensely influenced the Indian economy and have gone a long way in making it a lucrative consumer market. The government in a series of moves has opened up the retail sector slowly to FDI. There were initial reservations towards opening up of retail sector arising from fear of job losses, procurement from international market, competition and loss of entrepreneurial opportunities To evaluate the impact of international players on domestic markets, in 1997 FDI in cash and carry (wholesale) outlet was permitted. In 2006, 51 percent investment in a single brand retail outlet was permitted. Since then retailing through franchisee route has been explored by several global brands.

Discussions were carried out by the government in 2008 to allow 100 percent FDI in single brand and 51 percent in multi brand retailing, but did not succeed due to fierce opposition from its then allies and Left (Communist) party and also from the local trade associations. The government has ultimately taken the bold decision and notified the much-awaited policy allowing 100 % FDI in single brand retail and 51% FDI in multi brand retail in Nov, 2012 (Table-1).

Table-1 Evolution of Foreign Direct Investment (FDI) Policy

YEAR	MILESTONES
1991	Indian economy opened FDI upto 51% under the automatic route in select priority sector
1997	FDI upto 100% allowed under automatic route in cash& carry
2006	FDI upto 51% allowed with prior government approval in single brand retail
2008	Government mulled over the idea of allowing 100%FDI in single brand retail and 50% in multibrand retail

2010	Government proposing to allow FDI in multiband retailing
2012	Government allowed 100% FDI in Single Brand Retail and 51% FDI in Multi Brand Retail subjected to prescribed conditions

Source: YES Bank Analysis

Why Are the International Players So Keen For India?

India has been ranked as the fifth most attractive nation (Figure-1) for retail investment among 30 emerging markets by the US-based global management consulting firm, A T Kearney, in its Global Retail Development Index (GRDI) 2012. The Business Monitor International (BMI) India Retail Report for the fourth-quarter of 2011 forecasts that the total retail sales will grow to US$ 804.06 billion by 2015. According to a report by research firm CB Richard Ellis India, over 6 million square feet of retail mall space was added across India in the first six months of 2011; primarily due to aggressive expansion by organized retailers the Indian retail sector is poised to witness a sea change. The recent times have seen a significant discussion emanating towards Allowing 100% FDI in single branding and 51% multi brand retailing will have a game changing impact on the modern retail sector in India.

Figure 1
2012 Global Retail Development Index™

2012 rank	Country	Region	Market attractiveness (25%)	Country risk (25%)	Market saturation (25%)	Time pressure (25%)	GRDI score	Change in rank compared to 2011
1	Brazil	Latin America	100.0	85.4	48.2	61.6	73.8	0
2	Chile	Latin America	86.6	100.0	17.4	57.1	65.3	0
3	China	Asia	53.4	72.6	29.3	100.0	63.8	+3
4	Uruguay	Latin America	84.1	56.1	60.0	52.3	63.1	−1
5	India	Asia	31.0	66.7	57.6	87.9	60.8	−1
6	Georgia	Central Asia	27.0	68.7	92.6	54.0	60.6	N/A
7	United Arab Emirates	MENA	86.1	93.9	9.4	52.9	60.6	+1
8	Oman	MENA	60.3	98.3	17.4	50.4	58.9	N/A
9	Mongolia	Asia	6.4	54.4	98.2	75.1	58.5	N/A
10	Peru	Latin America	43.8	55.5	62.9	67.2	57.4	−3
11	Malaysia	Asia	56.7	98.1	18.9	54.8	57.1	+8
12	Kuwait	MENA	81.1	88.7	36.4	20.3	56.6	−7
13	Turkey	Eastern Europe	78.8	69.3	32.3	33.1	53.4	−4
14	Saudi Arabia	MENA	63.1	81.8	35.4	33.0	53.3	−4
15	Sri Lanka	Asia	12.7	68.3	79.0	51.3	52.8	+6
16	Indonesia	Asia	39.6	61.6	47.0	62.4	52.7	−1
17	Azerbaijan	Central Asia	19.2	41.5	93.6	53.2	51.9	N/A
18	Jordan	MENA	45.8	65.3	69.5	23.8	51.1	N/A
19	Kazakhstan	Central Asia	31.5	47.5	75.5	47.5	50.5	−5
20	Botswana	Sub-Saharan Africa	44.4	88.1	42.7	23.7	49.7	N/A
21	Macedonia	Eastern Europe	34.6	46.5	55.9	56.6	48.4	+8
22	Lebanon	MENA	60.2	30.2	48.9	54.2	48.4	−10
23	Colombia	Latin America	47.8	70.1	36.7	36.6	47.8	+1
24	Panama	Latin America	53.4	68.8	42.0	25.2	47.4	+2
25	Albania	Eastern Europe	24.6	47.6	74.8	39.9	46.7	−12
26	Russia	Eastern Europe	80.2	53.6	19.6	32.2	46.4	−15
27	Morocco	MENA	23.5	58.2	48.2	49.2	44.8	−7
28	Mexico	Latin America	71.9	70.0	15.1	20.3	44.3	−6
29	Philippines	Asia	28.3	54.6	52.5	38.3	43.4	−13
30	Tunisia	MENA	35.7	55.4	65.0	14.4	42.6	−12

| 0 = low attractiveness | 100 = high attractiveness | 0 = high risk 100 = low risk | 0 = saturated 100 = not saturated | 0 = no time pressure 100 = urgency to enter |

Notes: 2011 rankings have been updated to include revised data from Planet Retail to take into account prevailing macroeconomic conditions in the retail space. MENA = Middle East and North Africa.
Sources: Euromoney, Population Data Bureau, International Monetary Fund, World Bank, World Economic Forum, Economist Intelligence Unit, Planet Retail; A.T. Kearney analysis

Source: A.T. Kearney 2012 Global Retail Development Report.

All this puts India on the radar screen when compared to other countries in terms of attractiveness in retail investment (Figure-2).

Figure 2
2012 GRDI country attractiveness

Source: A. T. Kearney, 2012 Global Retail Development Index (GRDI).

Further, with the increase in income per capita ,exposure to western lifestyle due to internet and international channels the buying behavior of an average Indian has undergone a sea-change. Now, he is more matured and less saving oriented(Figure.-3) and is getting inclined towards consumerism. Indian consumer is not looking only for cheaper products rather he is looking for overall experience i.e. he wants maximum value-for-money **(Sharma, 2012).** And large base of these consumers which are still untapped provides a great opportunity to foreign players.

OBJECTIVE OF STUDY
In view of the above background, the author has recently undertaken a survey to assess the impact of the government's decision to allow 51% foreign direct investment (FDI) in multi-brand retail and 100% in single brand retail on -

- Indian consumer,
- Employment growth,
- Productivity of employees working in this sector.

RESEARCH METHODOLOGY

Questionnaire design and Measurement
A self administered questionnaire was designed to collect data.

Table-2 Number of measures used

S.No.	Construct	No. of Measures Used
1.	Consumer	6
2.	Employment	7
3.	Productivity	6
Total		19

The subjects were intercepted randomly at the exit doors in case of organized retailer, and at counter in case of unorganized retailer once they had completed their transactions. The stores selected included organized retailer – (Vishal Mega mart, Easy Day, 7/11) and unorganized retailer – (local Kirana stores of the region). The questionnaire was divided into 3 parts A; B & C. Part A had questions related to demographic information about the respondent. Part B contained thirteen measures for the shoppers to assess their views on the impact on consumers and employment where as Part C contained six measures for the employees working in this sector(i.e.-organized as well as unorganized retailers)which tried to capture the perception of the employees working in organized or unorganized towards productivity.

Data Collection
352 shoppers and 50 employees including males, females from cities like Dehradun, Kashipur, Haldwani, Rudrapur participated in the survey. 102 and 12 respondents did not provide complete information respectively making them unusable; yielding a response rate of 71.4 % & 76% respectively.

Primary data had been collected in the month of December of the year 2012. Mall intercept method (**Bush and Joseph, 1985**) is used to collect the data so as to assess the latest perception of the customers. The instrument used for the collection of the data is questionnaire which has been got filled by intercepting the customer at the exit doors of the retail stores or at the counter in case of Kirana stores.. The systematic random sampling method (i.e. every tenth shopper coming out from the outlet) is used to select the respondents. Further, the employees were contacted either during their breaks or when their working hours got over.

Sample size Adequacy
For sample size calculation the researcher wants no more than 5% error and is satisfied with 95% of confidence level. Assuming all other things constant, then in cities selected for sample selection considering where 70% of the population is aware about organized retailing and 30% is not aware of it a sample size of 352 & 50 is needed for the result. This sample size has been finalized based upon the standard sampling table for problems involving sample proportions (**Nan Lin, 1976**).

Validity Analysis:
It is carried out to ensure that the survey instrument is measuring what it is designed to measure or that each scale accurately measures the variables included in the study. To establish content validity, construct validity and face validity store managers, shopkeepers, senior faculty members of researcher's institute were asked to compare and evaluate the items included in the questionnaire with the objectives of the research. For examples jargons like VFM, PL etc have been removed from the instrument.

Reliability Analysis:

Instrument reliability – It is the degree of consistency between multiple measures of a particular variable and was tested using Cronbach's alpha coefficient. (Scales measuring store attributes related to store image were specifically measured to check its reliability). Cronbach's alpha coefficient is the most widely used reliability coefficient and assesses the consistency of an entire scale.

The size of a reliability coefficient is based on the average correlation among the test items and the number of items. According to Hair et. al, the acceptable lower limit is 70, however, 60 is acceptable for exploratory research. Scales for this study were considered to have good reliability with a **Cronbach's alpha value of .738.**

FINDINGS OF THE STUDY

Likely impact on consumer-

Seventy six percent of consumers were of the view that FDI would increase investment, lead to improvement of technical expertise, and increase the proliferation of brands, present more choice in front of the end user. They were also optimistic that FDI in this sector will improve the level of service and they would be getting maximum value-for-money (VFM).

However, nineteen percent were apprehensive and felt that entry of foreign players would increase price of products, kill the unorganized retailers as well as organized domestic players. Consequently, it will lead to unemployment and which in turn will reduce the purchasing power of the consumer. Their apprehensions are based on the perception that foreign players may use India as a 'garbage-place' where they could dump their below standard products. It is worthwhile to note that these 19% of the sample belonged to lower income group. Five percent were not able to comment of the impact of FDI on consumers
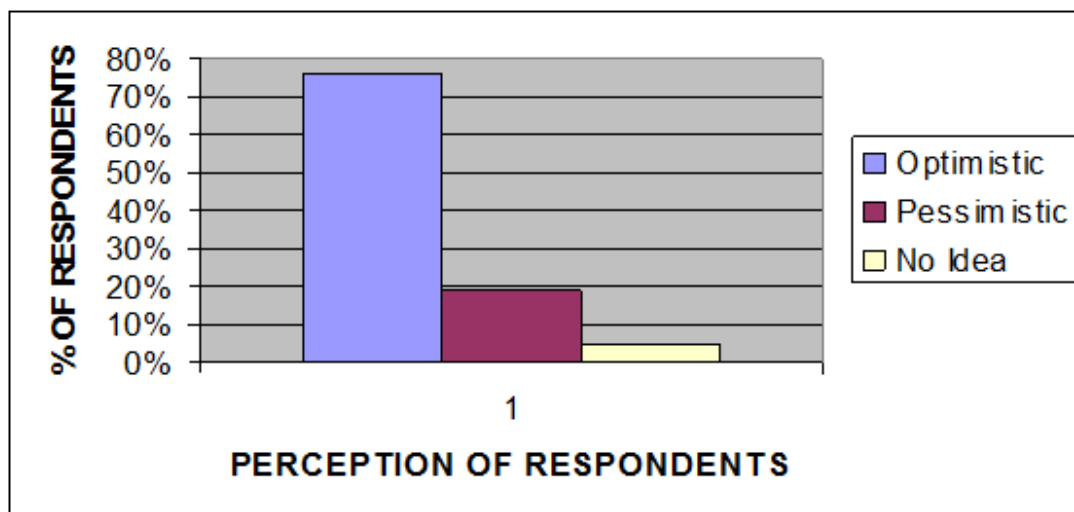
Graph 1: Impact on Consumer

These findings are supported by the study of **Madan, (2012)** which says that ultimate beneficiary from the opening of FDI in retail is consumer. They are left to choose the retail outlet that would give them goods at lesser price. Further, the impact of multi-brand retail on consumers was found to offer consumers more selections of goods and services to choose from and at a lower prices and fresher products **(Powell, 2012).**

Likely impact on employment
With regards to employment fifty two percent of the respondents were of the opinion that foreign direct investment would have a positive impact on the employment whereas thirty five percent expected negative impact on the employment. Approximately, thirteen percent of the respondents expected no significant change in employment with the opening up of this sector for foreign direct investment.
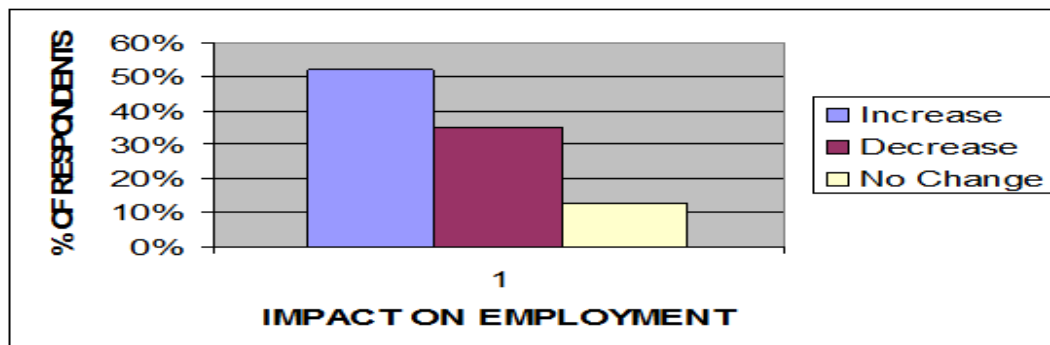
Graph 2: Impact on Employment
With regard to employment, around 48 percent of the respondents are of the opinion that the decision would have a positive impact on their employment whereas 35 percent expect no substantial change in the employment in this sector with opening up of FDI in retail. Around 16 percent expect the impact on the employment to be negative in this sector. **(CII, 2012).** The more employment would be created in the country either directly or indirectly where youth pass out is increasing as much as creation of employment. It would be generated in the agriculture, manufacturing, service industry which consists of GDP. The more people get employed would rehabilitate the economic cycle **.**

Further, the same sentiments were expressed by **Rawat (2012)** when he said "… foreign investments in Indian retail sector will ….create new jobs across the country …."

Likely impact on Productivity
Eighty one percent of employees (from unorganized system and organized sector) were of the view that their productivity is going to enhance due to better working conditions and increase in competition. Ten percent had opposite view to it and hold that productivity level decrease. Remaining Nine percent had expected no change.
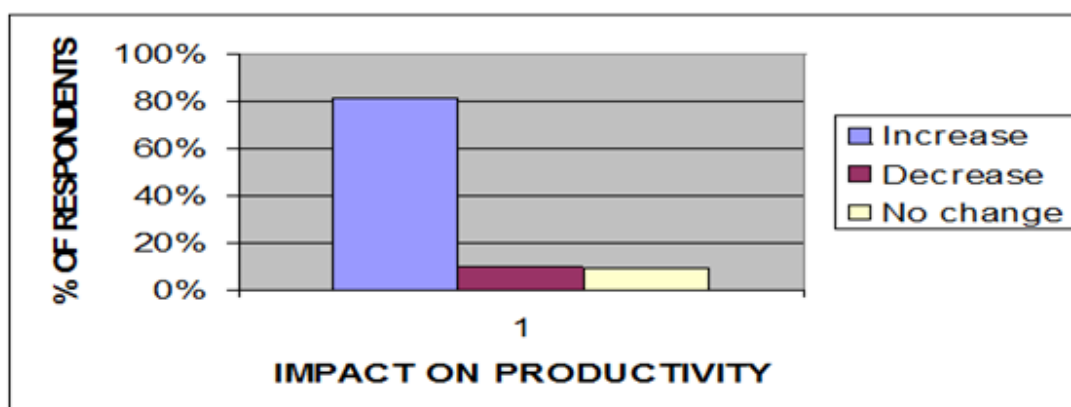
Graph 3: Impact on Productivity

Reasons for likely increase in productivity

The reasons attributed for the likely increase in productivity were based on the expectations related to higher salary, lesser working hours and better working conditions and these expectations are based on present conditions. The employees expect that with the retail sector becoming more organized due to the advent of foreign direct investment they all would be able to enjoy these benefits resulting in more job satisfaction and consequently leading to increase in productivity.

CONCLUSION

Retail sector has witnessed significant transformation in last one and half decade and with opening up of this sector for foreign players more critical changes are expected. Unorganized players have to change their business models as the customers' expectations are going to be high. Consumers are going to gain from FDI in retailing in terms of choice of products, quality, shopping ambience and services.FDI would also lead to increase in productivity and efficiency of the employees due to an improvement of employment in terms of salary, work culture and other benefits.

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LONG TERM COINTEGRATION OF STOCKS TRADED WITH DOLLAR AND GBP

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ABSTRACT

The authors attempt to explain the behavior of Indian Stock Market and various factors which affect it. This paper examines the various research studied conducted with reference to Indian or International stock exchange context. This paper tries to find out the important factors those are affecting the Indian stock market directly or indirectly. In this research two major factors have been considered those are Dollar and GBP. This research takes NSE and BSE both in consideration. Generally, it is assumed that Dollar and GBP affects the volume of share traded. The data is collected for the period 2002 to 2012 and Johansen Cointegration test is applied. The results showed that Dollar and GBP does affect the volume of share traded.

Key Words: Johansen Cointegration Test, Dollar, GBP, Stock Market.

INTRODUCTION

An exchange is an institution, organization, or association which hosts a market where stocks, bonds, options and futures, and commodities are traded. Buyers and sellers come together to trade during specific hours on business days. Exchanges impose rules and regulations on the firms and brokers that are involved with them. If a particular company is traded on an exchange, it is referred to as "listed". In India there are number of stock exchanges but two of them are very popular BSE and NSE. Stock exchanges to some extent play an important role as indicators, reflecting the performance of the country's economic state of health. Stock market is a place where securities are bought and sold. It is exposed to a high degree of volatility; prices fluctuate within minutes and are determined by the demand and supply of stocks at a given time. Stockbrokers are the ones who buy and sell securities on behalf of individuals and institutions for some commission. The Securities and Exchange Board of India (SEBI) is the authorized body, which regulates the operations of stock exchanges, banks and other financial institutions. On the other side we know that the growth of the country is directly related to the economy which consists of various variables like GDP, Foreign Direct Investment, Remittances, Inflation, Interest rate, Money supply, Exchange rate and many others. These variables are the backbone of any economy. The movements in the stock prices are affected by changes in fundamentals of the economy and the expectations about future prospects of these fundamentals. Stock market index is a way of measuring the performance of a market over time. These indices used as a benchmark for the investors or fund managers who compare their return with the market return.

The United States dollar ($), also referred to as the U.S. dollar or American dollar, is the official currency of the United States of America and its overseas territories. It is divided into 100 smaller units called cents. The U.S. dollar is the currencies most used in international transactions and is one of the world's dominant reserve currencies .Several countries use it as their official currency, and in many others it is the de facto currency.

The pound sterling (£; GBP), commonly known simply as the pound, is the official currency of the United Kingdom, the British Overseas Territories of South Georgia and the South Sandwich Islands, British Antarctic Territory and Tristan da Cunha. It is subdivided into 100 pence. A number of nations that do not use sterling also have currencies called the "pound".

REVIEW OF LITERATURE

Pal & Mittal (2011) analysed the long run relationship between two Indian capital markets and some macroeconomic variables such as interest rates, inflation, and exchange rate and GBP. They use the quarterly data from January 1995 to December 2008 and with the help of unit root test, co integration and error correction mechanism they found out that the inflation rate have the significant impact on both capital markets whereas interest rate and foreign exchange rate have the impact on one capital market. Gross domestic saving played insignificant role in both markets. The study can be made for longer period with some other macroeconomic variables gives us more comprehensive results.

Wickremasinghe (2011) examined the long run relationship between Sri Lankan capital markets (CSE) and six macroeconomic variables such as three month fixed deposit rate, consumer price index, US stock market index narrow M1 and GDP of Sri Lanka. They use the monthly data from January 1985 to December 2004 and with the help of unit root test, co integration, variance decomposition and error correction mechanism they found out that short term and long term relationship between stock prices and macroeconomic variables. Results of this study suggest that there is Bi-directional relationship exist between stock market index and fixed deposit rate stock prices and US Share price and GDP while remaining variables which are CPI, M1 and exchange rate casual bi-directional relationship exists. Results of variance decomposition suggest that GDP and M1 plays an important role in longer horizon to forecast variance in stock prices.

Berman & Saldanha (2010) It is also important to note that from a long term perspective, the average correlation between GDP growth rates for developed and emerging markets is low; this value was 0.24 from 1980 to 2009. While we believe emerging markets equities and economies have the potential to outperform moving forward, we believe that using GDP growth rates as a proxy for stock market behavior in these countries may be overly simplistic. MCSI (2009) GDP growth in emerging markets has been accompanied by strong stock market returns since 1990, the highest GDP growth countries have not always produced the highest stock market returns from either a real or nominal perspective. In U.S. dollar terms, the highest nominal GDP growth countries, China and Russia, did not produce the best stock market returns. Mexico, however, outperformed both countries with only about a sixth of their GDP growth.

Ahmed & Imam (2007) investigates the relationship between stock market and different macroeconomic variables such as money supply, Treasury bill rate, interest rate, GDP, industrial production index. They use series of tests such as unit roots, co integration, and vector error correction models. They analyze the Monthly data series for the period of July 1997 to June 2005 and they found that generally there exists no long run relationship between stock market index and macroeconomic variables but interest rate change or T-bill growth rate may have some influence on the market return.

El-Wassal (2005) investigates the relationship between stock market growth and economic growth, financial liberalization, and foreign portfolio investment in 40 emerging markets between 1980 and 2000. The result shows that economic growth, financial liberalization policies, and foreign portfolio investments were the leading factors of the emerging stock markets growth.

Batra, S (2003) mentioned that the most important business implication of the NPAs is that it leads to the credit risk management assuming priority over other aspects of bank's functioning. The bank's whole machinery would thus be pre-occupied with recovery procedures rather than concentrating on expanding business. RBI, through various circulars, stipulated guidelines to manage NPA. This view was supported by **Yadav, MS (2011)** and stated

that higher NPA engage banking staff on NPA recovery measures that includes filing suits to recover loan amount instead of devoting time for planning to mobilization of funds. Thus NPA impact the performance and profitability of banks. The most notable impact of NPA is change in banker's sentiments which may hinder credit expansion to productive purpose. Banks may incline towards more risk-free investments to avoid and reduce riskiness, which is not conducive for the growth of economy.

OBJECTIVES OF THE STUDY

The primary objective of this paper is to study the various factors which affect Indian Stock Market.

Methodology

This study is based on various factors which affect Indian Stock Market. Two Independent factors are considered namely Dollar and GBP and their combined effect is studied on the volume of Shares traded. The details of Independent variables are as follows:

The Sample: Sample consist of secondary data for a period of 10 years from 2002 to 2012

DATA ANALYSIS

Long Term Cointegration of stocks traded with Dollar and GBP

Hypotheses:

H01: There is no cointegration between the variables
H02: There is at least one cointegration Variable.
H03: There are at least two cointgrating Variables

RESULTS & FINDINGS

Table 1: Correlation Matrix

	STOCKS TRADED	DOLLAR	GBP
STOCKS TRADED	1	0.918554	0.913786
DOLLAR	0.910987	1	0.998898
GBP	0.913786	0.998898	1

This table draws the correlation between the variables. The correlation between stocks traded and Dollar is 92% which shows a positive relationship. The correlation between stocks traded and GBP is also 92% which shows a positive relationship. The correlation between Dollar and GBP is also 99% which shows a positive relationship.

Johansen Co integration Test:

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.816534	52.40123	29.79707	0.0000

At most 1	0.478298	15.09520	15.49471	0.0574
At most 2	0.034864	0.780692	3.841466	0.3769
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p- values				

Testing of Hypothesis using trace Test

H01:   There is no cointegration between the variables
Hypothesis is not accepted because the probability value is.0000, which is less than .005. Thus the hypothesis that there is no cointegrating variable is accepted.
H02:   There is at most one cointegration Variable.
Hypothesis is accepted because the probability value is.0574, which is greater than .005. Thus the hypothesis that there is at most 1 cointegrating variable is accepted.
H03:   There are at most two cointegrating Variables
Hypothesis is accepted because the probability value is.3769, which is more than .005. Thus the hypothesis that there is at most two cointegrating variable is accepted.

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized	Eigenvalue	Max-Eigen	0.05	Prob.**
No. of CE(s)		Statistic	Critical Value	
None *	0.816534	37.30603	21.13162	0.0001
At most 1 *	0.478298	14.31451	14.26460	0.0491
At most 2	0.034864	0.780692	3.841466	0.3769
Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

H01:   There is no cointegration between the variables
Hypothesis is not accepted because the probability value is.0001, which is less than .005. Thus the hypothesis that there is no cointegrating variable is not accepted.
H02:   There is at most one cointegration Variable.
Hypothesis is not accepted because the probability value is.0491, which is less than .005. Thus the hypothesis that there is at most 1 cointegrating variable is not accepted.
H03:   There are at most two cointgrating Variables
Hypothesis is accepted because the probability value is.3769, which is more then .005. Thus the hypothesis that there is at most two cointegrating variable is accepted.
Normalized cointegrating coefficients (standard error in parentheses)

STOCKS TRADED	DOLLAR	GBP
1.000000	22.62079	-30.9692
	(6.01236)	(6.94088)

The long term Cointgrating Equation for generating the value of Exchange rate is:

STOCKS_TRADED= 22.62079 DOLLAR – 30.96920GBP

This equation shows that by changing the level by -22.62 times DOLLAR and -30.96 times GBP, one can generate the Volume of Stocks traded

CONCLUSION

This study identifies the factors affecting the performance of stock market. The data used in this study were collected from the period of 2002 to 2012. In this paper, long term cointegration is calculated for identifying the factors which affect the volume of share traded in stock market. The Trace test as well as Max Eigen value test shows that there are at most two factors which affect the volume of stocks traded. The long term cointgrating Equation is also suggested taking into the test results. The results draw some concluding observations that the Dollar and GBP have positive impact on stock traded.

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MULTIVARIATE ANALYSIS TO STUDY THE IMPACT OF PROFITABILITY ON WORKING CAPITAL MANAGEMENT IN DABUR INDIA LTD. (2000-2012)

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Abstract

Management of working capital is must for the operational efficiency of any firm. Literature has also provided evidence in support of the role that efficient working capital plays in generating operating profits in the short run and the subsequent impact on the long term solvency of the firm. This paper has been treated from a reverse perspective. Here, the objective was to assess the impact of profitability for the smooth running of Dabur India Ltd. for a period of 12 years from 2000 to 2012 with the help of correlation and regression. The results of the analysis confirm that there is a significant relationship between Working capital management and profitability and FER emerges the most significant variable having its impact on working capital management.

Introduction

Efficient Working Capital Management leads to Corporate Profitability is a well established fact (**Niranjan Mandal and Dutta Smriti Mahavidyalaya (2010).** The way working capital is managed has a significant impact on both profitability and liquidity. A lot of research studies have supplemented and supported this fact, **Afza and Nazir (2009), Garcia-Teruel PJ, Martinez-Solano PM (2007), Lazaridis and Tryfonidis (2006).**

This research paper is an attempt in the same domain but with a different perspective. The aim here is not to assess the impact of WCM on profitability; rather it is the other way round. The objective of the current study is to assess the impact of profitability on working capital management. The idea around which this paper is built is that ample amount of profit generation is utmost requirement to provide operational funds in the form of working capital. The constraint here is the well known "Risk-Return Syndrome" which is based on the proposition that when there is an increase in liquidity, the risk of insolvency is reduced but at the expense of profitability. At the same time, when the liquidity is reduced the profitability increases but the risk of insolvency also increases. So the profitability and risk move in the same direction, but of course, exceptions are always there. The company that has been selected for the purpose of assessing working capital management is Dabur India Limited, the reason being it is one of the largest FMCG Company.

About DABUR

With a life of over 100 years and founded by **Dr.S.K.Burman**, Dabur India Ltd. had a very humble beginning in 1884 and now it has come a long way to become a multifaceted multinational, multi-product, modern Indian corporation with a global presence. Dabur's main lines of businesses are in the spheres of Health care, Personal care and Beauty care. It's strength lies in natural and herbal preparations.
Dabur is also an ISO 9002 certified company. The certification was obtained in 1995 by SGS YARSLEY international services Limited. It has 11 manufacturing plants in India and Nepal and a licensee in the Middle East with manufacturing base in Egypt also. The company has over 4,000 employees with around 1,500 looking after sales and marketing functions.

Today Dabur India Limited is the fourth largest FMCG Company in India with Revenues of over US$1 Billion (Rs 5,283 Crore) and Market Capitalisation of US$4 Billion (Rs 20,000 Crore). Building on a legacy of quality and experience of over 127 years, Dabur is today India's most trusted name and the world's largest Ayurvedic and Natural Health Care Company. The company has a wide distribution network, covering over 3.4 million retail outlets with a high penetration in both urban and rural markets. Dabur's products also have a huge presence in the overseas markets and are today available in over 60 countries across the globe. Its brands are highly popular in the Middle East, Africa, SAARC countries and the US. Dabur's overseas revenues account for over 30% of the total turnover.

REVIEW OF LITERATURE

Why working capital management? After going through the following research studies in the domain, the idea to study this concept evolved but of course with a different perspective…

A study conducted in a sample of Japanese and Taiwanese firms emphasized that the way the working capital is managed has a significant impact on the profitability of firms and increase in profits by reducing number of day's accounts receivable and reducing inventories, **Wang (2002). Mathuva** examined the influence of working capital management components on corporate profitability by using a sample of 30 firms listed on the Nairobi Stock Exchange (NSE) for the **periods (1993 to 2008)** and established a highly significant negative relationship between the time it takes for firms to collect cash from their customers (accounts collection period) and profitability. Another major finding was that there exists a highly significant positive relationship between the period taken to convert inventories into sales (the inventory conversion period) and profitability and there exists a highly significant positive relationship between the time it takes the firm to pay its creditors (average payment period) and profitability. **Deloof (2003)** found a significant negative relationship between gross operating income and the number of days accounts receivable, inventories and accounts payable of Belgian firms and on basis of these results he suggested that managers could create value for their shareholders by reducing the number of days' accounts receivable and inventories to a reasonable minimum. **Blinder and Maccini (1991)** in their study stated that more investment in working capital (conservative policy) might also increase profitability. When high inventory is maintained, it reduces the cost of interruptions in the production process, decrease in supply cost, protection against price fluctuation and loss of business due to scarcity of products. **Pandachi (2006)** emphasized that, the small firms should ensure a good synchronization of its assets and liabilities which can happen only with efficient working capital management. **Nazir and Afza (2009)** has also supported the view that managers can create value if they adopt a conservative approach towards working capital investment and working capital financing policies. The study also finds that investors give weight to the stocks of those firms that adopt an aggressive approach to managing their short-term liabilities. Another important study was done on Pakistani firms where the effect of several variables such as average collection period, average payment period, ITO(Inventory Turnover) in days, Cash Conversion Cycle (CCC), and CR on Net Operating Profitability and the Control variables were taken as debt ratio, size of the firm and financial asset over total asset ratio. This study concluded that managers can maximize shareholder value by efficiently managing components of Cash Conversion Cycle and it showed that there exists a strong negative relation between firm's profitability and measures of WCM, **Raheman & Nasr (2007). Shin and Soenen (1998),** highlighted that efficient Working Capital Management (WCM) was very important for creating value for the shareholders. The way working capital was managed had a significant impact on both profitability and liquidity. **Gill et al (2010)** analysed a sample of 88 firms listed on NYSE (New York Stock Exchange) for three years from 2005 to 2007 conclude that if a manager efficiently manages accounts receivables, accounts payables and inventory he can increase the profits of the firm. All these studies have one thing in common and that is the role WCM plays in enhancing profitability of the firms. The idea around which this research paper is build is to know whether

profitability has anything to do with WCM, if so, which components of Profits are influencing the WCM the most.

OBJECTIVES OF THE STUDY

1. To identify components of profitability which are directly related to Working capital Management in Dabur India Ltd over a period of 10 years from 2001-02 to 2010-11.
2. To identify components of profitability which are inversely related to Working capital Management in Dabur India Ltd over a period of 10 years from 2001-02 to 2010-11.
3. To identify the most significant variable resulting into efficient working capital management.

SCOPE OF THE STUDY

This study can be useful to the students and researchers on one hand and officials of Dabur India Limited's on the other. The results of this research can also benefit other FMCG companies who are working in the similar line of businesses like P&G, HUL, Future Group etc.

DATA COLLECTION

Secondary data had been collected from published Financial Reports of the Dabur India Ltd. over the period of ten years i.e. 2001-02 to 2010-11 which were downloaded from the company's websites.

TOOLS FOR DATA ANALYSIS

MS-Excel and Minitab 16 software had been used for data analysis and interpretation.

RESEARCH METHODOLOGY

The complete methodology follows the step by step procedure:

STEP 1: The very first step was to identify various ratios depicting profitability and it was found that profitability can be calculated on the basis of (i) sales and (ii) investments. As the scope of the present study is restricted to short term operational aspects, profitability ratios were calculated with respect to sales whereas the profitability ratios relating to investments had been ignored as they are a part of long term profitability. Profit, here has been taken as a factor of sales and is earned directly as a part of the sales revenue. The following ratios illustrated below were finally selected:

(i) PROFIT MARGIN RATIOS:

The Profit Margin refers to the profit contributed by per rupee of sales revenue and the ratios selected for current study were Gross Profit Ratio (GPR), Operating Profit Ratio (OPR), Net Profit Ratio (NPR).

(ii) EXPENSE RATIOS:

The Expense Ratios are the measure of cost control and are computed by establishing the relationship between different expense items and the sales. The ratios selected for the current study were Cost of Goods Sold Ratio (COGSR), Administrative and Selling Expense Ratio (ASER), Operating Expense Ratio (OER), Financial Expense Ratio (FER), Operating Ratio (OR), Total Operating Cost/Net Sales, Raw Materials Ratio (RMR), Direct Expense Ratio (DER).

The above two categories of ratios were related to the working capital ratio also known as Current Ratio. All these ratios were calculated with the help of information extracted from the financial statements of Dabur India Ltd. and analysis was done through MS-Excel. The results of the above calculated ratios have been shown in Table 1.

STEP 2: Finding and interpreting Correlation

 For the results of correlation, please refer to Table 2.
(i)   The correlation between CR and GPR was -0.2000, indicating a weak negative relationship between these two variables.
(ii)   The correlation between CR and OPR was -0.648, indicating a moderately strong negative relationship between these two variables.
(iii)   The correlation between CR and NPR was -0.740, indicating a moderately strong negative relationship between these two variables.
(iv)   The correlation between CR and COGSR was +0.200, indicating a weak positive relationship between these two variables.
(v)   The correlation between CR and ASER was +0.349, indicating a moderately strong positive relationship between these two variables.
(vi)   The correlation between CR and OER was +0.417, indicating a moderately strong positive relationship between these two variables.
(vii)   The correlation between CR and FER was +0.950, indicating a strong positive relationship between these two variables.
(viii) The correlation between CR and OR was +0.648, indicating a moderately positive relationship between these two variables.
(ix)   The correlation between CR and RMR was -0.518, indicating a moderately strong negative linear relationship between these two variables.
(x)   The correlation between CR and DER was +0.528, indicating a moderately strong positive linear relationship between these two variables.

STEP 3: Test of significance: For the purpose of testing significance of results, the alpha value was taken as .05 which is accepted in most of the social sciences research which is the p-value and the results had been interpreted with the help of the following decision rule:
If the *p*-value is smaller than standardised value of α (typically 0.05), it shows that the relationship between the x and y is significant. Whereas, if the p value is more than alpha, it shows that there is not have enough evidence that the variables are significantly co-related. The following variables are found to be statistically significant as per the above decision rule.

   (i) FER and WCR had a *p*-value of 0.000, which meant a highly significant result.
   (ii) OR and WCR had a *p*-value of 0.043, which also meant a statistically significant result.

The outcome of step 3 is that there are two x variables which could be used to run regression i.e., FER and

OR.

STEP 4: **Check for Multi-co linearity**
Problem of multi-co linearity exists when the two *x* variables are highly correlated and as a result it is redundant to include both related variables in the multiple regression models. The decision rule is that, if two *x* variables *x*1 and *x*2 are strongly correlated (that is their correlation is beyond +0.7 or –0.7), then one of them would do just about as good a job of estimating *y* as the other, so there is no need to include them both in the model. The correlation between FER and OR came out to be 0.811 (Please refer to Table 2) which was beyond +0.7 and -0.7. Even these were strongly related as their *p*-value is 0.004 which was less than 0.05. Now one of the OR or FER had to be removed. But which one? As OR was less significant

than FER (p value of OR was more than that of FER) , it was removed for consideration in next step. The final outcome of step 4 was that the researchers were left with only one variable i.e., FER to check its impact on WCR.

STEP 5: Finding the best fitting Model
After having established the fact that FER and CR were closely related and also highly significant, the regression analysis was done through MINITAB 16 software to find out the best-fitting model for the data. The results of step 5 have been shown in Table 3. Table 3 shows the regression coefficients in the *Coef* column for the regression model. The first coefficient (0.64167) was just the constant term (or $b0$ term) in the model and wasn't affiliated with FER. The second coefficient in the Coef column of this value was the coefficient of the *FER* term, also known as $b1$. In the regression analysis, the coefficient of *x1* (FER) equals 97.3. So y (CR) will be increased by 97.3 units when FER increases by 1 unit.

STEP 6: Finding and interpreting Residuals
In the end, Residuals (the difference between the estimated values for *y* and the observed values of *y* from the data) were calculated to check how best the regression model fits. The residual lots have been shown as Annexure 4. There are three conditions to check the fit of the model with the help of Residuals:

Condition1: The residuals should have a normal distribution with mean zero: The upper-left plot of Annexure 4 shows the residuals match a normal distribution as the residuals fall in a straight line. The upper-right plot of Annexure 4 shows that the horizontal line going across that plot; it's at zero as a marker. The residuals should average out to be at that line (zero). These Residuals versus Fitted Values plot checks the mean-of-zero condition and holds for the FER and CR.
Condition2:The residuals should have the same variance for each fitted (predicted) value of *y* (working capital ratio) : To look at the variance issue, the upper-right plot of Annexure 4, does not show any change in the amount of spread (variability) in the residuals around that horizontal line when moving from left to right.
Condition 3: The residuals should be independent (don't affect each other): Looking at the lower-right plot of Annexure 4, there is no pattern (a straight line, or a curve, or any kind of predictable up or down trend) so the independence condition was also met for FER.
Fulfilling all the three conditions, justifies that the model fits well!

FINDINGS AND SUGGESTIONS
Using GPR, OPR, NPR, COGSR, ASER, OER, FER, OR, RMR and DER as the explanatory variable and CR as the dependent variable, it was found out that:
(i)   The results of correlation confirm the fact that the relationship between WCM and profitability is significant in Dabur Ltd. as Working Capital Ratio is moderately and positively correlated with FER, OR and DER. Therefore, in order to ensure smooth availability of working capital in times to come, management at Dabur Ltd. should ensure that FER, OR and DER be maintained at optimal level.
(ii)   WCR is moderately and negatively correlated with OPR, NPR and RMR. Therefore, management should try to reduce these ratios in case their focus is on short-term operational solvency.
(iii)   Results of regression equation (CR = 0.642 + 97.3 FER) recommends that when FER is increased 97.3 units, it results into one unit increase in CR. Therefore, the management should take utmost care of this highly influencing element.
(iv)   FER emerges to be the most significant component of Profitability which results in maximum variability in WCM as justified by 90.2 percentage of R^2

LIMITATIONS OF THE STUDY
1) As the balance sheets of 2012-13 were unaudited, they have not been included or the purpose of the study.
2) The accuracy and authenticity of the data collected and conclusions drawn largely depends upon the corresponding accuracy and authenticity of the information supplied by the concerned websites, books, and journals

CONCLUSION
Effective management of working capital is a prime responsibility of a finance manager and for that to happen ample amount profits are required as only a portion of the profits earned can be used for sustaining working capital requirements.

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Table 1

Table No-2   RATIOS

Year	CR	GPR	OPR	NPR	COGSR	ASER	OER	FER	OR	RMR	DER
2001-02	2.7786	0.4815	0.0774	0.0554	0.5185	0.3134	0.4041	0.0206	0.9226	0.1357	0.0753
2002-03	1.9134	0.4934	0.0860	0.0691	0.5066	0.3135	0.4075	0.0139	0.9140	0.1363	0.0836
2003-04	0.9285	0.4825	0.0970	0.0882	0.5175	0.3059	0.3855	0.0060	0.9030	0.1366	0.0792
2004-05	0.7820	0.5150	0.1256	0.1167	0.4850	0.3113	0.3894	0.0034	0.8744	0.1755	0.0565
2005-06	0.9253	0.5331	0.1598	0.1380	0.4669	0.2876	0.3733	0.0041	0.8402	0.1893	0.0470
2006-07	1.1133	0.5170	0.1567	0.1418	0.4830	0.2812	0.3603	0.0025	0.8433	0.2046	0.0511
2007-08	0.9488	0.4720	0.1660	0.1496	0.5280	0.2232	0.3060	0.0040	0.8340	0.2140	0.0492
2008-09	1.1179	0.4551	0.1647	0.1541	0.5449	0.2100	0.2904	0.0055	0.8353	0.2343	0.0405
2009-10	1.0525	0.4884	0.1755	0.1504	0.5116	0.2281	0.3219	0.0019	0.8245	0.2072	0.0346
2010-11	1.2562	0.4627	0.1749	0.1431	0.5373	0.2063	0.2878	0.0039	0.8251	0.2347	0.0364

Table 2:

Correlations: CR, GPR, OPR, NPR, COGSR, ASER, OER, FER, OR, RMR, DER

	CR	GPR	OPR	NPR	COGSR	ASER	OER	FER	OR
GPR	-0.200								
	0.579								
OPR	-0.648	-0.083							
	0.043	0.819							
NPR	-0.740	-0.061	0.981						
	0.014	0.866	0.000						
COGSR	0.200	-1.000	0.083	0.061					
	0.579	*	0.819	0.866					
ASER	0.349	0.617	-0.830	-0.790	-0.617				
	0.323	0.058	0.003	0.007	0.058				
OER	0.417	0.601	-0.844	-0.820	-0.601	0.992			
	0.231	0.066	0.002	0.004	0.066	0.000			
FER	0.950	-0.165	-0.811	-0.864	0.165	0.505	0.560		
	0.000	0.649	0.004	0.001	0.649	0.137	0.092		
OR	0.648	0.083	-1.000	-0.981	-0.083	0.830	0.844	0.811	
	0.043	0.819	*	0.000	0.819	0.003	0.002	0.004	
RMR	-0.518	-0.288	0.949	0.935	0.288	-0.898	-0.921	-0.686	-0.949
	0.125	0.420	0.000	0.000	0.420	0.000	0.000	0.028	0.000
DER	0.528	0.119	-0.962	-0.927	-0.119	0.821	0.828	0.712	0.962
	0.117	0.743	0.000	0.000	0.743	0.004	0.003	0.021	0.000

Cell Contents: Pearson correlation
             P-Value

Table 3: Regression Analysis: CR versus FER
The regression equation is : CR = 0.642 + 97.3 FER
Predictor   Coef   SE Coef   T   P
Constant   0.64167 0.09857 6.51 0.000
FER   97.26   11.36   8.56 0.000
S = 0.203265   R-Sq = 90.2%   R-Sq(adj) = 88.9%

Table 4

Residual Plots for CR
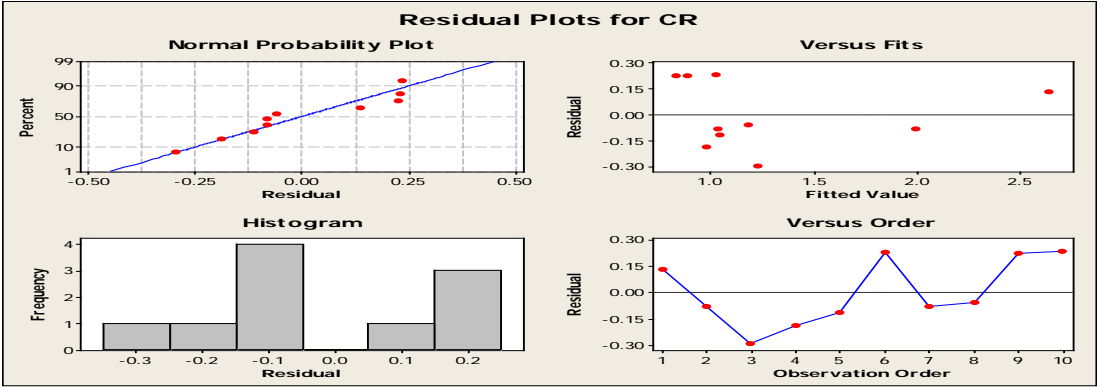
PERFORMANCE APPRAISAL OF THE CO-OPERATIVES BANKS IN GUJARAT.

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ABSTRACT

Finance is an essential requirement for every productive activity. Agriculture in India needs more attention as it provides livelihood for 65 percent of population and directly contributing 20 percent to the national income. It is obvious that the contribution of agriculture sector to the national income is not in line with the number of people engaged in that sector, which calls for an immediate attention for increasing the production and hence for a prosperous agricultural economy (Javir et al,, 1998). Agriculture in India has always been away of life, rather than a business and has suffered from stagnation due to low productivity arising from inadequate investment. The emergence of green revolution in India by the late sixties has radically changed the character of Indian agriculture, as seen by a growing tendency among the farmers to replace the traditional farming practices with scientific and modern practices evident by increasing use of HYV seeds, fertilizers, pesticides, irrigation, machinery and equipment etc., medium and longterm investments for land improvement, irrigation etc. But, majority of farmers being small and marginal, they were unable to afford these investments from their own savings, as it has been rightly stated " the farmers in the under developed countries cannot expect their capital needs to come from savings, because their income from farm operations is barely sufficient to provide the minimum necessities of life" (Roy, 1994). This makes the farmers to go for borrowed funds to a large extent.

Key Words: Co-oparative banks, Co-opartive financial activity, Mutual funding activity, banking activities

PART I: INTRODUCTION CO-OPERATIVE BANK

The introduction of the cooperative credit societies Act in 1904 for providing production credit to farmers marked the beginning of the institutionalization of cooperative banking system in India. The act of 1904 was amended in 1912 to facilitate the establishment of central cooperative banks at the district level, thereby giving it a three tier federal character. After the independence of the country, at the recommendations of the A.D. Gorwala committee (1954) one central cooperative bank for each district became dictum, particularly in the bigger states with a view to provide stability and facilitate emergence of a strong and powerful cooperative credit structure for the development of all cooperative activities at the district level. The establishment of central cooperative banks (DCCBs) at the district level was to serve as a link between the ultimate credit disbursing outlets, viz., Primary Agricultural Credit Societies (PACS) at the base level, District Central Cooperative Banks (DCCB) at the intermediate level and State Cooperative Banks (SCB) at the apex level. Until the nationalization of fourteen major commercial banks in 1969, DCCBs had the unique distinction of being the exclusive banking institution in the rural areas.

Until the introduction of financial sector reforms in the country, in the wake of the Implementation of the recommendations of Narasimhan committee (1991), the issues related to operational efficiency and financial viability of the banking institutions in India were generally subsumed under the social banking/ target oriented banking norms. In fact, even after the introduction of reforms in the banking sector in 1992-93, the application of prudential and other disclosure norms were restricted largely to the commercial banks (PSBs) in India. The cooperative banking sector in general, was excluded from its implementation in the initial few years, mainly in few of the states sponsored and state patronized character of the cooperatives in India. Now that the prudential norms are also made applicable to the cooperative banking sector, it is necessary to review the performance of the DCCBs and assess their substantiability or prospects to cope with the new reforms generated norms.

REVIEW OF LITERATURE

To devise the ways to evaluate the objectives of the study, it is necessary to have an idea of the methodology followed by the earlier related studies along with their findings. A review of literature connected with the working and performance of financial institutions in India and abroad was done, and is presented under the following heads. All over the world, number of studies has applied DEA to the question of efficiency in banking but very little empirical research can be observed in case of India. Bhattacharayya et al. (1997) Saha and Ravishankar (1999), Avinandan et al. (2002), Kumbhakar and Sarkar (2004), Ram Mohan and Ray (2004), Inderjeet Singh and Pramod Kumar (2004) are among those few researchers who have examined performance of the Indian commercial banks. They have mainly considered the reform impact and different ownership groups e.g. Public, private and foreign. Though DEA is based on the pioneering work of Farrell (1957), Charnes Cooper and Rhodes (1978) developed technique. Several different mathematical programming DEA 4 models have been proposed in the literature (Charnes et al, 1994 Seiford and Thrall 1990). Charnes, Cooper and Rhodes (1978) proposed a model, which had an input orientation and assumed constant return to scale (CRS) commonly known as CCR model. Banker, Charnes and Cooper (1984) proposed a model considering variable return to scale (VRS) commonly known as BCC model. Reddy (1994) assessed the working of Malkanoor Cooperative Rural Bank considering the variables like share capital, reserve fund, deposits and borrowings for the period 1978-79 to 1992-93. The compound growth rates were calculated by fitting an exponential growth function. The study revealed that the growth rates were relatively higher for deposits, reserves and investments. Palleri (1998) employed compound growth rate to evaluate the management of the credit distribution to agricultural sector by KCC Bank, Dharwad. The important indicators considered were amount of credit disbursed, amount of agricultural credit and non-agricultural credit, total deposits, number of beneficiaries, recovery performance and overdues. Javir *et al.* (1998) examined the advances extended by Thane Grameena Bank, Maharashtra for the period 1987 to 1995.

OBJECTIVES

- Explore the services and products offered by the banks to individual customers. special levels of your bank's Personnel/Staff, Answering and question solving by bank's staff, Atm, Debit card & Credit Card Service.

- Understand the perception of the customers and the management with respect to services offered by banks.special Atm & Credit Card Services.

- Generate additional information to analyze the gap between the customer and management perceptions about the services offered by banks. Conclude and enumerate the innovations required to reduce the gap and increase the customer base of banks.

PART II: RESEARCH METHODOLOGY

The study aims to assimilate data about the various aspects of Retail banking services, to analyze the perceptions of the management and the customers regarding the services offered in Retail banking and to find out whether any gaps do exist between the services offered and the customer expectations. I have taken 6 Scheduled Urban Co-operative banks of Gujarat State.

A) The Kalupur Commercial Co-Operative Bank Ltd. (KCCB)
B) Rajkot Nagrik Sahakari Bank Ltd. (RNSB)
C) The Ahmedabad Mercentile Co-Operative Bank Ltd. (AMCO)
D) Mehasana Urban Co-Operative Bank Ltd. (MUCB)
E) The Surat People's Co-Operative Bank Ltd.(SPCB)
F) Nutan Nagrik Sahakari Bank Ltd. (NNSB)

 The study is a mixture of Secondary and Primary data, with Questionnaires being our major instrument to collect primary data.

Sampling Unit: Sampling unit on Grade scale from 1 to 5 for each question.

Sampling Technique: Filling up common questionnaires with 05 questions under consideration both by customers and the managers of the different banks.

Sample Size: The sample size of the customers was 25 each from each of the six banks ie.150 customers. The management sample size was restricted to 2 each, namely the Branch Manager from the six banks which are 12 managers.

HYPOTHESIS:

H0**:** There is Gap between management perception and customer perception in regard of the service provided by the bank.
H1: There is not a Gap between management perception and customer perception in regard of the service provided by the bank.

DATA ANALYSIS

Following data was available from selected six co-operative banks through questionnaire. Five questions to ask the managers as well as customers.

Q-1. On a scale of 1-5 how do you rate the courtesy levels of your bank's (Personnel / Staff?)

Table No. 1 Comparison (Que.1)

Banks	Average Grading Given By Managers	Banks	Average Grading By Customer
KCCB	4	KCCB	3
RNSB	4	RNSB	3
AMCO	5	AMCO	4

MUCB	4	MUCB	4
SPCB	5	SPCB	4
NNSB	4	NNSB	3

Table No.2 Percentage Break up Que.1 (as per Management)

Rate	Excellent	Very Good	Good	Average	Poor
Percentage	34	50	16	0	0

Table No.3 Percentage Break up Que.1 (as per Customers)

Rate	Excellent	Very Good	Good	Average	Poor
Percentage	7	60	33	0	0

Interpretation: There is a gap that exists between the management and the customer perception regarding the courtesy levels of the staff. The proportion of management that rates the courtesy aspect as "excellent" is very high but very few numbers of customers thinks this aspect to be excellent. Majority of them feels it to be between "very good" and "good." It is almost in all banks that this Gap exists except for one bank that is MUCB bank, this is because management may feel that the employees courtesy level is high but when asked to the customer they feel it a little lower than the management. This is because sometimes customers may be victimized from rude type of behavior of employee due to some internal factors.

Q-2.Rate as to how well informed/knowledgeable you feel the bank staff is in Answering/solving your questions/queries?

Table No.4 Comparison (Que.2)

Banks	Average Grading Given By Managers	Banks	Average Grading By Customer
KCCB	4	KCCB	3
RNSB	3	RNSB	3
AMCO	4	AMCO	5
MUCB	3	MUCB	4
SPCB	4	SPCB	4
NNSB	4	NNSB	3

Table No.5 Percentage Break up Que.2 (as per Management)

Rate	Excellent	Very Good	Good	Average	Poor
Percentage	0	66	34	0	0

Table No.6 Percentage Break up Que.2 (as per Customers)

Rate	Excellent	Very Good	Good	Average	Poor
Percentage	20	34	36	10	0

Interpretation: The management perceives the knowledge aspect of its employees to be between very good and average. While few customers perceive it to be excellent, few as very good, good and average. In this particular question customer of private bank has given high grade as far as knowledge of the staff

is concerned, while the gap lies in public sector bank and sort of in foreign banks this is because sometimes customer also failed to understand what the employee is trying to convey, due to this reason gap is existing.

Q-3: How do you rate the quality of ATM services provided by the bank?

Table No. 7 Comparison (Que.3)

Banks	Average Grading By Managers	Banks	Average Grading By Customer
KCCB	5	KCCB	5
RNSB	4	RNSB	4
AMCO	5	AMCO	4
MUCB	3	MUCB	4
SPCB	5	SPCB	3
NNSB	5	NNSB	3

Table No.8 Percentage Break Up Que.3 (As Per Management)

Rate	Excellent	Very Good	Good	Average	Poor
Percentage	50	50	0	0	0

Table No.9 Percentage Break Up Que.3 (As Per Customers)

Rate	Excellent	Very Good	Good	Average	Poor
Percentage	24	36	16	20	4

Interpretation: The management rates its ATM services as – a very high and equal number as excellent and very good. Customers rate it as few as excellent, a high as very good, a few as good, average and very few as poor. There lies a gap in few banks as far as ATM service is concern this is because sometimes ATMs are out of its service like availability of cash, technical problems. Overall ATM service is match with customer expectation.

Q-4: How do you rate the Debit card services offered by your bank?

Table no.10 Comparison (Que.4)

Banks	Average Grading By Managers	Banks	Average Grading By Customer
KCCB	4	KCCB	4
RNSB	5	RNSB	4
AMCO	5	AMCO	5
MUCB	5	MUCB	4
SPCB	4	SPCB	4
NNSB	5	NNSB	3

Table No. 11 Percentage Break up Que.4 (As Per Management)

Rate	Excellent	Very Good	Good	Average	Poor
Percentage	66	34	0	0	0

Table No. 12 Percentage Break up Que.4 (As Per Customers)

Rate	Excellent	Very Good	Good	Average	Poor
Percentage	11	46	36	7	0

Interpretation: The management rates its Debit card services as- a very high as excellent and few as very good. Customers rate it as – a few as excellent, a high amount of them as very good, a sizeable amount as good and very few as average. As far as debit card service is concerned few banks has more or less it exist with little gap due to their hidden charges sometimes debit card not accepted for shopping due to this reason customer given less rating.

Q-5: How do you rate the Credit card services offered by your bank?

Table No.13 Comparison (Que. 5)

Banks	Average Grading By Managers	Banks	Average Grading By Customer
KCCB	4	KCCB	4
RNSB	4	RNSB	3
AMCO	5	AMCO	3
MUCB	5	MUCB	4
SPCB	5	SPCB	4
NNSB	5	NNSB	3

Table No.14 Percentage Break Up Que.5 (As Per Management)

Rate	Excellent	Very Good	Good	Average	Poor
Percentage	0	66	17	17	0

Table no.15 Percentage Break Up Que.5 (As Per Customers)

Rate	Excellent	Very Good	Good	Average	Poor
Percentage	0	50	27	17	6

Interpretation: Both the management and the customers rate the credit card services as same except in a few cases. That is a very high amount of them as very good and a few as good and average. There is high gap that exists as far as credit card service of the bank is concern in most of the banks this is because customer do not read all the required information regarding time duration, payment option etc. hence sometime banks charge some amount which customer may not be actually aware about that charges. Due to this reason customer expectation are not matching with the management.

Hypothesis testing and Results: From the response of mangers and customers through questionnaire are analyzed through z test because samples are more than 30. Hence Z test is appropriate here. After applying z test following result is available in relation to the hypothesis.

H0: $P = 0.5$, **H0:** $P \neq 0.5$,

p Bar: Proportion of success in the sample   0.92

q Bar: Proportion of failure in the sample   0.08
Z tabulated at 0.05 level of significance = ± 1.96
Z Calculation value is less then Z- table value
Hence, Hypothesis H0 is accepted
HO: There is a Gap between management perception and customer perception in regard of the service provided by the bank.

PART – III: CONCLUSIONS

- Proper training about the various products of the banks should be provided and proper follow should be taken to increase the knowledge of employee.
- Transaction time can be reduced by increasing people or adding new branches.
- Transparency at the time of account opening from the both the sides will make account opening process smooth.
- Government banks should timely update about the account and also new services.
- The functioning of the complaint department should be fast and to the customer's expectation.
- Transparency in charges and transaction is lacking in credit card and debit card services.
- Reduction in time period of loan processing and disbursing.
- Awareness and uses of phone and net banking should increase to decrease the rush at the bank.

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BRANDING STRATEGIES OF MNCs: A STUDY OF SELECTED FMCG PRODUCTS IN INDIAN MARKET

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ABSTRACT

Branding is an integral part of the business building process. Large corporations spend hundreds of millions of dollars building their brands. Brands have become the most valuable asset within any enterprise, quintessential zing the knowledge, the art, the science, and the work of each person in each work day, making them the ultimate symbol of much that is good and true and beautiful within our global economy. In time, Brands began to penetrate beyond the corporate world. The impact of branding in the business building process of FMCG companies in India was also witnessed two decades back. The Indian FMCG sector is the fourth largest sector in the economy with an estimated size of Rs.1, 300 billion. The sector has shown an average annual growth of about 11% per annum over the last decade.

This paper is an attempt to understand the concept and roles of branding strategy in the business building process of FMCG companies. For the better and in-depth understanding, case studies of four MNCs in the FMCG sector in India are studied. The branding strategies of top four MNCs i.e. P&G India, HUL, Colgate-Palmolive India and Amway India, especially in the body care products among FMCG product are analysed in details. The paper concludes that different MNCs in FMCG sector adopt different branding strategies each posing different pros and cons, depending upon their goal and vision.

Keywords: Brands, Bodycare products, Branding, FMCG, MNC, Positioning.

INTRODUCTION

Due to the rapid changes in the global market and the increased competition experienced between firms, "Brand Management" has become more important. Good brand management brings about clear differentiation between products, ensures consumer loyalty and preferences and may lead to a greater market share. Brands are highly regarded as an important source of capital for most business. The term brand has different meaning attached to it; a brand can be defined as a name, logo, symbol and identity or a trademark. A powerful brand will enhance a customer's attitude strength of the product association of a brand. Attitude strength is developed by experience with the product. Brand name and what a brand stands for are the core values for most fast food moving consumer goods (FMCGs). If properly managed, it will increase the competitive advantage of the fast moving consumer goods. The basic attribute of a fast moving consumer goods are also important for a FMCG brand to excel because the strength of a brand commonly provide the fundamental steps for differentiating between several competitors. Majority of the FMCG brands have distinguishable brand identifiers, for example Lux soap is easily recognized by customers. Conclusively, the best way to build brand value and stop product and service commoditization

is through continuous attempt to build brand equity. Strong brands are established by creating an emotional attachment with customers, seeking differentiation in communication and performing the service. Branding makes clear a restaurant's reason for existence and inspires its employees to get used to the brand thereby building it for customers.

Brands are used as shorthand to make trips to the grocery store easier; they are used to re-assure us about purchasing decisions and are even used to define ourselves in the society. A brand is a promise. With a brand, customer expectations are set. When someone buys a product or service, they count on those expectations to be fulfilled. The function and art of branding is a major contributor to the success of a product or service sold by the company that markets it. According to Webster 's Dictionary, a brand is defined as "a means of identification," or "an arbitrarily adopted name that is given by a manufacturer or merchant to an article or service to distinguish it as produced or sold by that manufacturer or merchant that may be used and protected as a trademark." Brand management aims to build into customers' minds a set of perceptions and attitudes relating to an offering, leading to positive buying behavior. To achieve this goal, managers must know a great deal about their customer base. The power of a brand is measured by its effect on buyers. A powerful brand will cause its customer base to either defer or refuse to purchase if the brand is NOT available. Some brands have reached a level of mass acceptance where they are used as action verbs, such as " Xeroxing " a document instead of copying it and " Fedexing " a package rather than mailing or posting it. One brand's identity is so strong that when we hear Aspirin we immediately think of Bayer.

INDIAN FMCG SECTOR

The Indian FMCG sector is the fourth largest sector in the economy with a total market size in excess of US$ 13.1 billion. It has a strong MNC presence and is characterized by a well-established distribution network intense competition between the organized and unorganized segments and low penetration cost. Availability of key raw materials, cheaper labour costs and presence across the entire value chain gives India a competitive advantage. The FMCG market value is set to treble from US$ 11.6 billion in 2003 to US$ 33.4 billion in 2015. Penetration level as well as per capita consumption in most product categories like jams, toothpaste, skin-care, hair wash etc in India is low indicating the untapped market potential. Burgeoning Indian population, particularly the middle class and the rural segments, presents an opportunity to makers of branded products to convert consumers to branded products. Growth is also likely to come from consumers 'upgrading' in the matured product categories. FMCG sector is also likely to benefit from growing demand in the market. Because of the low per capita consumption for almost all the products in the country, FMCG companies have immense possibilities for growth. And if the companies are able to change the mindset of the consumers, i.e. if they are able to take the consumers to branded products and offer new generation products, they would be able to generate higher growth in the near future. It is expected that the rural income will rise in 2007, boosting purchasing power in the countryside. However, the demand in urban areas would be the key growth driver over the long term. Also, increase in the urban population, along with increase in income levels and the availability of new categories, would help the urban areas maintain their position in terms of consumption. At present, urban India accounts for 66% of total FMCG consumption, with rural India accounting for the remaining 34%. However, rural India accounts for more than 40% consumption in major FMCG categories such as personal 203 care, fabric care, and hot beverages. In urban areas, home and personal care category, including skin care, household care and feminine hygiene, will keep growing at relatively attractive rates. Within the foods segment, it is estimated that processed foods, bakery, and dairy are long-term growth categories in both rural and urban areas.

Indian FMCG industry is expected to grow at a base rate of at least 12% annually to become a Rs 4,000 billion industry in 2020, according to a new report by Booz & Company. The Report titled "FMCG Roadmap to 2020 - The Game Changers" was released at the CII FMCG Forum 2010 in New Delhi Thursday. The Report noted that the positive growth drivers mainly pertain to the robust GDP growth, opening up and increased income in the rural areas of the country, increased urbanization and evolving consumer lifestyle and buying behaviour. The report further revealed that if some of the positive factors – driven mainly by improved and supportive government policy to remove supply constraints – play out favourably, the industry could even see a 17% growth over the next decade, leading to an overall industry size of Rs 6,200 Billion by 2020. The last decade has already seen the sector grow at 12% annually as result of which the sector has tripled in size. Releasing the report, Booz & Company Partner Abhishek Malhotra said, "While on an aggregate basis the industry will continue to show strong growth, we will see huge variations at multiple levels – product category (e.g. processed foods growing faster than basic staples), companies and geographies." "Many Indian customer segments are reaching the tipping point at which consumption becomes broad based and takes off following the traditional "S shaped" curve seen across many markets." The sector is poised for rapid growth over the next 10 years and by the year 2020, FMCG industry is expected to be larger, more responsible and more tuned to its customers," he further added.

OBJECTIVES

The objectives of the study are:
- To understand the concept and roles of branding strategy in business building process of MNCs.
- To examine the branding strategies of the selected MNCs with special reference to body care products of FMCG sector in India.
- To analyse different pros and cons of each branding strategies adopted by MNCs.
- To analyse the extent to which different branding strategies are successfully adopted by MNCs in Indian market.

REVIEW OF LITERATURE

McDonald et al. (2001) assert that an appropriate branding strategy is crucial as it would reinforce the desired positioning and hence influence purchase behavior. Unfortunately, even the best brand managers have struggled to choose the most appropriate branding strategy, in part, due to a lack of academic clarity and study. Pierce and Mouskanas (2002): Vijayraghavan (2003) discussed the appropriateness of different branding strategies and suggest that individual branding strategy is the most appropriate for FMCG companies. Laforet and Saunders (1994, 2005) found out that in actual practice, FMCG companies are using individual branding strategy in combination with corporate or house branding strategies. Saunders and Guoqun (1996) empirically demonstrated that consumers prefer corporate and individual brand types together for an FMCG product than either brand type use alone. In contrast, Laforet (2011) reported that corporate brand does not add any value to products in the FMCG sector. Strebinger (2004) has defined branding strategies based on the number of product categories and target groups a branding strategy serves. He proposed five types of branding strategies; first, corporate branding strategy that adopts a uniform brand for all product categories and target groups. Second, target group branding strategy where a company uses a different brand name for each target segment. Third, a product branding strategy in which a different brand name is used for each product category. Fourth, product and target specific branding strategy where there is a different brand for each combination of target group and product category. Firth, brand family strategy in which hierarchically ranked brands have a common endorser. Keller (2008) proposes four hierarchical types of a brand; 1) Corporate/company brand (conglomerate or

company or subsidiary name. 2) Family brand (brand used in more than one product category. 3) Individual brand (brand restricted to one product category). 4) Modifier (a means to signal refinement or differences in brands). Corporate dominant strategy is defined as the strategy in which only corporate brand name is used in all communications of the company (Gray and Smeltzer, 1985; Murphy, 1987; Laforet and Saunders, 1994, 2005).Olins (1989) has given it the name of Monolithic strategy whereas Aaker and Joachimisthaler (2000) and Rajogopal and Sanchez (2004) name it branded house strategy while Berens et al. (2002) call it corporate branding strategy. Here corporate brand symbolizes conglomerate name, company name and house/subsidiary name (Laforet and Saunders, 1994, 2005; Keller, 2008). Grey and Smelter also state that when a company, essentially operating in only one product line uses its company brand only, it is single entity branding strategy. In brand dominant strategy, different brand names that are different form corporate brand are used for different products of the company (Gray and Smeltzer, 1985' Murphy, 1987; Laforet and Saunders, 1994, 2005). Olins (1989) has given this stratefy the names of branded strategy whereas Aaker and Joachimsthaler (2000), and Rajagopal and Sanchez (2004) name it house of brands strategy while Berens et al.(2002) call it stand-alone strategy. Laforet and Saunders (1994) classify this strategy into two categories; first, Mono branding when corporate identity is disclosed and second, furtive branding when corporate identity is not disclosed. Mixed branding strategy is the strategy in which two brand names, that is corporate and individual product brand names, are used together with varying visibilities for branding product (Gray and Smeltzer, 1985; Murphy, 1987; Laforet and Saunders, 1994). Olins (1989) has named it endorsed strategy whereas Aaker and Joachimsthaler (2000) and Berens et al. (2002) name it sub branding strategy while Rajagopal and Sanchez (2004) call it brand endorsement strategy. Aaker and Joachimsthaler (2000) divide this strategy into three categories; first, master brand as driver strategy when corporate brand is more prominently visible. Second, sub brand as co-driver strategy when two brands are given equal visibility prominence. Gray and Smeltzer (1985) name it equal dominance strategy while Murphy (1987) names it balanced strategy whereas Laforet and Saunders (1994) name it dual branding strategy. Third, endorsement strategy when corporate brand receives less emphasis than product brand. Endorsement strategy has been further classified as strong endorsement, linked name and token endorsement. Laforet and Saunders (2005) argued that companies can also use more than two brands together for a product and called it multi-branded strategy.

METHODOLOGY

The research design chosen is both exploratory and conclusive in nature.   This study is done using the secondary data. Case studies method has been adopted to analyse the branding strategies of selected MNCs in body care products segment of FMCG. The branding strategies of four MNCs which specialize in body care products in Indian market are analysed in details. This study is restricted only to the body care products of FMCG sector in Indian market.

THEORETICAL FRAMEWORK

Which is the best branding strategy? Procter & Gamble are firm supporters of product brands; are they right and l'Oréal, their more flexible competitor, wrong? Each type of brand strategy has its own advantages and disadvantages, as has been described. However, a simple list of the pros and cons does not provide a procedure for making a choice in a given company in a given market. The choice of brand policy is not a stylistic exercise, but more a strategic decision aimed at promoting individual products and ranges as well as capitalising the brand in the long term. It should be considered in the light of three factors: the product or service, consumer behaviour, and the firm's competitive position. Brand policy is a reflection of the strategy chosen by a particular company in a specific context.

What parameters should be taken into account when choosing a branding strategy?
The first is corporate strategy, of which branding strategy is in fact the symbol. For example, in 2003, Schneider Electric, one of the leaders in the field of electrical distribution and industrial control, decided to revitalise its Merlin Gerin and Telemecanique brands, which were well known to research departments and electrical integrators and installers throughout the world. In so doing, Schneider ended an initiative launched some 10 years previously with a different aim in mind, namely to replace individual brands with a single, group brand. The company's new director, who had come from Steelcase, outlined the strategic positioning of Schneider Electric against GE, ABB and Siemens. Compared with these general electrical and electronic giants, Schneider Electric is not a small general electrical company but rather likes to see itself as a multi-specialist company. In fact, because it sells intermediate products, its customers are looking for a specialist company. On the other hand, when compared with its many single-specialist competitors, Schneider Electric is more of a general electrical company. So if it wants to position itself as a multi-specialist company, the specialities must be offered by specialist brands, united by a group brand, a single entity, which facilitates customer relations. This is why it was decided not to follow the single-brand path, but to bring the range of 50 product brands together under three integrated international brands – Merlin Gerin, Telemecanique and the US company Square D, in 130 countries. There is therefore a Schneider Electric front office and a Schneider Electric sales force organised by type of customer, and these customers are able to purchase products under different product brands Another consequence is that distributors will once again become the official distributors of Merlin Gerin or Telemecanique without there being any obligation, as in the past, to automatically reference both brands. Similarly, Groupe SEB, world leader in small household appliances, decided to form itself into a multi-brand group, with four international brands – Moulinex, Tefal, Krups and Rowenta. Why not follow the tempting single-brand path, like Philips? Precisely because of Philips. The strategy lies in the art of being different. The single brand is an advantage if you are already a single brand like Philips, one of the few international brands whose reputation is based on the fact that it is distributed throughout the world – even, via its light bulbs, in the depths of the Amazon basin. It is basically too late to try to emulate Philips. In today's fragmented markets, with their aggressive distribution networks and consumer segments, it is far better to exploit the targeted reputation (in terms of product and values) of the brands that people have bought precisely because they were brands.

The second parameter is the business model. In this respect it is interesting to compare companies within the same sector, since their brand policy is often a reflection of their business model, the driving force of their competitive edge and their profitability. This can be illustrated by comparing three giants of the European cheese industry – Bel, Bongrain and Lactalis. Bel develops range brands around a central innovative product, thereby giving rise to an entire range of products with The Laughing Cow, Kiri or Mini Babybel signature. Bongrain develops product brands – Chaumes, Vieux Pané, Caprices des Dieux, Haut Ségur – while Lactalis uses a single brand (Président) as an umbrella for all its cheeses and butter, and even milk in Russia and Spain. So why the different brand policies? In fact, the business models of these companies are not the same, hence the different brand strategies. Bel likes to see itself as the inventor of modernity, anti-traditionalism, accessibility and everyday values. It does not deal in those speciality cheeses bought as a weekend treat. As the inventor of modernity, it must therefore create brands, with their own particular shapes and characteristics that can subsequently be offered in a variety of forms to capitalise on the investment in promotion. Bongrain decided to develop processed AOC (appellations d'origine contrôlées) cheeses to make them more accessible in terms of taste, price, preservability and usage. Vieux Pané is a processed version of the AOC cheese category called 'Pont l'Evêque' but, as such, does not have the right to use the name of the appellation. Bongrain therefore has to give each of the specialities it creates a new name – hence the product-brand policy. The disadvantage

of this is that it has to promote each new brand, meanwhile supporting through advertising many small volume brands. The business model of Lactalis is to segment generic categories in order to bring them up to date and into line with everyday life and the modern life-style. This model gives rise to an umbrella-brand policy – under a single brand (Président), there are descriptive names for each of the varieties, each of the various forms, with low-fat butter remaining a quality butter, Emmental a real Emmental, and Brie a real Brie.

The third parameter for choosing branding strategy is cultural. The United States has developed the culture of the product brand – a brand that produces a single product. Ivory, the founder brand of Procter & Gamble, is and continues to remain a soap, which explains the company's reluctance to extend the brand and even the ideological opposition of such authors as Trout and Ries who have berated it in their work for the past 20 years. But the US domestic market favoured this product-brand policy. On the other hand, it also explains why Europe and Japan have been the main exponents of the umbrella-brand policy. Nivea and Nestlé are just two of the many European examples. In Japan, apart from the size of the domestic market, the concept of the company has also counted for a lot in the sense that, the more products and sectors a company covers, the greater its reputation. It would simply not occur to the director of a Japanese company not to use the corporate name to promote all kinds of brand extensions. Yamaha is a typical example, putting its name to such widely diverse products as motorcycles and pianos.

The fourth parameter is the pace of innovation. How do you develop product brands in a sector that updates its offer on an annual basis? In this instance, a single-brand policy covering the entire range is preferable, as in the case of Nokia, Sony-Ericsson, Alcatel, Samsung and even Whirlpool and GE.

A fifth parameter is the added-value lever on which a product is based. When the added value in a particular market is linked to reassurance, reputation and scale, a single brand umbrella strategy is recommended (in the world of industry, this is often the corporate brand), although a source-branding strategy with two levels – a real 'branded house' like Garnier or l'Oréal Paris – can work equally well. However, the more segmented the market, with top-quality, personalized products, the more one has to favour either a portfolio of l'Oréal product brands or an endorsing brand strategy that sanctions the sub-brands (the logic of Danone or Nestlé in dairy products). Next there is the problem of resources. In the absence of sufficient funding, a company should concentrate its efforts on a single brand, especially if it is international. The need to achieve a visibility threshold comes before all other considerations. However, in case of co-branding, it is impossible to do so: this is why Philips and Douwe Egberts (a leading coffee company) created a separate name (Senseo) to designate their joint innovation in coffee machines.

Finally the brand vision impacts the choice of architecture. In the cosmetic market there are thousands of products and many scientific terms, and innovations are essential. This is what leads to an opacity in the market. Brands serve as milestones and a question that is frequently asked is which naming strategy should be used? There is no single answer to such a general question: it depends a lot on the brand's conception of itself.

CASE STUDIES CONSIDERED FOR ANALYSIS OF BRANDING STRATEGIES OF FMCG COMPANIES IN INDIA:

Most companies have evolved from being single product companies. Over time, firms accumulate manufacturing and marketing capabilities. The desire to grow, coupled with capabilities, fuels the ambition to venture into uncharted markets or purvey untried products or services. The result is obvious. A single product company from being a rule once upon a time has become an exception. It is difficult to

spot a company that offers a single product. The growth pattern followed by the marketers takes either horizontal or vertical or both directions. As the number of products handled by a company increases, the obvious question it raises is: what kind of branding relations would they enjoy. That is how products and brands would be related. The product-brand relationship as it exists in the current marketing environment can be observed with the help of branding strategies that are followed by the different companies. Companies differ in their approaches to branding. A cursory look at the branding practices followed by the companies in the East and West reveals polarity in strategies. Companies in the West favour product branding strategies. The champions of product branding include P&G, HUL from among the FMCG companies operating in India. Why do companies vary significantly in terms of their branding strategies? Many factors seem responsible. On the whole, the trade off seems to be two sided. On the other hand, cost oriented logic influences thinking in favour of a 'one brand, many products' policy, while the customer or market oriented rationale creates forces in the direction of a 'one product, one brand 'approach. Given the trade-off between the economic logic and market reality, the choice amongst the branding strategies is not easy. The difficulty of choice gets manifested in the variety of strategies that firm use to organize their brands. Had there been one universally superior way of pursuing branding, most companies would have converged on that. In reality, however, that is not the case. The case studies of top four MNCs in the FMCG sector specially body care segments are analysed below:

CASE STUDY 1: P&G INDIA

P&G India is one of the largest and amongst the fastest growing consumer goods companies in India. Established in 1964, P& G India now serves over 650 million consumers across India. Its presence pans across the beauty & grooming segment, the household care segment as well as the Health & well being segment with trusted brands that are household names across India. These include vicks, Ariel, Tide,Whisper, Olay, Gillete, Ambipur, Pampers, Pantene, Oral-B, Head & Shoulders, Wella and Duracell. Superior product propositions and technological innovations have enabled P&G to achieve market leadership in a majority of categories it it present in. P&G adopts the product branding strategy. Product branding is one extreme of the branding continuum. It is fiercly driven by consumer logic. In terms of customer perception and information processing, the most effective way to designate a product is to give it an exclusive name, which would not be available to any other product. This way, the brand is able to acquire a distinct position in the customer's mind. What the brand represents is clearly understood and internalized by the market. The purpose of branding is to differentiate your cow from other cattle on the ranch. The reality is that cattle on the ranch do look almost like clones. A successful branding programme is based on the basis of singularity. It creates on the market quite like your product. A brand must singularly represent a product. Hanging multiple products on a name is likely to cause confusion. A brand represents a position, an idea, a concept and a product. That is the way it should be.

In P&G India, each brand such as Olay, Oral-B, Pantene, Head & Shoulder etc. is promoted exclusively so that it acquires its own identity and image. The thrust is on making the brand acquire its own set of associations and a stand of its own. Product branding allows brands of P&G to acquire differentiation and exclusivity. The brand does not share other products and does not take on company associations. The company's name is relegated to the back seat to fulfill the legal compulsions which make it mandatory to identify the manufacturer. Any brand of P&G does not get benefits from the company name. The identity is not shared. The greatest advantage in favour of product branding is that a brand can be targeted accurately to a distinct target market or customers because its positioning can be precise and unambiguous. For instance, Head & Shoulder shampoo is branded as Anti-dandruff shampoo. So, those customers who want to buy shampoo to get relief from dandruff will go for Head & Shoulder rather than

Pantene. Which focus more on hair fall control. In this way, customers of P&G brands connect easily with the product brands since what the brand represents to them tends to be clear.

P&G has numerous Strategic Business Units. These include baby care, beauty care, feminine care, health care, fabric care, home care, food beverages and tissues and towels. The immediate reaction is: 'How can a company venture into so many unrelated fields ?' P&G has been an ardent follower of the product brand strategy. Its brands are standalones; people don't even know that they all share a common root in P&G. Such level of operational flexibility stems from its branding policy. The company does not share a common identity. So customers do not exclaim,'Oh! How can a company like P&G make Pringle Potato Chips? It is a detergent company! (That is, if source of Ariel is made a part of its identity). A Company following product branding is better positioned to venture into unrelated areas of activity without being subjected to market scrutiny.

CASE STUDY 2: HINDUSTAN UNILEVER LTD. (HUL)

Hindustan Unilever Ltd. (HUL) is India's largest Fast Moving Consumer Goods Company with a heritage of over 75 years in India and touches the lives of two out of three Indians. HUL works to create a better future everyday and helps people feel good and get more out of life with brands and services that are good for them and good for others. With over 110 brands, it has a large brand portfolio. In each product line, it has built a number of brands over a period of time. Some of the popular brands of HUL include Lux, Lifebuoy, Surf Excel, Rin, wheel , Fair & Lovely, Pond's, Vaseline, Lakme, Dove, Clinic Plus, Sunsilk, Pepsodent, Clear, Axe, Close-Up etc.

HUL has also been an adherent of product branding. It uses individual names to promote a product with an intention to provide it a distinct position. For instance, in the toilet soap category, HUL has brands like Lux, Lifebuoy, Rexona, Pears and Liril. In terms of positioning, Lux has been a toilet soap of film stars. Lifebuoy has always taken the position of a soap that fights germs hidden in the dirt and promotes health. It remains the only soap exclusively directed at the male user. Rexona occupies the platform of a gentle soap with natural oils to have a good effect on skin. Liril enjoys the position of a 'freshness' soap. Similarly, in the shampoo category, Sunsilk occupies the position of a beauty shampoo which makes hair soft, lustrous and bouncy, while Clinic brand is a shampoo for vitamin nourishment or for preventing dandruff. In the last couple of years, HUL appears to have abandoned its pure product brand approach. The company has instead chosen to pursue a strategy of exploiting the power of its brands to the fullest by leveraging them. It aims to now encash upon the investment over preceding decades to cultivate some of the world's most powerful brands. The product branding delivers a number of benefits to the HUL. First, with an identifiable brand uniquely positioned and directed at a segment, the firm is able to cover an entire market spectrum by making multiple brand entries. With exclusive brand creation, the firm leaves very little scope for market confusion. It is a customer-friendly approach. Customers know what to look for when specific need is triggered. Appreciating brand differences is much easier when product branding is followed especially when the products are similar.

HUL also follows the strategy of line branding. For instance, the brand,' DENIM' was introduced with a distinct concept. The brand appeals to a distinct market segment who appreciate and like the brand concept. The core idea is that brand connects with a consumer group. Today, customers do not tend to contended with one product which the brand offers. Rather they want additional products which go hand-in-hand with the brand concept or application. So the Denim users want the brand to offer all complimentary products which enhance beauty- Deodrant, Shaving Cream, After Shave, Soap and Body Talc. So HUL came up with Denim Deo, Denim Shaving Cream, Denim After Shave, Denim Soap and

Denim talc. Another example can be brand "Dove". Initially, 'Dove' was introduced as beauty bar soap. But due to the demand from the customers, 'Dove' comes with different related product with with the existing bar soap. These include Dove body wash, Dove deodrant, Dove conditioner, Dove lotion and Dove hair care. Another example we can quote here is the brand 'Lux'. Today, there are variety of related products with brand 'Lux'.These include Lux body wah, Lux bar soap, Lux shower gel etc. In this way, the products combine to form a complete whole and draw their identity from the main brand. As a result, it improves the brand's marketing power rather than selling them as individual brands.

CASE STUDY 3: AMWAY INDIA

Amway India Enterprises, the largest direct selling FMCG company in India and a wholly owned subsidiary of Amway Corporation (USA). Amway India is the country's leading direct selling FMCG-company which manufactures and sells world-class consumer products. All its products are covered by a 100 per cent Money Back Guarantee. If not completely satisfied with the product, the consumer can return it for a 100% refund. At present, Amway India offers over 130 products in five categories. They are Personal care category, Home Care category, Nutrition & Wellness category, Cosmetics and Great Value Products. With the exception of Cosmetics range (Artistry) and some products in Nutrition and Wellness category, all Amway India products and bottles are manufactured in India. The products match Amway's global quality standards. They carry a tamper-proof seal and a '100 per cent Money Back Guarantee'. Amway products are environment friendly, and are not tested on animals. Amway encourages the return of its used product bottles for re-cycling and to prevent their misuse.

Amway follows the strategy of line branding. For instance, the brand,' Body Series' was introduced with a distinct concept. The brand appeals to a distinct market segment who appreciate and like the brand concept. The core idea is that brand connects with a consumer group. Today, customers do not tend to contended with one product which the brand offers. Rather they want additional products which go hand-in-hand with the brand concept or application. So the Body Series users want the brand to offer all complimentary products which enhance beauty- Body gel, lotion, bar soap, Complexion bar etc. Another example we can quote here is the introduction of various products under the brand Santinique. Sanitique So Amway came up with Sanitique Color Care shampoo, Sanitique care conditioner, Sanitique Color and Heat prodector, sanitique Dandruff control hair etc. We can also quote the examples like Artistry Anti-Ageing Lotion, Artistry Creamy Massage, Artistry lotion, Artistry Skin care etc. Lastly, brand 'Attidude' also comes up with Attitude Doedrant, Attitude Skin Lotion, Attitude Foot cream etc. In this way, the products combine to form a complete whole and draw their identity from the main brand. As a result, it improves brands' marketing power rather than selling them as individual brands. In this way, ultimately it enhances the business building process of Amway through line branding.

CASE STUDY 4: COLGATE-PALMOLIVE INDIA

Colgate-Palmolive adopts the strategy of Umbrella Branding for its variety of products. The company enjoys the distinction of pursuing umbrella branding. The company uses its name on various products like body lotion, tooth paste, mouth wash, shampoo, liquid hand wash and soap.Some of the products of Colgate-Palmolive which uses its brand name are Colgate Dental cream, Colgate 360, Colgate Active Salt, Palmolive Aroma Shower Gel, Palmolive Thermal Spa, Palmolive Natural Liquid Hand Wash, Palmolive Soap, Palmolive Kids care shampoo-in-one etc. Umbrella branding scores well on the dimensions of economics for the company. Investing in a single is less costly than trying to build a number of brands. By leveraging a single and common name across a variety of products, the brand distributes its investment. Hence umbrella branding works out to be an economical strategy for the company. Using an umbrella brand to enter new markets allows considerable savings. The brand bestows the new product advantages of brand awareness to the company, associations and instant goodwill. That

is, the product inherits all those from the brand pool simply by incorporating the umbrella name, Colgate-Palmolive. Umbrella branding may make even more sense in the current marketing environment, characterized by information overload and brand proliferation. The brand and media scenes have become clutter to the extent that most consumers suffer from excessive bombardment of information. In a situation of information explosion, registering a brand in a consumer's mind may be nearly impossible. The strategy of Umbrella branding of Colgate-Palmolive make sense because the brand already enjoys awareness and image advantage over new brands not only in India but throughout the world.

CONCLUSION
In the new emerging scenario, brands are becoming the most valuable assets that a business can possess. Brands are wealth generators of the twenty-first century. When products are not differentiated in the factories, they are differentiated in the consumers' minds. Brands are capable of transforming mundane products into objects of desire. Accordingly, the market value of a business is determined by the number and types of brands it holds. Brands create identifiable streams of earnings for a firm. Firms like HUL, Amyway India Ltd, P&G India and Colgate-Palmolive are not highly valued because of tangible assets they hold. Rather their value is dictated by the power of their brands. Brand power is nothing if none of the customer following it enjoys.

It has been observed that companies start with one product but over time- as they accumulate manufacturing and marketing capabilities- they tend to become multi-product. As the number of products handled by a company increases, it raises certain questions; what kind of branding relations would they have among themselves? Companies differ in their approaches to branding. Western companies seem to favour product branding while the companies in the east practice mega-brand approach. A company can choose from a variety of branding strategies. Product branding is driven by customer logic. Each product is given a distinct brand name. Line branding is targeted at a market segment. It seeks to appeal to them with a concept. Usually lien brands offer complementary products and hold them together under a common concept. For example HUL adopts line branding in some case. Range brands extend beyond product complementary. Rather, the products under the range brands emanate from some area of expertise or competence. A range brand can have apparently dissimilar products – but all of them share a common expertise. Umbrella branding means promoting all products under a common name. It is favoured because of economies, but this approach is highly deficient from the viewpoint of customers' logic. Firms cover brand because of their wealth generating power. They are new generation assets. Different MNCs adopt different branding strategies depending upon their vision and goal. Some MNCs adopt multiple strategies for branding for various categories of products but some companies adopt a single strategy for the variety of products as a branding strategy.

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CONSUMER BEHAVIOUR ON SMARTPHONE'S - A STUDY ON THE PERCEPTIONS OF YOUTH POPULATION WHILE PURCHASING SMARTPHONE'S.

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ABSTRACT

Mobile phone now a day's become the necessities of an individual life. Now instead of a simple phone, people now prefer to have Smartphone which provides many applications to the consumers. Smart phones are the advanced form of mobile phones which provides wide range of application to the consumer such as advance ability of computing, it also provides all things which a computer system provides as well as access the internet on high speeds can be possible through this, through this it is possible to manage both your personal as well as professional e-mail accounts through smart phones. There are two choices available for a consumer whenever he/she thinks to buy a smart phone either an Apple iphone or a Blackberry phone. In order to know about the consumer purchase behaviour and purchase process when it comes to buy Smartphone's by youth generation, I have conducted a research on this topic. I have prepared a structured questionnaire in order to know about their behaviour while purchasing and also to know which all factors that they consider in order to take their decision of purchasing a Smartphone. This paper presents the results of survey of 900 respondents relating to their behaviour while purchasing Smartphone's.

Keywords: Consumer Behaviour, Smartphone's, Apple iphone, Blackberry, Gadgets

1.0 INTRODUCTION TO SMARTPHONE'S

Smartphone's are the advanced form of mobile phones which provides wide range of application to the consumer such as advance ability of computing, it also provides all things which a computer system provides as well as access the internet on high speeds can be possible through this, through this it is possible to manage both your personal as well as professional e-mail accounts. In addition to this various feature provided by Smartphone's are as follows: - first one is there is an application called PDA which is used in order to store the personal information so that you can access this information at any time whenever require by you (Asif & Krogstie, 2011). Second one is it is possible to search for a place through the map application provided in these Smartphone's. There are various Operating systems which are used in Smartphone's which are as follows:- RIM which are used in Blackberry phones, iphone, Android etc. In UK the demand for smart phones are increasing day by day due to its application. According to a report more than 275 of adults of UK are using Smartphone's. There two most popular brand among the UK adults first one is Apple iphone which is covering 32% share among adults in UK and second one is Blackberry Smartphone's which are captured around 24% market share in UK and its consumers are mostly younger adults and teenagers (Reuver, 2011). In UK in between 2010-11 the share of Android is increased from 1% to 9.2% approximately. The share of Apple iphone is increased from 6% to 11% approximately and the share of RIM almost goes double which can be cleared from the table in annexure 1:-

1.1 CONSUMER BEHAVIOR

Buying behavior of consumer means the manner a consumer behaves and reacts while taking a decision to purchase anything, in the present study it is related to take a decision to purchase a Smartphone. There are many steps involved in this first is to recognize the need to have a Smartphone. This need may arise due to any reason. Second step is to collect the necessary information to satisfy that need. There are two main ways in order to collect the information first one is internal sources which is our memory and second way is to collect through external means such as friends, family and websites etc. As today is the world of globalization and competition, if you want to purchase a particular thing there are various choices available, like if you want to buy a Smartphone there are various options available such as Apple iphone, Blackberry and so on. Now a consumer has to evaluate each alternative for the purpose of taking the decision related to purchase. After purchasing the thing now main thing is satisfaction, it depends upon the customer services provided by the companies. If a consumer is satisfied with these services then he may repeat the purchase but if he/she is not satisfied with the customer services, then they never purchase that thing again and it will create a negative image of company in their mind. sometimes there is no need of that thing in the life of consumer he/she may purchase the thing because their friends are having the Smartphone or some consider it as a symbol of status *(Chaudhuri and Holbrook, 2001).* In order to take decision about purchase, generally a process is followed by the consumer. First of all there is a need for that thing and in order to satisfy this need he collect information either by external or internal means, then find out the alternatives and then evaluate these alternatives in order to take final decision whether to purchase Smartphone's or not. If after purchasing, he is having positive feedback then it will lead to positive word of mouth communication which in turn have a positive effect on the image and goodwill of the company.

1.2 IMPORTANCE OF STUDYING CONSUMER BEHAVIOR

Now a day's consumer is the central point for every organization. As it is possible to maximize revenue of the company only when the desire or needs of consumer is fulfilled, so for this first of all there is an urgent needed to understand the behavior of consumer while purchasing. Through this it is also possible to know about the various factors that influence consumer behavior. It is very important for producers as with the help of this it is possible for producer to design the product as well as services. On the other hand advertisers by knowing the behavior of consumer decide about the advertising strategy,

2.0 LITERATURE REVIEW

Smartphone's mainly prefer by those consumers who used phone in order to store information as well as want entertainment in his life. Apples targets segments which includes class of those who are either persuing any professional degree or indulge in any profession (Terui, 2004). In the current study I have taken respondents from university who all are having Smartphones, through this it is possible for me to know about their point of view about the Smartphone's. If we consider the market share of Apple Iphone it is relatively less as compare to Nokia or Blackberry. But due to advancement people now prefer to own a Smartphone because of its application and features such as speed of accessing internet is very high as well as gaming feature and so on (Bindle & Boden, 2011). There are various factors that lead to increase in the demand of Smartphone's, first factor is social as well as cultural factors, in which following things such as due to change in preference of consumer the demand for these phones are increasing and people now depends upon the mobile in order to keep in touch with each other everywhere and in Smartphone's various additional features are attached as well as due to increase in literacy the demand for Smartphone's are increasing (Bogue , 2010). The perceptions of the consumer towards the technological devices are changed in a positive manner. These are some of the social and cultural factor that affects the demand for Smartphone's. Now political factors that should be taken into consideration are as follows such as

taxation policy are the law of importing. In the list of mobile phones company there are no. of phones are available that increase competition in the market (Goode, 2010). The main targets of this Smartphone's are professionals, corporate users, students, entrepreneurs and medical users. The main purposes of professionals to use Smartphone's are as follows in order to keep in touch with others as well as to store information (Gilad, 2011). The students are using Smartphone's is to do many tasks simultaneously without carrying any additional gadgets. These Smartphone's is considered to be a symbol of status and uniqueness (Rich, 2011). The corporate users are using Smartphone's for the purpose of storing the information as well as access the information whenever there is a need for such information. The Entrepreneur uses Smartphone's for the purpose of recording their appointment. Medical users are using the Smartphone's for the purpose of storing their medical record as well as check and update the information (Goldman, 2010)

In Order to make improvement in iPhone there is a need to emphasis on the marketing research. For the purpose of ensuring success it is essential to do market research for this as well as keep in touch with you customer and handle their problem with dignity and care. In order to get iphone known by all it is important to extend the base of your customers, now iphone also targets both business class as well as professional people. Also now its targets different age groups such as the group having age in between 15-20, then 20-26, 26-43 and 43 and above. Through this it is possible to increate the market share (Jungsun & Kizildag, 2011). The people of age group of 15-20 use iphone for the purpose of accessing internet, for gaming purpose and downloading songs and all. The person of age group of 20-26 uses iphone for all above purpose, in addition to this they are using iphone for storing their personal as well as professional information (Mohr & Slater, 2011). The people of age group of 26-43 generally use iphone for storing critical information and for business application as well they also use this for social and personal purpose. The main thing which makes Apple from social phone to a business phone the awareness of brand plays an important role. For this a survey is conducted in order to know about the views of people about iphone features so that changes are implemented in the next generation iPhone (Pantano & Servidio, 2011).

3.0 RESEARCH METHODOLOGY
It is one of the most important areas which is related to methods as well as decision of steps taken in order to perform a research work is decided, if we are considering its simple meaning it means steps followed in order to get deep knowledge of the topic so that important conclusions and results are drawn easily. It includes following steps first one is to identify the problem, and then decide about the research design as well as sources from where the data is collected. In this one of the most essential step in research is to decide about the methods and reason why this method or technique is adopted as well as decide about the no. of samples which means sample size and then collect necessary information from them and in last decide about the techniques used in order to analyze that data.

3.1 PROCESS OF RESEARCH
Research process means step followed in order to conduct the research work. Similarly for this research study first of all, the research problem is identified which is to understand behavior of customers while purchasing Smartphone's, then a research design is formulated in order to decide about the conceptual framework for the research. After formulating research design the researcher has identified the sources from where data can be gathered to accomplish the research objective. For this research data has been gathered both from primary & secondary sources since the primary data were required to understand the behavior as well as factors that influence them to purchase Smartphone's. After identifying sources a structured open-ended questionnaire was designed to collect data from customers. A sample size of 900

units was selected. After collecting the data from 900 respondents this data was analyzed using Bar Diagrams, Pie Charts & Chi Square test & then interpretations were made thereafter.

3.2 OBJECTIVES OF THE STUDY

The main objective is to study the Consumer behavior and purchase process while purchasing a Smartphone. In addition to this it includes:-

1.   To analysis the needs of consumers.

2.   To analyze the consumer decision making process with due attention to factor responsible for it.

3.   To know the brand loyalty among the consumer.

4.   To find out the motivating factors for consumer in purchasing Smartphone's

5.   To know about the point of view of those people who wants to purchase a Smartphone as well as their behavior in relation to the application of it.

3.3 JUSTIFICATION OF THE STUDY

This study is mainly focus on to find out factors that influence a consumer to purchase a Smartphone. The Methodology used in the making of this Report is the collection of the Primary data. The data is collected through Primary Resources i.e. Questionnaire method. Lastly, performance evaluation was done to know how effectively and efficiently are the mobile phone providers working in order to satisfy the needs of users. This comparative study is considered to be very important for those who want to purchase Smartphone. It can be used before taking a purchase decision for a smart phone This is essentially done through the analysis of various characteristics of phone like applications offered, games, email service, messenger etc. This analysis may be compared with the other studies done on this earlier. This study will also help in any further studies for a comparison of the present with the past. It is the expert who has to analyse significantly whether blackberry or apple iphone is better. So this topic is chosen so as to know what the mobile users like. This topic will help me, as a student, in getting practical knowledge of the technical area and to know what the users want in a mobile phone. The project is to be carried out aims to perform the comparative analysis to find out the better product between apple iphone and blackberry as well as through this it is possible to analyze the behavior of consumer while purchasing Smartphone's as well as various factors that motivate them to purchase Smartphone's.

3.4 RESEARCH DESIGN

In this study descriptive research design as it involves a survey which main aim is to gather and analyze relevant data that will provide the necessary information so that decision related to purchase of a Smartphone is taken by evaluating all the alternatives.

3.5 SAMPLE DESIGN

a) **Sampling Design: –** In the current study, in order to carry out the research work, non probability sampling technique is adopted , in this investigator on the basis of his suitability chose the sample.
b) **Respondents: -** They are the students and belong to age group starts from 20 and ends to 29.
c) **Sampling Unit –** Sampling unit is Individual person.
d) **Sample Size –**900

3.6 DATA COLLECTION TECHNIQUES

For this research secondary data has been collected through various websites and literature review is done to gather the information from the pioneering work of various persons. Also Primary data was collected through administering a structured questionnaire to 900 youth respondents.

Primary data has been collected using structured questionnaires (Annexure). It is considered to be a research instrument which consists of various questions in order to know about the behavior of customers while purchasing Smartphone's as well as through this it is possible to make comparison between the features of iphones and Blackberry and then it is convenient to know which Smartphone is better on the basis of its application. Secondary data is collated through various books, magazines, taking reference of any other author study etc.

3.7 DATA ANALYSIS TECHNIQUES

Descriptive research will find the answers for the questions as who, when, what, where and how topic can called be descriptive. After collecting data by filling up the questionnaires now it is important to analyze that data for the purpose of getting important results. Data is presented in tables and then with the help of this making bar diagrams. There are various tools and techniques which are used in order to analyze the data first one is collect the data and then arrange that data in form of tables, diagrams and apply various test such as chi square test which is generally used in which a comparison between expected and observed values is taking place in order to draw results:-

Various tools used for data analysis are as follows:

CHI-SQUARE TEST

In order to know whether there is any difference in thinking of respondent's which are divided on the basis of gender regarding their preference to Apple iphone and Blackberry. It is used in order to know the basic difference between expected and observed values. In order to calculate its value, firstly expected values are subtracted from observed values and then finding out the squares of these differences and then the resultant figure is decided by the expected value and then find out the total of this it is termed as calculate or critical, now Degree of freedom is calculated by multiplying r-1*c-1 where r means rows in the table and c means columns in the table. Now tabulated value is calculated, then tabulate value is compared with critical value. If critical value is less than tabulated value, then null hypothesis is accepted otherwise it is rejected.

TESTING OF HYPOTHESIS

H_0: There is no difference in thinking of respondent's which are divided on the basis of gender regarding their preference to Apple iphone and Blackberry.

H_1: There is difference in thinking of respondent's which are divided on the basis of gender regarding their preference to Apple iphone and Blackberry.

Table 1.1 : PROFILE OF RESPONDENTS

Profile of Respondents	Respondents (900)	
Age (in yrs)	**N**	**%**
20-24	487	54.11

24-29	413	45.89
Occupation	**N**	**%**
Students	593	65.89
Business	307	34.11

Table 1.2 : PROFILE OF RESPONDENTS

Gender	Male		Female	
	N	**%**	**N**	**%**
	550	**61.11**	**350**	**38.89**

INTERPRETATION

1) The Profile of respondents as depicted in Table 1.1 shows that majority of them i.e. 593 respondents almost 54.11% fall in the category of age bracket of 20 to 24 years and remaining 413 respondents i.e. 45.89% fall in the category of age bracket of 24-29.
2) Majority of the respondents who were a part of this survey constituted of 593 students (65.89%) followed by 307 business persons (34.11%).
3) Due importance was given to take response from both male and female respondents and hence 350 (38.89%) females participated in this survey as against 550 (61.11%) male respondents.

Table No. 1.3 : Importance of style and design while purchasing Smartphone's

Use	N (50)	No. of Respondents (%)
Not Important	54	6
Fairly Important	540	60
Very Important	306	34

INTERPRETATION

By analyzing the response of the above question it is concluded that about for 6% of people style of a mobile phone is not important, for 60% style if fairly important and for 34% style is very important.

Table No. 1.4 : Money you ready to spend on purchasing phone

Money you ready to spend on purchasing phone	N (900)	No. of Respondents (%)
£100-£200	180	20
£200-£300	234	26
£300-£400	198	22
More than £400	288	32

INTERPRETATION

By analyzing the response of the above question it is concluded that about 20% of people are willing to spend from £100-£200, 26% of the respondents are willing to spend between £200 and £300, 22% of the respondents are willing to spend between £300 and £400 and remaining 32% of the respondents are willing to spend more than £400 in order to purchase a mobile phone, so majority i.e. 32% of the respondents are willing to spend more than £400 in order to purchase a mobile phone

Table 1.5 : Comparison of Blackberry Vs Apple iphone

Basis of comparison	Blackberry	%	Apple iphone	%
On the basis of Application	414	46	486	54
User Friendly	594	66	306	34
Gaming purpose	360	40	540	60
Better Messenger Services	540	60	360	40
Better gravity Call	522	58	378	42
Professional in nature	468	52	432	48

INTERPRETATION

By analyzing the response of the above question it is concluded that about 54% of respondents like iPhone in terms of applications and 46% of respondents like Blackberry in terms of applications. So majority of the respondents prefer iphones when it comes to applications. Apples targets segments which includes class of those who are either perusing any professional degree or indulge in any profession (Terui, 2004). In the current study I have taken respondents from university who all are having Smartphones, through this it is possible for me to know about their point of view about the Smartphone's. If we consider the market share of Apple Iphone it is relatively less as compare to Nokia or Blackberry. 66% of respondents feel that Blackberry phone is more user friendly while 34% of respondents feel iphone is more user friendly. So majority of the respondents prefer Blackberry when it comes to friendliness regarding usage of phone. 40% of respondents prefer Blackberry for gaming while 60% of respondents prefer iPhone for gaming. 60% of respondents feel that Blackberry has better messenger service while 40% of respondents feel that iPhone has better messenger service. 58% of respondents feel that Blackberry has better gravity call while 42% respondents feel that iphone has better gravity call. 52% of respondents think that Blackberry is more professional while 48% think that iPhone is more professional

Table 1.6 : Buying force

Buying Force	N(900)	Percentage
Friends / Relatives	342	38
Retailers	104	11.56
Brand Image	76	8.44
Advertisement	378	42

INTERPRETATION

Above table and graph shows that Out of 900 respondents, 38% of respondents are influenced by friends and relatives, 11.56% of respondents are influenced by retailers, 8.44% of respondents are influenced by brand image and 42% of respondents are influenced by advertisements. So it is concluded that majority of respondents are influenced by advertisements. This includes references group consumers accept information provided by their peer groups on the quality, performance, style, etc. these groups influence the person's attitude, expose them to new behaviors and' life style, and create a pressure on the individual. Most consumers belong to a family group.

Table 1.7

NULL HYPOTHESIS	Calculated Value of Chi-Square	Tabulated value at 1 d.o.f	Hypothesis
1. There is no significant difference between Male and female on the basis of application of both Blackberry and Apple Iphone	1.525	3.84	**Accepted**
2. There is no significant difference between Male and female on the basis of user friendly approach to both Blackberry and Apple Iphone	1.3334	3.84	**Accepted**
3. There is no significant difference between Male and female on the basis of gaming function of both Blackberry and Apple Iphone	19.947	3.84	**Rejected**
4. There is no significant difference between Male and female on the basis of better Messenger Services of both Blackberry and Apple Iphone	43.033	3.84	**Rejected**
5. There is no significant difference between Male and female on the basis of better gravity call of both Blackberry and Apple Iphone	29.192	3.84	**Rejected**
6. There is no significant difference between Male and female on the basis of professional nature of both Blackberry and Apple Iphone	1.517	3.84	**Rejected**

5.0 FINDINGS

Following are the important objectives or we can say that the important research findings are as follow:

- **To understand the consumer behaviour while purchasing Smartphone's**

The acknowledged marketing techniques are the ones that employ people in the product without any effort. It is achieved when individuals are discussing about it among themselves. The main idea that is distressed to make it happen is the knowledge of targeted consumers and information of what makes them happy (Sernovitz, 2009).

- **To understand how important is the marketing strategy on the customer's satisfaction.**

If you want to buy a particular thing then there are various alternatives available, the buyer has to evaluate each alternative before taking the final decision related to purchase. But after taking the decision related to purchase if there is some doubt in the mind of consumer about the choice or a feeling of restlessness after buying a product is known as "cognitive dissonance, In order to reduce the feeling of dissatisfaction one of the important strategy used by them is to take opinion of others, if the people around them assure them about the wisdom of their decision, cognitive is reduced to a very great extent. It is also essential to collect that information which is in support of your decision related to purchase. Advertising is one of the important sources of supportive information. Consumers may give more attention to advertisements for the brands that they have chosen. Provide good quality products (ideas/good/services) that meet customer's expectations after the purchase has been made. Do not design advertisements that create unreasonable expectations that their products cannot meet. Because if it cannot meet the expectations created by its advertisements then there will be cognitive dissonance in consumer's mind. Marketers may also send supportive information in order to assure consumers that there decision related to purchase is correct. This will give the customers a sense of security that from whom they have purchased the product is still there with them.

5.1 SUGGESTIONS AND RECOMMENDATIONS

- Both the companies should focus on increasing their market share by utilizing the opportunity available in the form of people now becoming more and more open towards smart phones due to developing internet wap, wifi services all around.

- Iphone should work on its messenger service to compete with Blackberry and overcome this competitive drawback faced by it.

- Blackberry is a winner when comes to professional services but the company needs to work hard to overcome or match the gaming and entertainment services or applications offered by iphone.

- Blackberry should target youngsters to increase its market share and iphone on the other hand should increase its presence in corporate world.

- Iphone should also focus on improving its presence in the market as it is very less as compared to blackberry.

- Most important of all is that both the players should increase the awareness about their applications, services and special features which differentiate them from other players like Nokia from which they are facing stiff competition.

5.2 CONCLUSION

The market coverage for both Blackberry and Iphone in UK are more as compare to other market players like Nokia and Sony Erricson. Most of the people use their mobile phone for SMS purpose and the messenger service which provided by Blackberry is very good as compare to other mobile players such as Nokia. People are now switching towards smart phone. Therefore it is a good signal for Blackberry and Iphone for future growth.

Most of the people prefer at least their mobile phone screen should be medium sized. Blackberry has a medium sized screen as compare to a big screen of Apple iphone. Majority of people like stylish phones

and when it comes to comparison between Blackberry and Iphone, Iphone wins the race as it is more stylish.

Cost of Iphone lies between £300-£400 and more and Blackberry lies in all the categories starts from £100 and above. Iphone is a better option when it comes to application but Blackberry phone is more users friendly. Iphone is a better then Blackberry for gaming but when it comes to gravity call, blackberry is a better option. Blackberry also comes out to be better professional phone as compared to iphone. The iPhone will be promoted as both professional and hip. The market of smart phone is leading by Apple's iPhone but there is threat which is available for Apple's iPhone which is Google's Android mobile operating system. In Order to make improvement in iPhone there is a need to emphasis on the marketing research. In order to get success it is essential to do market research for this as well as keep in touch with you customer and handle their problem with dignity and care. In order to get iphone known by all it is important to extend the base of your customers, now iphone also targets both business class as well as professional people. Also now its targets different age groups such as the group having age in between 20-24 and 24-29.

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CORPORATE SOCIAL RESPONSIBILITY: IS IT A POSITIONING STRATEGY ?

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ABSTRACT

CSR is a process with the aim to embrace responsibility for the company's actions and encourage a positive impact through its activities on the environment, consumers, employees, communities, stakeholders and all other members of the public sphere. The role of Corporate Social Responsibility in the business world has developed into an important aspect of corporate behavior over the past several years. More or less it has become a strategy to position a brand. Since if a corporate is able to create a socially responsible image in the eyes of customer it enjoys a top position in the minds of customer which in turn can affect the profitability of the company in long and in a way helps in enhancing value for company.

Purpose: *The aim of the research is to understand the customer perception regarding CSR activities also to analyze the firms which are using CSR as a positioning strategy & the extent to which they are successful.*

Design/methodology/approach: *It is a descriptive research in which we have incorporated the views of various customers using questionnaire as a statistical tool. A sample size of 40 customers is considered for the study and the sampling technique used is convenience sampling. The resulting data is analyzed by SPSS 20 software for understanding the general customer perception regarding CSR activities and if they impact the image of a corporate in the eyes of customer?*

Findings: *The study finds that still the correct understanding of CSR is not spread in most of the masses but any kind of philanthropic activity performed or persuaded by any corporate house does impact their credibility in the market and is somehow successful in positioning a brand .*

Research limitations: *Major limitation of research is that though it is covering a very broad topic, the sample size of 40 customers may not be the correct representative of the entire population.*

Originality/Value: *corporate social responsibility is a very wide area and it cannot be covered in single research, however we have tried to gather the customer's insights into the given topic and have tried to elaborate upon the same.*

Key Words: corporate social responsibility, brand, positioning, strategy.

INTRODUCTION

Positioning strategy refers to the choice of target market segment which describes the customers a business will seek to serve and the choice of differential advantage which defines how it will compete with rivals in the segment (Doyle, 1983). A Positioning Strategy is how the company wants to be perceived in the minds of prospects versus its competition. Positioning clearly distinguish the company

from its competitors. The positioning strategy is based on the value prospects (in a particular market segment) expect to receive relative to and unique from the competitors as it relates to addressing specific customer decision making criteria.

Types of positioning strategies

A positioning strategy is vital to provide focus to the development of advertising campaign. The strategy can be conceived and implemented in a variety of ways that derive from the attributes, competition, specific applications, and the types of consumers involved or the characteristics of the product class. Each represents a different approach to developing a positioning strategy, even though all of them have the ultimate objective of either developing or reinforcing a particular image for the brand in the mind of the audience. seven approaches to positioning strategy are presented : (1) Using Product characteristics or Customer Benefits (2) Price quality approach (3) The Use or Application approach (4) Product user approach (5) The Product Class approach (6) The cultural symbol approach (7) The competitor approach

Using Product characteristics or Customer Benefits as a positioning strategy

This strategy basically focuses upon the characteristics of the product or customer benefits. For example if we say Imported items it basically illustrates a variety of product characteristics such as durability, economy or reliability etc. Sometimes even it is being noticed that a product is positioned along two or more product characteristics at the same time.

Pricing & Quality as a positioning strategy

Pricing plays an important role in positioning a product since almost each and every customer expects quality product in return for the money which is spent. Sometimes it is also observed that we prefer to buy highly price product basically because of perception, as most of us perceive that if a product is expensive will be a quality product where as product that is cheap is lower in quality. If we look at this Price – quality approach it is important and is largely used in product positioning. In many product categories, there are brands that deliberately attempt to offer more in terms of service, features or performance. They charge more, partly to cover higher costs and partly to let the consumers believe that the product is, certainly of higher quality.

Positioning strategy based on Use or Application

Positioning by use of application refer to the fact that the focus of marketer is on how the use of the product should be given utmost importance? And how can such product be linked with that particular use? Basically this type of positioning is done deliberately to expand the brand's market. Introducing new uses of the product that will automatically expand the brand's market. For example Nescafe Coffee for many years positioned itself as a winter product and advertised mainly in winter but the introduction of cold coffee has developed a positioning strategy for the summer months also.

Positioning strategy based on User

Another positioning approach is to associate the product with its users or a class of users. In this kind of positioning focus is on how the product can be best alternative of a particular user group? The best example can be of Johnson and Johnson which is repeatedly used for years and years for babies and the brand has positioned itself as a baby products brand.

Positioning strategy based on Cultural Symbols

In today's world many advertisers are using deeply ingrained cultural symbols to differentiate their brands from that of competitors. The essential task is to identify something that is very meaningful to people that other competitors are not using and associate this brand with that symbol. Using and popularizing trademarks generally follow this type of positioning.

Positioning strategy based on Product Class
Positioning by product class can be done if two products lie in the same product class. Thus by joint promotions, both of these products improve their positioning. Positioning by product class mainly uses sales promotion as it tool. For example Get a toothbrush with toothpaste free. Both of these products lie in the same product class and hence can be positioned accordingly.

Positioning strategy based on Competitors
 In this type of positioning strategies, an implicit or explicit frame of reference is one or more competitors. In some cases, reference competitor(s) can be the chief aspect of the positioning strategies of the firm, the firm either uses the same of similar positioning strategies as used by the competitors or the advertiser uses a new strategy taking the competitors' strategy as the base.

Figure -1 Types of positioning strategies

CSR as a positioning strategy
Corporate social responsibility is the actions built by corporations to benefit society in one or the other manner. These actions are beyond pursuing any rules and policies which are made by government organizations in other words we can say it is an additional responsibility towards society which are taken up by organizations on voluntary basis .

CARROLL'S MODEL OF CSR

(Carroll,Archie B.,1991) "It is suggested here that four kinds of social responsibilities constitute total CSR: economic, legal, ethical and philanthropic. Furthermore these four categories or components of CSR might be depicted as a pyramid. To be sure all of these kinds of responsibilities have always existed to some extent but it has only been in recent years that ethical and philanthropic functions have taken a significant place".
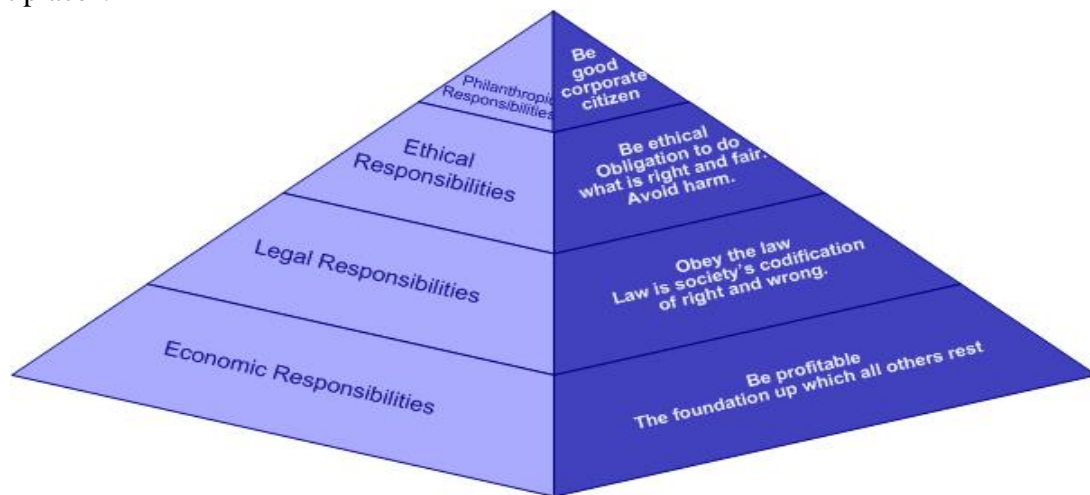
Carroll's CSR Pyramid

Figure -2 source: Carroll, Archie B., (1991) "The Pyramid of Corporate Social Responsibility: Toward the Moral Management of Organizational Stakeholders".

Economic Responsibilities

In the past business organizations were created as economic units designed to provide goods and services to societal members. The profit motive was established as the primary incentive for starting up any kind of business. Business was considered to be a basic economic unit in the society and the principal role which was assumed to be taken up by them was to produce goods and services that consumers needed and wanted and to make a reasonable profit in the course. However the idea of the reasonable profit motive got changed into a notion of maximum profits.

Legal Responsibilities

Society has not only authorized business to operate according to the profit motive at the same time business is expected to obey with the laws and regulations publicized by federal, state, and local governments as the basic rules under which business must operate. Business is always expected to fulfill its primary motive for profit making within this frame work of certain rules and regulations .Legal responsibilities reflect a view of "codified ethics".

Ethical Responsibilities

Though legal responsibilities cover the major aspect of ethics, ethical responsibilities symbolize those standards, norms, or expectations that reflect a concern for what consumers, employees, shareholders, and the community regard as fair, just, or in keeping with the respect or protection of stakeholders' moral rights. Ethical responsibilities include as that which is much more than law, it is a higher level of performance than the requirements designed in the law structure.

Philanthropic Responsibilities
Philanthropy includes those corporate actions that are in response to society's expectation that businesses appear be good corporate citizens. This includes actively engaging in acts or programs to promote human welfare or goodwill. Examples of philanthropy include business contributions to children education, building old age homes, providing financial help to farmers in villages, etc.

OBJECTIVE OF THE STUDY
The main objective of the paper is to understand people perception and understanding about the term CSR. We have also tried to understand whether a company with more CSR activities has been able to position itself.

Data Analysis Methods
This study used statistical analysis software—SPSS 20.0 for Windows. In SPSS 20.0, frequency analysis and other statistical methods are used for the recovery and analysis of questionnaire data.

Sample Description
SPSS 20.0 statistical software was used to analyze the 40 questionnaires which were filled out with basic personal information and with various responses of the respondents. The sampling technique which was used is convenience sampling which is one of the widely used techniques of probability sampling. The sample size consists of various students, academicians and few corporate employees.

DATA ANALYSIS
Table 1.1 : Are you aware of the term corporate social responsibility

	Frequency	Percent	Valid Percent	Cumulative Percent
yes	26	65.0	65.0	65.0
no	14	35.0	35.0	100.0
Total	40	100.0	100.0	

Table 1.1 shows that 65% of people are aware of the term corporate social responsibility and 35% of people are still not aware of this term. However further questioning with them shows that they are showing positive responses towards the corporate which are doing philanthropic activities.

Table 1.2 : With the philosophy of making profits in business, do you think it is justifiable for companies to be socially responsible?

		Frequency	Percent	Valid Percent	Cumulative Percent
	yes	36	90.0	90.0	90.0
Valid	no	4	10.0	10.0	100.0
	Total	40	100.0	100.0	

The data shows that 90% of people believe that it is acceptable & justifiable for companies to be socially responsible and the companies should perform such operations on a regular basis.

Table 1.3 : Which of the following statements reflect that a company is socially responsible?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Adhering to laws	10	25.0	25.0	25.0
	Making reasonable profits	10	25.0	25.0	50.0
	Spending money in developing infrastructure for the growth of economy	2	5.0	5.0	55.0
	Giving yearly dividends	1	2.5	2.5	57.5
	intensifying activities in such a way that every aspect of them benefits society in one or the other manner	17	42.5	42.5	100.0
	Total	40	100.0	100.0	

The data however shows that people are still not very clear about the definition of CSR since CSR is not restricted to certain parameters but the concept of CSR still needs to extend itself in each and every person in the society.

Table 1.4 : Do you think ITC has established itself as a socially responsible company?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	31	77.5	77.5	77.5
	no	9	22.5	22.5	100.0
	Total	40	100.0	100.0	

ITC which is known as Indian Tobacco Company and it has a core business of selling tobacco. It was started around 1910; in the name of imperial tobacco company which was british owned has now positioned itself as a company with the focus on society development. The gathered data shows 77.5% of people agree that ITC has established itself as a socially responsible company.

Table 1.5 : Do you like to purchase products of companies which are socially responsible?

		Frequency	Percent	Valid Percent	Cumulative Percent
	yes	38	95.0	95.0	95.0
Valid	no	2	5.0	5.0	100.0
	Total	40	100.0	100.0	

Table 1.6 : Do you think that by purchasing products of such companies you also contribute to society?

		Frequency	Percent	Valid Percent	Cumulative Percent
	yes	35	87.5	87.5	87.5
Valid	no	5	12.5	12.5	100.0
	Total	40	100.0	100.0	

Table 1.5 & 1.6 shows that majority (data shows 95% of customers are willing to purchase) of customers are willing to purchase the products of companies which are socially responsible and 87.5 % of them believe that in this way either directly or indirectly they are also contributing in the growth of society.

Table 1.7 : Do you think that companies with more social initiatives sell quality products?

		Frequency	Percent	Valid Percent	Cumulative Percent
	yes	38	95.0	95.0	95.0
Valid	no	2	5.0	5.0	100.0
	Total	40	100.0	100.0	

Table 1.8 : Quality of products & services is an important aspect in responsibility towards society?

		Frequency	Percent	Valid Percent	Cumulative Percent
	yes	36	90.0	90.0	90.0
Valid	no	4	10.0	10.0	100.0
	Total	40	100.0	100.0	

Table 1.7 & 1.8 shows that people also link quality with social responsibility and they perceive that if a firm is selling quality products they in a way serving society also they have a perception that any firm which is socially responsibly will always sell quality products.

CONCLUSION
The study concludes that CSR though is not a new term but still a major mass of population is not aware about the concept. The customers who understand CSR believe that a company which is engaging itself in

CSR activities is meant to deliver quality products; the underlying assumption is that it is highly sensitive towards society. Also the quality aspect of product is linked with CSR. ITC is perceived to be a socially responsible company. In a way we can say that majority of us believe that we are living in a society which needs enormous improvements and if we observe that any firm or any individual is doing so, we assume that person/firm to be highly insightful. Hence CSR can be used as a strategy to position a brand.

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GOOGLE CHALLENGES WHILE ENTERING CHINA

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ABSTRACT

*The present paper is about the entry of Google in a totalitarian regime of China, having very strict laws and rules related to the freedom of speech and expression, which eventually is also applicable to the working and operations of internet search engines, as early as in the year 2000. Google was a US based search engine which launched its IPO in the year 2004 and was growing at a very healthy pace. It had a global presence with profit margins to the tune of above 25 percent in the year 2006. However, its operations in China were negatively affected by the deliberate attempts by the Chinese government to make the website of Google.com very slow. To be able to make information available to the Chinese population, the top echelons of the Google management decided that instead of not letting the Chinese have any access to the Google content, it ensured that at least some information was made available to them; even if that was through the process of self censorship. This decision was materialized in the launching of Google.cn in the year 2006. The newly launched website posted contents and materials which was allowed by the authoritarian practices of the Chinese government. However, the trouble for the Google surfaced when the US authorities alleged that the US internet industry, with special reference to Yahoo, Cisco, Microsoft and Google were working against the freedom of speech and expression in China and favoring the information filtering process of the Chinese government (**Oliver & Shinal, 2005**)*

Keywords : Google, Google.cn, China, Yahoo, GooglePlex, Microsoft

1.0 INTRODUCTION TO GOOGLE

Google there is no need to give introduction to the word Google it is considered to be the world largest site for searching information in a quick way. It came into existence on 1998 by two students Of Stanford. They stated their work like an assignment given by the college. But they both by using some unique technique develop such an efficient quick engine which provides information very easily. Such unique idea attracts the mind of many people as well as their co fellows towards them as well as there are some investors who show their interest in financing their project. After that they collect some funds from their families, friends as well as from their investors for the purpose of opening their office at California. But now a day's it's performs its operations from a very big place at California named GooglePlex. As the time passes Google expands its business it's not only considered to be a search engine but also facilitates various services like mapping services as well as you open an account at Google also and so many services in addition to this. The no of products launched by Google now increases to 40 as well as it are

also expands its business and network in more than 150 countries all over the world. Due to its expansion and diversification strategy it becomes the no 1 search engine all over the world.

1.1 Market Performance of Google

Before knowing about the market performance of the Google it is essential to know about the mission as well as purpose of the Google which are explained below:

1.2 Mission of Google

The mission of Google is to collect and then organize the information related to any topic in such a way one can easily get this information without facing any difficulty.

1.3 Purpose of Google

The no of products launched by Google now increases to 40 as well as it are also expands its business and network in more than 150 countries all over the world. Due to its expansion and diversification strategy it becomes the no 1 search engine all over the world. The main purpose of Google is to save the time of their users by representing the information in such a way that one can easily get this information in order to make the Brand Google universal brand which is used by everyone *(Walton, 2001).*

If we look at the data of 2011 we found that the Google lost about 16% of the share of the market by reducing its share to 64% which is previously 74%, On the other hand Microsoft increases its market share to 75% which is previously quite less. There are various sites which also help in searching the information such as Yahoo; Ask their market share is increasing day by day which is considered to be a threat for the Google. It is also cleared from the above fact that in 2010 the no of people who access Google for search of information are around 160 million which in 2011 reduced to 135 million. On the other hand there is increase in the number of people who access Microsoft from 61 to 93 million which is a good signal for Microsoft but a very bad indicator for Google

2.0 REASONS OF GOOGLE ENTRANCE IN CHINA

In recent year China wants to make itself a modern economy and expand its operations all over the world by adopting global strategy. There are various reasons for Globalization such as universal recognition as well as due to opportunity of growth in the foreign market are more. In between the period of 2002 to 2006 the market share of Google in china is reducing rapidly now the option available with Google either to stop its operations in China or to adopt some changes in order to expand its business in China *(Walton, 2001).* For this there is a discussion on this topic in order to make this type of opportunity to Google. In 2006 it is decided by Google to stay active in China.

The reasons for entering into China market as well the decision related to stay active in China is influenced by many factors which are as follows; first one is there is a great scope of expansion as well as profitability in Chinese market as well as the mission of Google is to collect and then organize the information related to any topic in such a way one can easily get this information without facing any difficulty, in this mission there are two types of organizational commitment is included first one is to fulfill the interests of its users in order to get competitive advantage as compare to its competitors as well as second thing involved is related with access of information which means that the information is arranged in such a way that one can easily find out the data relevant for them *(Thompson, 2007)*

2.1 Internet scenario in China

In 2006 it was forecasted by the Google that there is a rapid increase in the internet market of China which means the no of users which were currently 105 million increased to 250 million nearby 2010. The no of people who used mobile phones in china was 350 million in 2006 which is anticipated to increase by 57 million every year. Before taking the decision related to launch Google.cn in China, Google already existed in China during the period of its existence as the Google .com is universal engine used by all for the purpose of getting useful information on the basis of their want *(Schrage, 2006)*

In US the main competitor of Google is Yahoo where Yahoo is having its own US based search engine but the market share of Google in US is more than as compare to the share of Yahoo. In the same way Yahoo also developed a local Chinese search engine in China but the main question here is that whether Google develop its own Chinese search engine in China or not. Google here took the decision not to make any Chinese search engine but instead to develop such type of engine which is capable of understanding many languages such as Chinese, Korean as well as Japanese. If we considered the data of 2002 with the help of its US based search engine it is able to capture 25% market share in China, there is some type of complexity involved in the government policies. In order to avoid such type of complexity Chinese user base is having following type of things includes first one is all people who are running their business as well as people having higher post in that companies and pro western Chinese people. In 2002 due to some technical problem the people who uses computer in China they are not used Google.com there is a verdict about this in China that the Google is not giving information in quick manner *(Schrage, 2006).* Now there is a matter of concern regarding why China did not use or access the Google.com suddenly and the reason why government sensor it, by investigating this issue the founder of the Google found that it was due to the Baidu.com who wants to capture more market share at Chinese market by decreasing the share of Google.com by taking help of Government. In this Baidu.com is considered to be the main competitor of Google in China as well as Google.com is considered to be slow speed site for Chinese people. The result of it the market share of Google is decreasing continuously. The market share of Google.com which is quite high n beginning now decreased to 64%. The rate of downloading MP3 files from Google.com which is 25% in 2002 now decreased to 19%. So these are some of the points which shows the internet market position of Google.com in china. The brief description of all points is as follows:

- Prediction of Google that there is a rapid increase in the internet market of China which means the no of users which were currently 105 million increased to 250 million nearby 2010.

- The no of people who used mobile phones in china was 350 million in 2006 which is anticipated to increase by 57 million every year.

- The main question here is that whether Google develop its own Chinese search engine in China or not. Google here took the decision not to make any Chinese search engine but instead to develop such type of engine which is capable of understanding many languages such as Chinese, Korean as well as Japanese.

Baidu.com is considered to be the main competitor of Google in China as well as Google.com is considered to be slow speed site for Chinese people. The result of it the market share of Google is decreasing continuously. In this Google decide how to increase its share in Chinese market.

2.2 Problems faced by Google in China

In between the period of 2002 to 2006 the market share of Google in china is reducing rapidly now the option available with Google either to stop its operations in China *(Einhorn, B & Elgin, B, 2007)*. Various problems faced by Google in China are as follows:

1. First one is that the people of China now considered Google.com a slow search engine that will lead to decrease in market share to 63.7% which is very high previously as well as the market share of MP3 in 2006 decrease to 19% which is 25% in 2002.

2. There is some type of complexity involved in the government policies regarding censorship. In order to solve this issue there is one option available with Google is to Self censor'

3. The people of China considered, in order to search information from Google.com is very time consuming process and they didn't like to wait for such longer time to access information

4. The people who uses computer in China considered that Google.com is going down by 10% of the time, News in Google.com never appear on time as well as the Images of Google.com is available only 50%

5. Another important thing that is considered to be a matter of concern here is that Yahoo local Chinese search engine is losing its market share day by day due to two main important reason first one is the issue of security as well as privacy and second issue related to it is government interference of China. In addition to this Microsoft at that time closed one Chinese blog of a politician due to the government policy. So if the Gogle wants to enter into Chinese marker it has to take into consideration folloeing two things before launching Google.cn first one is security as well as privacy and second is government policies of China.

The people of China considered, in order to search information from Google.com is very time consuming process and they didn't like to wait for such longer time to access information due to its poor quality Of accessing information at China and Google founder here is very sad about this issue that it is not possible for them to give good quality of accessing information to the world fifth largest populated country. So these are the main problems faced by Google in china, the description of this are as follows first one is poor quality of accessing information, issue related to security as well as privacy and government interference and prediction of people at China that News in Google.com never appear on time as well as the Images of Google.com is available only 50% *(Einhorn, B & Elgin, B. 2007)*.

3.1 Google's solution to China's filtering

Now there is a need to find out the solution to the problems faced by Google in China so that action will be taken on time to solve these problems. Google's solution to solve these problems are as follows;-

First one is it is important for Google is find out the impact of self censorship on the search results *(Kahn, 2002)*. In order to increase its market share at China it is essential for Google to look for such topics which are already censored by the government of China, it is related to various subjects such as political, religious. In political subjects it may include topics like democracy and in religious topics like Dalai Lama and so on. It will create the interest of people in Google and it is also possible for Google to regain its market share in China which is decreasing continuously

The another problems faced by Google is that whenever people of China tried to open any ink which are censored it may either closed itself or automatically a no censored link is opened. The main reason behind this the Software which named Great Firewall of china, it is very complex as well as difficult to understand and it's heavily depends upon the Intimidation. There is an emphasis on developing blogs which are censored but the topics which are to be banned there is no list of it which is to be provided by the Chinese Government. In order to launch Google.cn, in china it is essential to estimate the search queries in China *(Thompson, 2006).*

In order to find out the solution to this problem, a study this is already done at Harvard Law School related to the Extent as well as effectiveness of censorship of China. On the basis of this study it is found out that there are 90% of sites in China which is blocked, 31% of the sites of internet did not perform task in independent manner in Tibet, as well as a major portion i.e. 83% of the sites of internet having their mane on the former resident of China. There is an important result of the study which is related to the effectiveness of censorship, the result of that showed that till 2006 the censorship remains effective but not in full extent and the information available on sites are very limited which are depend upon the topics which are censored by government of China. After taking the interest of people of china as well as improve the way of accessing the information and the local conditions of China which is very unique Google took decision related to launch a self censored website named Google.cn in China in 2006. For the purpose of getting competitive advantage, it believed on one thing which is transparency which also make it different from its competitors which are Baidu.com, Yahoo Google.cn provides user with a text if they access any page which is censored instead of telling them about the particular page it give information to the users reading the occurrence of censorship. The launch of Google.cn does not mean that the Google.com is disappeared from China instead while launching Google.cn in China there is verdict by the Founders of Google.com it is only an addition services in form Of Google.cn provided by them and existence of Google.com as a search engine does not lose its identity from China. The use of Google.com is very much limited in China because of its poor quality of access at China still the Site Google.com is available in China as it is a universal site available in all languages. Now in order to solve the problem relating to privacy of user as well as to prevent from any action taken by Chinese government Google just like Yahoo as well as Microsoft develop a blogger such a Gmail in order to ensure privacy to the users as well as prevent from government intervention. At the beginning of 2006 there was no point of view of the Google.com to mix up with the censorship system of China instead of this it makes Googel.cn censored as transparent to users *(Fong, 2007).*

In order to take care of Googel.cn, Googel is hired a very competent person named Kai-Fu Lee, he is a very renowned as well as famous personality of China, the main reason for hiring this person to ensure the presence of Google in China as well as by an expectation that Kai-Fu Lee, convert Chinese market a very profitable segment for Google. But if we considered today's trend the share of China in profits of Google is very small. As well as Kai-Fu Lee, also wants that the research centers of Google in China become the major center that brings unique as well as innovation technology for Google. It is done by appointing the software engineers from China who are extremely talented,

3.2 Allegations against Google from US Congress
The trouble for the Google surfaced when the US authorities alleged that the US internet industry, with special reference to Yahoo, Cisco, Microsoft and Google were working against the freedom of speech and expression in China and favoring the information filtering process of the Chinese government. In 2006 after the launch of Google.cn in a very short period now it's the time for Google to come in front of U.S. House of Representative's Committee engaged in International relations in addition with other companies of US such as MSN, Yahoo in order to investigate the operations of these companies in China. The main

question which is asked by the Vice President of Google is related to the reason for self censored of Googel.cn in China. The reply given by the Vice President of Google is that in order to enter into Chinese market first of all they studied how it is possible for Google.cn to lead in the market and the methods adopted in order to get competitive advantage. In addition to this they also studied the methods of Self censoring system of Chinese government. After getting the reply from the vice president now the government of US wants Google to explain this to their shareholders also. In 2007 the most of their shareholders prepared a proposal which is totally against the anti-censorship and submitted to the Office of Comptroller of New York city. Now all the stockholders voted against this and which means a step towards closing of Google.cn from China but at that time it is not the right time to close it but the proposal of stockholders main aim is to close down of Google.cn from China *(Thompson, 2007).*

3.3 Google performance after launching Google.cn in Chinese market

After two years of launch of Google.cn in Chinese market in 2006 the performance of Google is quite well. If we considered the market share Google.cn market share is quite well it is ranked as number two in terms of their share as compare to its main competitor in China which is Baidu.com *(Einhorn & Elgin, 2006).* But In mid of 2007 the market share of Google is increased from 19% to 23% and the market share of Baidu.com is decreased to 58.1% from 63.7%. In order to increase its share in Chinese market, Google tried to make Google.cn a Chinese site by performing two things first one is appointing the engineers from China as well as came in to partnership with the Chinese businesses. In 2007 the main concern of Google is to take permission regarding autonomy to Google local management in China. In order to make Google.cn distinct from Google its gives Google.cn a Chinese name i.e. "Guge," in order to cater the attention of more users towards "Guge," for the purpose of increasing its market share. The view of CEO of Google towards China is that as a Country China is able to make its distinct identity by its innovation as well as it is having its own way of looking and thinking which makes it separate from other countries. In order to expand its business Google run two centers of research in China. Also in order to cater more share in Chinese market Google.cn came into contract with many firms of China such as in 2007 it comes into partnership with a public company of China mobile in order to give fast internet services to the Chinese people in order to increase its market share as well as it also comes to the partnership with various music companies of Chinese as well as various sites engaged in video sharing such as Chinese version of YouTube named Xunlei.com

CONCLUSION

Google it is considered to be the world largest site for searching information in a quick way. As the time passes Google expands its business it's not only considered to be a search engine but also facilitates various services like mapping services as well as you open an account at Google also and so many services in addition to this. The mission of Google is to collect and then organize the information related to any topic in such a way one can easily get this information without facing any difficulty. Google lost about 16% of the share of the market by reducing its share to 64% which is previously 74%. The reasons for entering into China market as well the decision related to stay active in China is influenced by many factors which are as follows; first one is there is a great scope of expansion as well as profitability in Chinese market. In 2002 due to some technical problem the people who uses computer in China they are not used Google.com there is a verdict about this in China that the Google is not giving information in quick manner. By investigating this issue the founder of the Google found that it was due to the Baidu.com who wants to capture more market share at Chinese market by decreasing the share of Google.com by taking help of Government. In this Baidu.com is considered to be the main competitor of Google in China as well as Google.com is considered to be slow speed site for Chinese people. There is some type of complexity involved in the government policies regarding censorship. In order to solve this

issue there is one option available with Google is to Self censor. In order to increase its market share at China it is essential for Google to look for such topics which are already censored by the government of China, it is related to various subjects. In order to find out the solution to this problem, a study this is already done at Harvard Law School related to the Extent as well as effectiveness of censorship of China. Now in order to solve the problem relating to privacy of user as well as to prevent from any action taken by Chinese government Google just like Yahoo. After taking the interest of people of china as well as improve the way of accessing the information and the local conditions of China which is very unique Google took decision related to launch a self censored website named Google.cn in China in 2006. In order to take care of Googel.cn, Googel is hired a very competent person named Kai-Fu Lee, After two years of launch of Google.cn in Chinese market in 2006 the performance of Google is quite well. If we considered the market share Google.cn market share is quite well it is ranked as number two in terms of their share as compare to its main competitor in China which is Baidu.com

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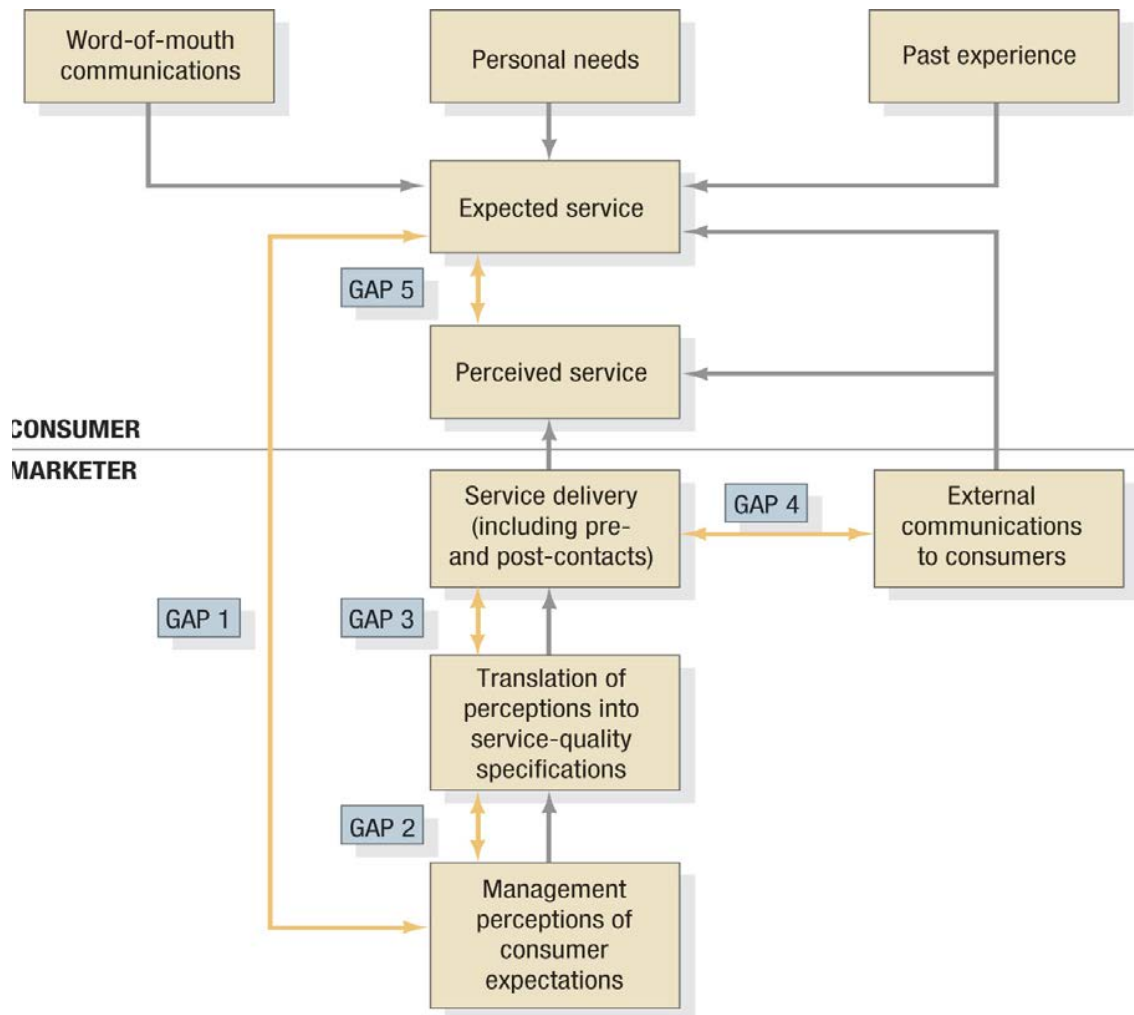
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Figure 1: GAP Model

Source: Parasuraman et al. (1985)

Table 1: Five broad dimensions of service quality

Dimension	Definition
Tangibles	Appearance of physical facilities, equipment, personnel and written materials
Reliability	Ability to perform the promised service dependably and accurately
Responsiveness	Willingness to help customers and provide prompt service
Assurance	Employees' knowledge and courtesy and their ability to inspire trust and confidence
Empathy	Caring, easy access, good / communication, customer understanding and individualized attention given to customers

Source: Adapted from Zeithaml et al. (1990)

In SERVQUAL, both – store service performance and consumer expectations of the store service, are explicitly measured to assess the 'gap'.

Measures of Retail Service Quality

Service quality in retailing is different from any other product / service environment (Finn, 2004). Because of the unique nature of the service, improvements and measurements of quality in retailing cannot be approached in the same way as that of the service perspective. In retail service it is necessary to look at quality from the perspective of services as well as goods and derive a set of items that accurately measure this construct (Mehta et al., 2000). For this reason, Dabholkar et al. (1996) developed and empirically validated the Retail Service Quality Scale (RSQS) to capture dimensions important to retail customers based on the triangulation qualitative research technique. They conducted qualitative research using three different methodologies – phenomenological interviews, exploratory depth interviews and tracking customers through the store. Combining these qualitative findings with the existing literature and SERVQUAL, Dabholkar et al. (1996) proposed that retail service quality has a hierarchical factor structure comprising five basic dimensions namely physical aspects, reliability, personal interaction, problem solving and policy with first three basic dimensions having two sub – dimensions each and overall service quality as a second order factor.

The sub – dimensions of the basic dimension physical aspects are: appearance and convenience; the sub – dimensions of the basic dimension reliability are : promises and doing it right; and the sub – dimensions of the basic dimension personal interaction are: inspiring confidence and courteousness / helpful.

Importance of customer satisfaction

Satisfying customers is one of the main objectives of every business. Businesses recognize that keeping current customers is more profitable than having to win new ones to replace those lost.

REVIEW OF LITERATURE

Good customer satisfaction has an effect on the profitability of every business. Most people prize the businesses that treat them the way they like to be treated; they'll even pay more for this service. However a lack of customer satisfaction has an even larger effect on the bottom line. Customers who receive poor service will typically relate their dissatisfaction to between fifteen and twenty others. The cost of gaining a new customer is ten times greater than the cost of keeping a satisfied customer (Gitomer, 1998). In addition, if the service is particularly poor, 91% of retail customers will not return to the store (Gitomer, 1998). In fact, if the service incident is so negative, the negative effects can last years through repeated recollection and recounting of the negative experience (Gitomer, 1998; Reck, 1991).

The message is obvious – satisfied customers improve business and dissatisfied customers impair business (Anderson &Zemke, 1998; Leland & Bailey, 1995). Customer satisfaction is an asset that should be monitored and managed just like any physical asset. Therefore, businesses that hope to prosper will realize the importance of this concept, putting together a functional and appropriate operational definition (McColl – Kennedy & Schneider, 2000). This true for both service – oriented and product – oriented organizations (Sureshchander, Rajendran & Kamalanabhan, 2001).

The primary issue with developing an operational definition with the specific components of customer satisfaction is to clearly identify the nature of the organization's business. This further extends into the effective collection, analysis and application of customer satisfaction information.

Services and products are the two major orientations of business. Product – also referred to as goods, are the physical output of a business. These are tangible objects that exist in time and space. These are first created, then inventoried and sold. It is after purchase that these are actually consumed (Sureshchander, Rajendran & Kamalanabhan, 2001; Berry, 1980). Products might include computers, automobiles, or food at a restaurant.

Services, on the other hand, are less materially based. The differentiation between service and product is the intangible nature of a service – it cannot be touched, held and so on. Another difference is the issue that consist primarily of social interactions or actions (Berry, 1980). The consumption of a service involves the interaction between the producer and the consumer. Also, services are produced and consumed simultaneously (Carman & langeard, 1980). Services might include computer repair, automobile sales, or the attendance of a server at a restaurant. Delivering quality service is a business necessity (Cullen, 2001).

COMPONENTS AND REQUIREMENTS OF CUSTOMER SATISFACTION

The concept of customer satisfaction is composed of several components from distinct sources (McColl – Kennedy & Schneider, 2006). Customer satisfaction begins with clear, operationaldefinitions from both the customer and the organization.

Understanding the motivations, expectations and desires of both gives a foundation in how to best serve the customer. It may even provide information on making improvements in the nature of business. This is the heart of research into customer satisfaction (Naylor & Greco, 2002). The importance of clearly defining the key concepts and elements of satisfaction provide a template by which information can be gathered about what is, and what is not, working. This includes both hard measures – those that are more tangible and observable (i.e., number of complaints, average wait time, product returns, etc) and the soft measures – those less tangible aspects (i.e., friendliness, helpfulness, politeness, etc) (Hayes, 1998).

The organizational requirements of customer satisfaction are the internally based processes, components, standards, and criteria that a business strives to achieve. These are the performance goals and benchmarks set forth by the business, for the business. These are the elements of corporate culture (Hayes, 1998).

Meeting or exceeding these is often an indicator of success or failure. At times, these indigenous components of customer satisfaction may overlap with those set forth by the customer; at others they may be divergent.

Those processes, components, and standards that are deemed important by the customer are another important source of information. In order for a business to meet the needs and desires of the customer, the business must know the needs and desires of the customer. This information is vital not only for successful business, but also for understanding and improving customer satisfaction. This important component helps to set the standards and components of satisfaction from the perspective of the consumer (Hayes, 1998).

Satisfaction dimensions are developed from the previously identified requirements. These are the specific components that make up the requirements. For example, if a customer and organizational requirement is for customer service, the satisfaction dimensions may include interactions, timeliness, and responsiveness. These are the clusters that identify the requirements (Hayes, 1998).

Critical incidents are the specific operations that relate to the satisfaction dimensions. These are often the concrete and measurable behaviours and actions of employees, groups, or organization (Hayes, 2008).

From this continued definition and distillation of various sources of data, the actual development of a customer satisfaction instrument or tool can begin in earnest. As always, the planning of the research is the most important component in successful information – gathering process. It is further helpful that a model of customer satisfaction that incorporates the organizational and customer requirements exists and is applicable in practice.

STATEMENT OF THE PROBLEM

Research has always been concentrated in measuring customer satisfaction or SERVQUAL for customer services. What most researchers agree and have a consensus on is that SERVQUAL being a crucial element in customer satisfaction even when the offering involved a combination of a product and service. The study aims at measuring the influences of service quality in unorganized retailing with customer satisfaction taken as the effective outcome measure.

SCOPE OF THE STUDY

SERVQUAL has two components to it:

1. Customer expectations
2. Customer perceptions

Customer expectations are those that the customer expects as should be and can be type of services. Service offered varies with providers and the amount of variation that customer can tolerate is known as tolerance.

The gap between what is thought to be adequate service and desired service is known as zone of tolerance. The present study concentrates on customer perceptions of the following service quality dimensions, price and product quality:

- Tangibles
- Reliability
- Responsiveness
- Assurance
- Empathy

For the purpose of data collection a structured questionnaire was constructed taken into account SERVQUAL dimensions such as tangibles, reliability, responsiveness, assurance, empathy and other dimensions like price, product, quality and customer perceptions of unorganized retail outlets to assess customer satisfaction, repurchase intention and positive word of mouth. Other secondary sources were also used for the purpose.

RESEARCH OBJECTIVES

The objective of this study is to assess the influence of service quality on customer satisfaction. In accordance with this objective, the survey encompasses the following objectives:

a. Describe service quality dimensions in unorganized retailing business that perhaps influence customer satisfaction
b. Assessing servqual dimensions that contribute to customer satisfaction
c. Assessing the dominant service quality dimensions that influence customer satisfaction in the unorganized retail sector.

Hypothesis

H_o: Service quality of unorganized retail units has impact on customer satisfaction.

H_a: Service quality of unorganized retail units has positive impact on customer satisfaction.

METHODOLOGY

Research methodology used in the study is descriptive method. Descriptive method is a method that describes the study systematically, factually and accurately utilizing facts, behaviours and relationship between phenomena being studied.

Analysis method: correlation and regression

Table 2: Operational variables used in the research

Variable	Concept	Sub variable	Indicator	Scale
Service quality	Conceptualized as the comparison of service expectations with actual performance perceptions	1. Reliability	• Speed of service • Accuracy of transactions	Ordinal
		2. Responsiveness	• Speed of response to complaints • Concern and desire for assisting	
		3. Assurance	• Concern for customers • Staff attitude • Security for transactions, parking, etc	
		4. Empathy	• Ease of communication • Attention and patience of the sales staff	
		5. Tangible	• Availability of kids corners, parking spaces, recreational facilities, food courts • Cleanliness, ambience, maintenance, etc • Range of products, layout, shelves, aisles, display signs, promotional islands, assortments • Staff performance	
Customer satisfaction	Conformance between the expectations of customers with perceived performance		Expectations of service performance	Ordinal

Results

Questionnaires distributed to 150 respondent customers and the findings are tabulated as under:

Table 3: Customer expectation to the quality retail services

S. No.	Statement	Average
1	Promptness of service	4.81
2	Accuracy of transactions	4.83
3	Speed of processing transactions	4.58
4	Speed of response to complaints	4.69
5	Concern and desire for assisting	4.69
6	Staff concern for customers	4.76
7	Staff attitude to customers	4.79
8	Security in transactions, parking etc	4.22
9	Ease of communication	4.50
10	Attention and patience of staff	4.71
11	Availability of parking, ATM counters, etc	4.53
12	Cleanliness, ambience, etc	3.51
13	Range of products, assortments, etc	3.64
14	Staff performance	3.62
	Average	4.42

From the above table, on average, customer expectations are at 4.42 level (from the range 1 (not important) to 5 (very important)

Table 4: Customers perceived service quality in unorganized retail unit

S. No.	Statement	Average
1	Promptness of service	4.15
2	Accuracy of transactions	4.14
3	Speed of processing transactions	4.04
4	Speed of response to complaints	4.10
5	Concern and desire for assisting	3.20
6	Staff concern for customers	4.04
7	Staff attitude to customers	4.03
8	Security in transactions, parking etc	3.15
9	Ease of communication	4.06
10	Attention and patience of staff	4.05
11	Availability of parking, ATM counters, etc	3.05
12	Cleanliness, ambience, etc	3.04
13	Range of products, assortments, etc	4.10
14	Staff performance	4.12
	Average	3.53

From the above table, customers perceived service quality ratings are at 3.53 levels (from the range 1 (not good) to 5 (very good).

The influence of service quality in unorganized retail units:

The relation between service quality and customer satisfaction i.e., correlation coefficient is 0.677 and has positive relation.

Table 5: Correlation

Variable	Service quality	Customer Satisfaction
Service quality	1.00	0.677
Customer satisfaction	0.677	1.00

Determination coefficient is used to measure the influence of independent variable X (service quality) to the dependent variable Y (customer satisfaction)

Table 6: Model Summary

Model	R	R square	Adjusted R square	Standard error of estimate
1	0.677a	0.458	0.315	0.22181

Regression linear equation defined from the table is $Y = 1.365 + 0.23X$

Table 7: Coefficients

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.	5% confidence interval	
	B	**Std. error**	**Beta**			**Lower bound**	**Upper bound**
(constant a)	1.365	0.655		2.011	0.044	- 0.055	3.022
X	0.230	0.211	0.545	2.122	0.051	0.021	0.811

CONCLUSIONS

1. Based on the results obtained
   a. Customers have highest expectations on the promptness of service, accuracy of transactions, security issues and concerns; the customer's lowest expectations are cleanliness, ambience, etc. It must however be noted here that this rating is a comparative assessment and therefore this dimension of service quality scores lower in comparison to promptness, security and other security related issues. The dimension 'Staff performance' in our informal interviews was reported to be satisfactory by the respondents and therefore did not expect substantial improvements in their performance.
   b. Customers reported highest satisfaction for promptness and speed of service along with accuracy of transactions at cash counters. They were also satisfied with the processing of transactions and efforts to expedite processing whenever the traffic at the counters increased. The lowest satisfaction levels were reported at the willingness of staff to assist customers in accessing facilities, assortments, information on products, stock positions etc.

2. It is very obvious from the results that Pantaloons Future Group is doing very well in the retail segment and has been able to deliver quality service in their retail outlets. Dimensions like attention to details, promptness in addressing complaints; initiation of corrective action on faulty transactions and goods is sought by the respondents. These issues could be prioritized as the most

important ones for offering better and improved service quality to customers and to make shopping a pleasurable experience.

3. Improvements that can be done by management are:
   i. Improving communication amongst staff members, using updated systems to process complaints, and ensuring error-free transactions.
   ii. Training of staff to enable them in assisting customers and provide them with relevant and timely information. Courtesy, etiquette and communication skills could be honed through continuous training of the staff.
   iii. Improvements in the ambience of the outlet, better shelves and space management, clear electronic sigh posts, clean walkways and aisles, lighting, promotional islands, etc should improve overall shopping experience for customers.
   iv. Provision for children's area, food courts, adequate parking space, security, and ATM facilities could provide hassle free shopping experience for customers.

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TO STUDY ON LONG TERM FINANCING BY BANKS

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ABSTRACT

A term loan is a loan from bank for a specific amount that has a specified repayment schedule and the maturity period varies from one to ten years. The banker has to take lot of care while financing term loans as these loans are usually of high amount and if defaulted bankers have to bear heavy losses, therefore to avoid losses; appraisal of term loan should be inbuilt method of assessment of risk element contained therein. The appraisal of the term loan is divided in distinct parts so that the entire process is done in the structured manner so that the interest of the lending banker is not jeopardized.

Appraisal of managerial competence is necessary because the ultimate success of even a very well conceived and viable research may depend on how competently it is managed by the promoters. Examination of the technical feasibility aspects involves an assessment of the propriety of the technology / process for the unit, collaboration aspects, size of the plant and other logistics of operation. Examination of the market and demand forecasting is to find out whether the enterprise is in a position to generate adequate surplus over a period of time. Appraisal of financial feasibility aspects includes identification of various elements of research cost, ascertaining the respective amounts and also projections in respect of the various financial parameters and their validation.

The appraisal is done to ensure that the loan is given to the company, which is managerially, technically, and financially feasible and which ensures the repayment of the interest along with principal amount and makes the proper utilization of the funds. The proper assessment of loan will make sure that the loan will be given to a right person for right use which in turn reduces the amount of risk involved in long term financing.

Key words: *Long term financing, risk, appraisal.*

INTRODUCTION

The purpose of this paper is to provide a broad overview of the concept Long term financing by banks. Banks perform two main functions of accepting deposits and lending loans. Lending money to different kinds of borrowers is the most important functions of a bank. Bank lends money by the way of short-term loans and long term loans. Long-term loans mainly consist of Term Loans.

A term loan is a loan from bank for a specific amount that has a specified repayment schedule and a floating interest rate. Term loans almost always mature between one and 10 years. Term loan is required for the purpose of setting up of new business activity, renovation, modernization, expansion/extension of existing units, purchase of plant and machinery, vehicles, land for setting up a factory, construction of factory building or purchase of other immovable assets. These loans are generally secured against the mortgage of land, plant and machinery, building and other securities.

Term loans are made available in different forms. Fund-based term loans are provided for outright acquisition of capital goods. On the other hand, non-fund based term loan are in the form of Deferred Payment Guarantees (DPG) where the liability to make payment crystallizes after the bills against such guarantees are presented for payment. Bank also underwrite the equity issues floated by companies, and in the process, banks assume a long-term

exposure in the company. Decision-making in all such credit proposals require appraisal of all those aspects which have a bearing on the operation of the company over an extended time period.

SCOPE AND APPROACH

The scope and approach in providing term credit by lending bankers are therefore different from working capital credit or other conventional form of advances. Term loan is a form of a participation loan in as much as the lending institution has a stake in the unit for a fairly long time period, which is akin to holding a share in the equity or debenture issued by the bank. Longer the period of repayment, the riskier is the proposition, and therefore any appraisal of term loan should have an inbuilt method of assessment of the risk elements contained therein.

APPRAISAL OF TERM LOAN

Today, the basic purpose of appraisal of a proposal for providing term credit requirements is to ensure that the borrower acquires the proposed fixed assets, puts them to use in producing merchandise which would have a market, and generate enough cash from operations to repay the term loan and service the interest commitments thereon over the stipulated period of repayment. The appraisal process therefore envisages a meticulous examination of all relevant aspects of the economics of the project. A few important questions that come to the mind of a credit analyst in course of a term loan appraisal are given below:

- Who are the promoters and what are their credentials? Does the available information suggest that they are capable of promoting and managing the project successfully?
- Whether the finished goods produced would have an assured market (demand / supply analysis),
- Whether the technology proposed to be employed is adequate,
- Whether the plant capacity is adequate i.e. whether commensurate with the existing and future demand pattern envisaged,
- Whether the projections relating to operations and profitability of the project over the repayment period are realistic,
- Whether the amount of the proposed loan is adequate vis-à-vis the term requirement of the research.
- Whether the projected cash generation is adequate to service the loan?
- Most importantly, if the loan is not repaid by the entrepreneur in terms of the agreed schedule, whether proper risk hedging mechanism is in place so that the interest of the lending institution is not jeopardized.

These are some of the indicative question that must be answered in course of the term loan appraisal. It is therefore important that the task of appraisal is divided into distinct appraisal areas, so that the entire process is done in a structured manner. These areas may be the following:

1. Appraisal of Managerial Competence / Human Appraisal

2. Appraisal of Technical Feasibility Aspects

3. Appraisal of Market / Demand Forecasting

4. Appraisal of Financial Feasibility Aspects

PROCEDURE OF TERM LOAN PROCESSING

The procedure of loan processing in Cosmos Co-operative Bank is carried in different steps. The bank processes the loan step by step to minimize the risk involved in lending money. Firstly the bank collects all documents from the borrower. Collection of various documents is usually done at branch level. All documents are collected according to the checklist of the bank. Checklist is the list of all documents that the borrower has to submit; until and unless all documents are submitted to the bank loan processing does not start.

The next step in loan processing is preparing In Principle. In Principle document is prepared for those borrowers who are new to the bank, in the sense they have not taken loan from the bank before or they do not have an account

with the bank. In Principle document helps to know the borrower in a better way. In Principle document contains the details like details about the business of the borrower, requirement of loan, security available, past experience of the promoters, financial statements of last 3 years, comments on financials and recommendation about the loan requirement. This document is prepared by the credit analyst it is approved by the Manager then it is pass on to the General Manager for approval, if approved by the General Manager then it is forwarded to Managing Director for the approval, if it is approved by the Managing Director then the file is processed otherwise it is rejected. For the regular customer the In Principle document is not prepared.

Then at the branch level the loan application form is filled from the borrower. After this the file is processed. Processing of file takes place in different steps:

STEP 1: APPRAISAL OF FINANCIAL FEASIBILITY
In financial appraisal the bank scrutinizes all financial documents like:

1. Analysis of Balance sheet and Profit and Loss account of last 3 years.
2. Projections are checked for next 5 years. The period of projection depends upon the term of the loan.
3. Document verification is done for Memorandum of Association and Article of Association. The object clause is checked and it is seen that project intended by the borrower fits in the object clause or not.
4. Legal opinion is taken from the bank's lawyer in case of the security that is offered by the borrower to the bank. Valuation report given by the borrower is compared by the valuation report from the bank. Insurance of the security is checked and it is seen whether the security offered is valid or not and it is in the bank's favour or not.
5. Ratio analysis is done. Ratios are removed for the current financial year and for the projections. The trend of the ratios is checked i.e. whether they are improving or not.
6. Break-even analysis, cash flow and repayment capacity and period are checked.

STEP 2: APPRAISAL OF MANAGERIAL COMPETENCE
In managerial appraisal the promoter's competence is checked like qualification of the promoters, experience of the promoters, capacity of raising money, capacity to absorb losses, professional capacity, track record, production capacity, net worth of the promoters, etc.

STEP 3: APPRAISAL OF TECHNICAL FEASIBILITY
In the technical appraisal the bank checks that whether the business the borrower wants to carry is valid or not. If the project involved is too technical in nature then the service of technician management firm is taken so that the appraisal is done in a better way and to minimize the risk. In technical appraisal, availability of raw material, labour, energy requirement, government policy, etc. are checked.

STEP 4: APPRAISAL OF MARKET / DEMAND
In this step whether the intended product of the borrower will have demand or not is checked. The substitutes of the products are checked. The competitor's analysis is done in that particular field.

After these different appraisals the CRM (Credit Risk Rating Model) note is prepared which contains the information of the promoters, financials, loan requirement, security offered, recommendations, terms and conditions, etc. in short it contains the information of all appraisals. Then this proposal is passed to the General Manager for his approval, if approved, it is signed and future passed on to the Committee Meeting (which consist of 5 members of Board of Directors) if it is approved there then it is passed to the Board Meeting. If all Board of Directors and the Managing Director approve it then the loan is sanctioned. The sanction letter is prepared with the terms and conditions (that are to be followed by the borrower) it is then signed by Board of Directors and then sent

to the borrower for his approval if borrower approves it and follows the terms and conditions that are prescribed in sanction letter then the loan is disbursed.

Background of the company applying for loan proposal and the reason for applying for term loan:
ABC started with ABC Sanskrit College Trust, which was established in 1976 basically with an intention to impart / teach Vedas and Shastras to all section of the society.

In 2002 the trust got the permission to start with the medical course BDS (Bachelor of Dental Surgery). The college was started in the name of ABC Mahavidyala Institute of Dental Science and Research Centre. However subsequently it has been decided to separate the dental college activity. So for this purpose ABC Medical Educational Trust was formed in July 2005 and was registered on 20/06/2005 under the registration number 222/05. This trust is exclusively having activity of dental college under 'ABC Mahavidyala Institute of Dental Science and Research Centre'.

To start the dental college activity for the medical course BDS the ABC Medical Educational Trust needs financial assistance from bank and therefore they have applied for term loan to the bank.

Loan requirement of the company:

Sr. No.	Type of Facility	Purpose	Loan Amount (Rs. in Lakhs)	
			Required	**Existing**
1.	Term Loan	Starting a Dental College	600.00	0.00
		Total	600.00	0.00

Security offered by the company:

Sr. No.	Type	Description	Outstanding Balance	Valuation	Value
1.	Principle	College Land and construction thereon	00.00	00.00	750.00
2.	Principle	Equipments	00.00	00.00	300.00
3.	Collateral	Residential Premises of Mr. Sukhvindra Kaur	00.00	26/5/08	622.30
		Total	00.00		1672.30

Appraisal of Managerial Competence / Human Appraisal:

Sr. No.	Name of the Promoters	Qualification and Experience	Annual Income
1.	Aditya Kaur	M.B.B.S 15 years experience of running education institute - Jay Guru Education Society.	12.01
2.	Yuvaraj Kaur	B.D.S Working with his father Mr. Aditya for last 8 years	2.00
3.	Satish Shah	M.B.B.S Having 15 years experience in business	8.76

The promoters of ABC Medical trust are well qualified in the medical Field itself. The promoters are having experience in this field for more than 8 years. The promoters have their annual income, which is fair enough.

Appraisal of Technical Feasibility Aspects: The land allotted for the Dental College is 5 acres, which is more than sufficient. The location of the college is in the municipal limits of the city. It is extremely well connected by the city bus service from both cities Hydrabad and Vijayawada.

Campus is self-contained with massive classrooms; hostels separately for boys and girls, reading room, conference room, sports, library, Internet facilities, cafeteria and other amenities are also available therein. College has been approved by the Dental Council of India and Ministry Health and Family Welfare and also affiliated to NTR University of Health Science, Vijayawada, A.P. The intake of the college as permitted by DCI is 100 students per year.

College has adequate number of dental chairs to meet the short term and long term demand of the institute. The clinical facilities are decided to handle more than 150 patients per day. An ultramodern X-ray machine with dark room facility is made available.

The college is attached to one of the premier hospitals of state J.D. General Hospital and J.D.Medical College, Vijayawada. The hospital and medical college is the close vicinity of the institute. The Dental College is having the facilities of J.D. General Hospital and Medical College for training the college students in the area of medicine, surgery, physiology, anatomy and other allied subject.

Appraisal of Market / Demand Forecasting: The proponents are already established in education institute, who are not in need of any marketing of their college. The demand for the college is high as there is no college in the city that offers the course of BDS. The promoters also have plans to start MD courses after 4 years for the BDS students. They also have plans for starting allied courses related to medicine. The college has got permission of 100 students per year from DCI. The course of BDS consist of 4 years, so four years there will be 400 students as the students will proceed from one year to another year.

Project Cost Details and Means of Finance:

Project Cost Details:

Sr. No.	Particulars	Already Incurred	To Be Incurred	Total
1.	Land & Building	00.00	750.00	750.00
2.	Equipments	00.00	300.00	300.00
	Total	00.00	1050.00	1050.00

Means of Finance:

Sr. No.	Particulars	Already Incurred	To Be Incurred	Total
1.	Share Capital	00.00	450.00	450.00
2.	Term Loan from Bank	00.00	600.00	600.00
	Total	00.00	1050.00	1050.00

Details of Guarantors:

Sr. No.	Member No.	Name	Occupation	Annual Income
1.	100018	Aditya Kaur	Education Institute	12.01
2.	100026	Yuvaraj Kaur	Education Institute	2.00
3.	100066	Satish Shah	Education Institute	8.76
			Total	22.77

APPRAISAL OF FINANCIAL FEASIBILITY ASPECTS:
Key financial data

Particulars	2006 Actual	2007 Project^n	2008 Project^n	2009 Project^n	2010 Project^n
Gross Sales	156.15	251.67	287.86	398.20	486.90
Other Income	00.00	00.00	00.00	00.00	00.00
Gross Profit	27.52	78.83	64.68	159.97	214.90
G.P.Percentage	17.63	31.33	22.47	40.18	44.00
Net Profit	4.07	28.86	15.14	48.94	103.50
N.P.Percentage	2.61	11.47	5.26	12.30	21.20
Depreciation	24.41	44.62	35.36	28.31	22.60
Cash Accruals	28.48	73.48	50.50	77.25	126.11
Gross Block	345.40	612.06	625.53	1017.35	989.00
a) Net Block	320.99	567.45	590.14	989.04	966.33
b) Investment & Non Current Assets	00.00	00.00	00.00	00.00	00.00
Bank Term Loan	00.00	00.00	00.00	570.93	441.11
Unsecured Loan	173.24	191.48	181.65	00.00	00.00
Other Long Term Liability	00.00	00.00	00.00	00.00	00.00
c) Total Long Term Liability	173.24	191.48	181.65	570.93	441.11
Net Fixed Assets (a+b+c)	147.75	375.97	408.49	418.11	525.25
Raw Material	00.00	00.00	00.00	00.00	00.00
W/P & Consumables	00.00	00.00	00.00	00.00	00.00
Finished Goods	00.00	00.00	00.00	00.00	00.00
Receivables	00.00	00.00	00.00	00.00	00.00
Cash & Bank Balance	84.05	5.67	50.60	6.35	2.70
Other Current Assets	7.60	67.85	32.01	2.47	2.49
Total Current Assets	91.65	73.52	82.61	8.82	5.20
Sundry Creditors	39.04	71.43	82.56	00.00	00.00
Working Capital Finance	00.00	00.00	00.00	00.00	00.00
Other Current Liability	15.68	22.84	30.55	00.00	00.00
Total Current Liability	54.72	94.27	113.11	00.00	00.00
Net Current Assets	36.93	(20.75)	(30.50)	8.82	5.22
Capital	180.60	326.32	362.84	362.84	362.84
Reserves	00.00	00.00	15.16	64.09	167.66
Profit & Loss	4.06	28.87	00.00	00.00	00.00
Net Worth	184.66	355.19	378.00	426.93	530.40
Current Ratio	1.67	0.78	0.73	00.00	00.00
Debt-Equity Ratio	0.94	0.54	0.48	1.34	0.8

COMMENTS ON KEY FINANCIALS
Sales / Receipts: During the year 2006-07 the college has collected tution fees of Rs.210.20 Lakhs and during 2007-08 Rs.238.00 Lakhs. The total revenue of the college during 2006-07 was Rs251.66 Lakhs that has risen to Rs.287.86 Lakhs in 2007-08.

The college undertakes BDS course of 4 years with permitted, 100 students per year. Out of permitted total 400 students, during 2007-08, the college has enrolled 360 students. Fees for BDS course are Rs.99500/- per year and per student therefore total fees for the year 2007-08 is expected to be Rs.358.20Lakhs.

During the year 2008-09 the college projected total fees collection of Rs.436.95 Lakhs from 387 students. During the year they are starting MD course and expecting 27 students. The fees expected are Rs.1.00 Lakh for BDS course and Rs.2.75 Lakhs per year for MD course. The fee structure seems to be reasonable and it is expected to remain same in projected years.

College expects higher enrollment of students in projected year against the allowed admission capacity. Further the college is earning income from hostel fees and miscellaneous fees. During 2007-08 other income stands to Rs.49.85 Lakhs and study growth is projected in coming years.

Profitability: The College is having surplus over last three years. The college is expecting higher surplus (excess of Income over Expenditure) in the projections period. Projected surplus seems to be in line with gross receipts.

Current ratio: The applicant is running dental college (not business-trading / manufacturing). The college has applied for term loan only and not for working capital limit, hence current ratio is not applicable.

Net worth and Debt-Equity Ratio: As on 31/3/08 corpus fund of college with surplus stand Rs.377.99 Lakhs and unsecured loan Rs.181.64 Lakhs. Debt –Equity ratio as on 31/3/08 is 0.48:1 shows satisfactory position.

Unsecured loan will be repaid out of bank term loan in 2008-09. Position of Debt- Equity ratio is expected to remain at accepted level of 1.34:1 as on 31/3/09. In next year on one side corpus fund will increase by retaining the surplus and on other side term liability will get reduced due to repayment and hence debt-equity ratio will improve further.

Break-even and sensitivity: After availing term loan, interest will be fixed cost. In 2008-09 the college will break even at total income Rs.294.69 Lakhs. In 2006-07 they had income of Rs.251.67 and in 2007-08 the income was Rs.287.86 Lakhs. The break even after availing term loan is near to the present income of the college and hence reachable.

Details about Repayment Capacity and Moratorium period

Repayment Capacity:

Particulars	2009	2010	2011	2012	2013
Surplus (After Tax)	48.93	103.50	176.87	265.02	333.11
Interest	99.34	90.04	68.90	49.68	29.02
Total (A)	**148.27**	**193.54**	**245.77**	**314.70**	**362.13**
Term loan Rs.600 Lakhs. EMI @13%p.a. Rs.13.65 Lakhs. Repayment Obligation	122.86	163.82	163.82	163.82	163.82
Total (B)	**122.86**	**163.82**	**163.82**	**163.82**	**163.82**
DSCR A/B	**1.20**	**1.18**	**1.50**	**1.90**	**2.20**
Average DSCR: <u>1.60</u>					

During 2008-09 repayment is considered for 9 months. However yearly repayment will be lower than assumed above, as total disbursement will take place in 2-3 months and actual EMI's will be lower. This shows that the trust will be able to repay the loan out of college income.

Moratorium period: As it is ongoing education institute no moratorium period is recommended.

Merits of the proposal: a) All the trustees are having sound experience in running Education Trust.

b) The scope for educational Institute is vast in near future.

Demerits of proposal: a) Revenue and profitability of educational institute depends on actual intake of students.

Recommendations: Considering the business of the applicant scope for the activity, past financial and projections, it is recommended to sanction following limits:

1. Term Loan: Rs.430Lakhs

Purpose: Building of Mahavidyala (Dental College)

Rate of Interest: 13%   Margin: 40%

Period: 60   Repayment: 60 monthly Installment

Security: Land with building at Survey No-105, Gaddiannaram. A.P.

2. Term Loan: Rs.170Lakhs

Purpose: Equipments of Dental College

Rate of Interest: 13%   Margin: 40%

Period: 60   Repayment: 60 monthly Installment

Security: Equipments and land with building at Survey No-105, Gaddiannaram. A.P.

Terms and Conditions: a) Mrs. Kaur will be taken as guarantor to the loan and all trustees will be guarantors to the loan in the individual capacity.

b) Part of the term loan will be disbursed for repayment of unsecured loan and for creditors of capital expenditure, after getting the list of unsecured loans and creditors certified by C.A.

c) Remaining term loan will be disbursed by way of pay slip / D.D. as per quotations. These quotations will be taken from the trust.

d) The trust will have to submit post-dated cheques towards repayment of the term loan.

e) Trust will have to submit documents to the satisfaction of bank that ABC Mahavidyala Institute of Dental Science and Research Centre is being run the control of the trust and ABC Medical Education Trust does not have any other activity and financial statements other than that of the Mahavidyala.

CONCLUSION

In today's economy term loans form the major part of finance for carrying out a business. The term loans are usually of high amounts and therefore the banks have to be very cautious while sanctioning these loans. Therefore it becomes essential for the banks to conduct thorough credit appraisal for term loan. Credit appraisal programme should necessarily be inbuilt system of processing the loans in banks as its basic purpose is to ensure that the borrower acquires the proposed fixed assets, puts them to use in producing merchandise which would have a market, and generate enough cash from operations to repay the term loan along with the interest within the stipulated term loan period.

Credit appraisal is the step which decides everything. Credit Appraisal is the process by which a lender appraises the creditworthiness of the prospective borrower. It is a very important step in determining the eligibility of a loan borrower for a loan. The credit appraisal is done to ensure that the loan is given to the

company, which is managerially, technically, and financially feasible and which ensures the repayment of the interest as well as principal amount of the term loan. Every potential borrower has to go through the various stages of a credit appraisal process of the bank.

All banks have their own rules to decide the credit worthiness of their borrowers. In the similar manner Cosmos Bank is very much clear about their loan processing policy and always sticks to the producer prescribed by the top management. The bank is successful leader in the industrial loan market. Moreover it concentrates more on the customer satisfaction. It has a very good client list for the industrial loan. The Bank makes use of the advanced software called as CRM, which enhance the fast processing of the loan. The bank sees to it that the loan is given to a right person and for right use.

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PRESS FREEDOM IN INDIA: A LEGAL STUDY

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"Freedom of Press is an Article of Faith with us, sanctioned by our Constitution, validated by four decades of freedom and indispensable to our future as a Nation."

: Former Prime Minister Rajiv Gandhi

ABSTRACT

Freedom of Expression has always been emphasized as an essential basis for the democratic functioning of a society. Freedom of Press has remained an issue that has led to endless number of debates across the democratic world in the past few decades. The democratic credentials of a state are judged today by the extent of the freedom press enjoys in that state. The Press provides comprehensive and objective Information of all aspects of the country's Social, Political, Economic and Cultural life.

Key Words: press, freedom ,democracy, Constitution, legislative privilege

INTRODUCTION

A free press is very important and essential for the effective functioning of a democracy. A free press has also been described as the oxygen of democracy; one cannot survive without the other.. Our actual experience since Independence, and especially in the last decade or so, also suggests that a free and vigilant Press is vital to restrain corruption and injustice at least to the extent that public opinion can be roused as a result of press investigations and comments.

The press serves as a powerful antidote to any abuse of power by government officials and as a means for keeping the elected officials responsible to the people whom they were elected to serve. The democratic credentials of a state are judged today by the extent of the freedom press enjoys in that state. At this present juncture of time, as we approached the sixth decade of our freedom, it is essential to keep in mind, the pertinence of freedom of press, which is regarded as the fourth pillar of democracy

A further dimensions to the freedom of expression is added by the existence of mass society in which communication among citizen can take place only through the use of media like the Press and broadcasting and not directly which prevails both technical and in the Indian context, financial, the importance of the Press is even more crucial.

WHAT IS FREEDOM OF PRESS?

'Freedom' means absence of control, interference or restrictions. Hence, the expression 'Freedom of press' means the right to print and publish without any interference from the state or any other public authority. But this, Freedom, like other freedoms, cannot be absolute but is subject to well known exceptions acknowledge in the public interests, which in India are enumerate in Article 19(2) of the constitution.

The prime purpose of the free press guarantee is regarded as creating a fourth institution outside the government as an additional check on the three official branches:-
• Executive.
• Legislative.
• Judiciary

SIGNIFICANCE OF FREEDOM OF PRESS

Press plays an educative and mobilizing role in moulding public opinion and can be instrument of social change, for the freedom of Press is regarded as "the mother of all other liberties in a democratic society. The press serves as a powerful solution of power by government officials and as a mean for keeping the elected officials responsible to the people whom they were elected to serve. A Free press stands as one of the great interpreters between the Government and the people. So, the freedom of Press has to be protected and at the same time, the freedom of individual even in the press should also be protected, preserved and any attempt to encroach the freedom of press has to be prevented.

HISTORY OF FREEDOM OF PRESS IN INDIA

The beginnings of the struggle for free speech in India date back to 18th century British India. The history of the freedom of press in India is inseparable from the history of the nationalist movement. The nationalist movement for a free India was fought with repression of the freedom of speech and expression through a series of legislations aimed at stifling the possibility of a consolidated outery against colonial subjugation. That the press played an invaluable role in generating political consciousness is evident from the fact that the British government found it necessary to introduce repressive enactments from time to time neutralise the power of the print medium.

Press and Registration of Book Act, 1867

The earliest surviving enactment specially directed against the press was passed in 1867, the Press and Registration of Books Act. The object was however to establish government control over the Freedom of press. It was a regulatory law which enabled Government to regulate printing presses and newspapers by a system of registration and to preserve copies of Books and other matter printed in India.

Official Secrets Act, 1923

A general Act which has a greater impact on the press, in particular is the Official Secrets Act, 1923, which is aimed at maintaining the security of State against brakeage of secret information sabotage and the like. The Indian press (Emergency) Powers Act 1931 imposed on the press on obligation to furnish security at the call of the Executive. The Act ,(as amended by the Criminal law Amendment Act,1932) empowered a provincial Government to direct a printing press to deposit a security which was liable to be forfeited if the press published any matter by which any of the mischievous acts enumerated in S.4 of the Act were furthered ,e.g., bringing the Government into hatred or contempt or inciting disaffection towards the Government ; inciting feelings of hatred and enmity between different classes of subjects including a public servant to resign or neglect his duty.

Press (Objectionable matter) Act,1951

The preamble of the press (Objectionable Matter) Act, 1951, looked innocuous as it was " to provide against the printing and publication of incitement to crime aid other objectionable matter ". The other

improvements were as follows: While the Act of 1931 was a permanent statute, he Act of 1951 was a temporary one to remain in force for a period of two years; the new Act provided for a judicial inquiry by a sessions Judge before security could be demanded from a printing press or forfeited to Government ; and the person against whom a complaint had been made could demand the matter to be determined with the aid of a jury6 and had a right of appeal from the order of the sessions Judge to the high Court.

Press Council Act,1965

Following the British precedent, a press Council was constituted in 1996 under the press council Act 1965, which was enacted to implement the recommendations of the press commission. The object of establishing the council was to preserve the freedom of the press to maintain and improve the standards of newspapers in India . It was to form a code of conduct to present writings which were not legally punishable beet were jet objectionable.

FREEDOM OF PRESS: CONSTITUTIONAL PERSPECTIVE

"Where it is left to me to decide whether we should have a government without newspapers, or newspapers without a government, I should not hesitate a moment to prefer the latter."[1]. The Preamble to the Indian Constitution resolves to secure for all the citizens of India, liberty of thought, expression and belief.[2] From Article 19(1)(a) of the Indian Constitution, i.e. 'Freedom of Speech and Expression', the media derives its rights.It is a fundamental right.[3] Freedom of Press is not specifically mentioned under the Indian Constitution, but it is included under Article 19(1)(a) of Constitution of India. Article 19 (1)(a) of the Constitution from which the media derives its rights guarantees to every citizen of India, Article 19(1) (a) reads :

19. (1) All citizens shall have the right
(a) to freedom of speech and expression;
The exceptions to the right guaranteed under Article 19(1)(a) are contained in Article 19(2) which reads:
Nothing in sub – clause (a) of Clause (1) shall affect the operation of any existing law, or prevent the state from making any law, in so far as such law imposes reasonable restrictions on the exercise of the right conferred by the said Sub-Clause in the interests of the sovereignty and integrity of India, the security of the state, friendly relations with foreign states, public order, decency or morality, or in relation to contempt of court, defamation or incitement to an offence.
The media derives its rights from the right to freedom of Speech and expression available to the citizen. Thus, the media has the same rights --- no more and no less than any individual to write, publish, circulate or broadcast.

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[1]Thomas Jefferson in a letter to Edward Carrington, January 16,1787

[2] Constitution of India,Preamble

[3] Fundamental rights under the Constitution of India (Part III of the Constitution) are those basic rights that are recognized and guaranteed as the natural rights inherent in the status of a citizen of a free country. These rights cannot be infringed or taken away from the citizen by governmental action or statute except to the extend permitted by the 'reasonable restrictions' enumerated in Clauses (2) to (6) of Article 19. While statutory rights other than fundamental rights can be taken away by legislation, fundamental rights cannot be taken away by legislation, can only impose reasonable restrictions on the exercise of the right. Dharam Dutta v. Union of India, (2004) 1 SCC 712, para 36,pp 738-39.

COMPARISONS WITH THE AMERICAN CONSTITUTION

Article 19(1)(a) finds its roots in the First Amendment to the Constitution of the United States of America. The First Amendment reads:

Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof; or abridging the freedom of speech, or of the press; or the right of the people peaceably to assemble and to petition the government for a redress of grievance.[4]

Unlike the First Amendment to the American Constitution, the Indian Constitution does not make a specific or separate provision for the freedom of the press. Further, while the restriction on the right to freedom of speech and expression are expressly spelt out in Article19(2), this is not so under the First Amendment. The US Supreme Court has read into the rights of the press certain implicit restrictions which are, in principal, no different from Article 19(2). However, generally, from a judicial and social standpoint the freedom of the press in America is far more robust than the corresponding Indian guarantee.

The question of whether or not to insert in the Indian Constitution a separate right for the press as distinct from that of the ordinary citizen was extensively debated by members of the Constituent Assembly. The Constituent Assembly came to the conclusion that such a provision was not necessary. Dr. B.R. Ambedkar, Chairman of the Constituent Assembly's Drafting Committee argued:

The press is merely another way of stating an individual or a citizen. The press has no special rights which are not to be given or which are not to be exercised by the citizen in his individual Capacity. The editor of a press or the manager is all citizens and therefore when they choose to write in newspapers, they are merely exercising their right of expression and in my judgment therefore no special mention is necessary of the freedom of the press at all).

Although no special provision was made to safeguard the rights of the press , the courts have time and again confirmed that the rights of the press are implicit in the guarantee of freedom of speech and expression under Article 19(1)(a) of the Constitution.[5] In fact, successive judgments of the Supreme Court of India have struck down laws that abridge the freedom of the press and have echoed the sentiment expressed in the First Amendment.

Ramesh Thappar v. State of Madras,[6] amongst the earliest cases to be decided by the Supreme Court, involved a challenge against an order issued by the Government of Madras under Section 9(1-A) of the Madras Maintenance of Public Order Act, 1949 imposing a ban on the entry and circulation of the journal, Cross Roads, printed and published by the petitioner. The Court struck down Section 9(1-A) holding that the right to freedom of speech and expression was paramount and that nothing short of a danger to the foundations of the State or a threat to its overthrow could justify a curtailment of the right to freedom of speech and expression. The impugned provision which authorized the imposition of restrictions for the wide purpose of securing public safety and public order fell outside the scope of the reasonable restrictions permitted under Article 19(2) and was held to be unconstitutional.

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[4] US Constitution , First Amendment , Article 1

[5] Brij Bhushan v. State of Delhi , AIR 1950 SC 129; Express Newspapers Ltd. V. Union of India , AIR 1958 SC 578 : Sakal Papers v. Union of India , AIR 1962 SC 305; Bennett Coleman & Co. v. Union of India (1972) 2 SCC 788 : AIR 1973 SC 106.; Maneka Gandhi v. Union of India, (1978)1 SCC 248

[6] AIR 1950 SC 124

In Brij Bhusan v. State of Delhi,[7] the Supreme Court quashed a precensorship order passed against the publishers of the Organiser. The order was passed by the authorities under Section 7(i)(c) of the East Punjab Safety Act, 1949. The Court held that Section 7 (i)(c) which authorized such a restriction on the ground that it was necessary for the purpose of preventing or combating any activity prejudicial to the public safety or the maintenance of public order' did not fall within the purview of Article 19 (2).

FREEDOM OF PRESS AND LEGISLATIVE PRIVILEDGES

What is legislative privilege?
To enable legislators to effectively perform their functions, to discuss and debate matters of importance without fear or favour, without hindrance or obstruction, the Constitution confers special rights on Parliament and the State Legislatures.

Freedom of press and legislative privileges - conflict of :
The conflicts of freedom of press guaranteed under Art.19(1)(a) and the legislative under Art.105 and Art.194 are unavoidable...
The Supreme Court *M.S.M. Sharma v. Sri Krishna Sinha*[8], held that under the scheme of the Constitution of India, the legislature have the right and privilege to prohibit absolutely the publication of the report of the debates and the proceedings in the floors of the houses and the houses are competent to impose punishment for breach of such privileges. Thus the freedom of speech and expression as contained in Art. 19(1)(a) is subjected to Art.105(3) and Art.194(3) of the Constitution. The privilege of Legislature prevails over the fundamental right to freedom of speech and expression. The reports of the proceedings in newspapers are protected under the Parliamentary Proceedings (Protection of Publication of Act. 1977. The Parliament has the power to power to the publication of its proceedings and prescribe punishment the resolution of the house of Parliament. In case of conflict between the fundamental right to freedom of speech and expression and the privilege of Legislature, the privilege of Legislature shall privilege the fundamental fight freedom of speech and expression.
In case of any conflict between the privilege of the Parliament under Art.105(3) of the Constitution and the freedom of speech and expression, the inconsistency has to be resolved by harmonious construction of the provisions. Article 19(1)(a) being general in nature must give away to the special provision under Art.105(3) of the Constitution.

RECOMMENDATIONS FOR ENSURING FREEDOM OF PRESS:

1. Codification of Legislative Privileges

A complementary measure will be to insist upon the codification of legislative privileges, with the proviso that where a breach of privilege is alleged, the legislature should only be permitted to file a complaint, the decision regarding whether contempt is proved and, if so, the punishment to be awarded being left to a Court of Law. The idea that the legislature should itself be both the accuser and the judge might have had a historical reason in England; but there is not reason for such a fundamentally unjust approach to be accepted in our context.

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[7] AIR 1950 SC 129

[8] AIR 1959 SC 395

2. The Main Goal - Growth with Freedom

What should never be overlooked when thinking of the Press in the Indian context is that it is only a free Press which can help develop a body of citizens who are well informed both regarding current events and also about the problems facing the country; and the alternatives available for tackling them. It is only such a Press that can enable a young democracy like India to survive, and also help its development in a manner where social justice is ensured and the interests of the common people served.

3. Importance of Constitutional Amendment

All the difficulties in the way of ensuring that the Press can have the maximum freedom to carry out its function of collecting facts about different facets of national life, analysing them and commenting upon them so as to keep the general body of citizens in our young democracy well informed show that the Press requires some special protection. Many authorities have held that the Right to Freedom of Speech conferred by Article 19(1) of the Constitution is adequate to protect the freedom of the Press. Further, due regard has to be given to the recommendations made by the National Commission to Review the Working of the Constitution (NCRWC). They have recommended the inclusion of Freedom of Press-media under Article 19(1)(a).

4. Press Needs To Improve

The inadequacies of the Indian Press need not be connived at. There is no doubt that private business and those who control it, are treated by most newspapers with kidgloves. This partly is because of the ownership of many newspapers and therefore the philosophy of those who are appointed to senior journalistic positions. It is seen that the editors and journalists cannot have adequate freedom of collecting and disseminating facts and offering comments as they are under the pressure of the capitalist owners. So, the pressure of the capitalist owners should be minimized.

5. Positive Assistance To Independent Papers

At the same time, it is important that steps are taken positively to make it possible for independent papers to survive and develop. Assistance to them should be provided through general institutions meant to help the growth of independent entrepreneurs, including small ones.

6. The State, should stop becoming the Main Threat

This resistance is necessary because experience all over the world, as well as our own experience since Independence, suggest that the State remains the source of the most potential threat to Press freedom.

CONCLUSION

On analysing the current scenario, latest issues and developments of Freedom of Press, it can be concluded that although the Press is considered the watchdog of democracy, sadly, there is scant regard for this truism in a country which is, ironically, the world's largest democracy. In keeping with its affirmation that freedom of expression is "one of the essential foundations of a democratic society", the Court has clearly shown a preference for freedom of press. In conclusion, it must be reiterated that the freedom of press and information are fundamental to healthy working of a democracy and therefore, must coexist with the freedom of speech and expression.

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AN EVALUATION OF OPPORTUNITY AND CHALLENGES FOR GREEN MARKETING IN HOTEL INDUSTRY OF DAMAN

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ABSTRACT

Green marketing is another emerging marketing strategy that incorporates a broad range of activities like product modification, fair –trade practices, adopting eco -friendly production process and packaging. The 4 P's of green marketing are *that of a conventional marketing but the challenge before marketers is to use 4P's in an innovative manner. The present paper is an attempt to analyze the factors affecting the Green Marketing-Mix (Product, Service, Price, Place, and Promotion) in the hotel industry. A self-developed questionnaire is used as an instrument to collect the information and response. The study reveals certain important factors and innovations, which can be adapted by them into their hospitality operations to turn themselves green.*

Keywords: Green Innovations, Marketing Mix, Hospitality operations

INTRODUCTION

According to the American Marketing Association, Green Marketing is the marketing of products that are presumed to be environmentally safe. Thus green marketing incorporates a broad range of activities, including product modification, changes to the production process, packaging changes, as well as modifying advertising. A number of factors have caused business firms to behave more responsibly towards the natural environment. Perhaps foremost among these is the possibility of capitalizing on opportunities from the sale of environmental services and products. Environmental awareness has increased dramatically, particularly since the organized environmental movement emerged in the late 1960s. Issues ranging from global warming to animal rights to species preservation to the protection of wetlands are now prominent in the media and in the minds of consumers. "Green" consumers have thus arisen with preferences for products made from recycled materials or products whose use entails reduced environmental impact. Often such products command premium prices, and therefore the task of marketers has become all the more crucial. Due to global warming, green house gas emissions, pollution, and energy crisis, world is facing a severe threat of being a very difficult place to live in. Therefore, the marketers need to include a green approach in framing the marketing programs/ strategies. With regards to this the marketers now have to go green. It means that due care must be taken while framing the marketing plans, strategies and policies so as to prevent the environment and nature from any harm caused due to its operations not only today but also in future.

REVIEW OF LITERATURE

Walker, R.H. & Hanson, D.J. (1998)[i] had found from the early research which focused predominantly on the characterization of the "green" consumer, conceptualization of environmental consciousness, environmentally related behaviors such as recycling, and attitudes towards environmental problems such as pollution. This was followed by a period in which energy conservation, legislation, and public policy issues were added to the agenda which remained predominantly managerialist in perspective. Desmond, J. & Crane, A. (2004)[ii] attempted to bring attention to the general and pervasive exclusion of service industries from discussions of green marketing practices. They explore why circumstance may exist, and provided arguments to support the adoption of environmental practices by services providers. Also in trying to identify how the service sector can contribute to the preservation of the environment, a greening of services matrix was presented. This matrix was designed to demonstrate through hypothetical examples the many ways that service industries can reduce, reuse or recycle resources, either collectively or individually, and thereby embrace the green initiative. Finally, the authors submitted a total quality/ benchmarking approach as a means by which services organizations may adopt environmental practices. Karna, J., Hansen, E. & Juslin, H. (2003)[iii] Green marketing has not lived up to the hopes and dreams of many managers and activists. Although public opinion polls consistently show that consumers would prefer to choose a green product over one that is less friendly to the environment when all other things are equal, those "other things" are rarely equal in the minds of consumers. How then, should companies handle the dilemmas associated with green marketing? They must always keep in mind that consumers are unlikely to compromise on traditional product attributes, such as convenience, availability, price, quality and performance. It's even more important to realize, however, that there is no single green-marketing strategy that is right for every company. It is suggested that companies should follow one of four strategies, depending on market and competitive conditions, from the relatively passive and silent "lean green" approach to the more aggressive and visible "extreme green" approach - with "defensive green" and "shaded green" in between. Managers who understand these strategies and the underlying reasoning behind them will be better prepared to help their companies benefit from an environmentally friendly approach to marketing. Stone, G.W. & Wakefield, K.L. (2000)[iv] Evidence is reported from a qualitative study which investigated corporate perceptions of this context and revealed the strategic orientations which have subsequently been employed by *green* marketers. The findings suggest that managers do indeed perceive the backlash to have occurred and to have been caused by the factors posited. It is argued that these understandings have assumed the role of myths in shaping organizational perceptions of the *green marketing* context. Four subsequent strategic routes are identified namely passive greening, muted greening, niche greening and collaborative greening. Jain et al (2004)[v] focused that Environmentalism has fast emerged as a worldwide phenomenon. Business firms too have risen to the occasion and have started responding to environmental challenges by practicing green marketing strategies. Green consumerism has played a catalytic role in ushering corporate environmentalism and making business firm green marketing oriented. Based on the data collected through a field survey, the paper makes an assessment of the extent of environmental awareness, attitudes and behavior prevalent among consumers in India and lists implications of the study findings for the government and non-governmental organizations engaged in marketing of green ideas and products in the country. Mohammed (1999)[vi] reported on an ongoing exploratory research on how the environmental agenda can influence the hospitality industry marketing and management strategies. In two stages, the study attempted to understand the behavior of hospitality industry in Egypt towards the environment by examining executives' (personal and business) environmental values and triangulating these values these values with

marketing practice and environmental management.']he purpose of this attempt was to develop typologies of behavior based on hotels' environmental activity (greenness) and responsibility values and then theories on the reasons, meanings and purposes of such behavior. Pujari, D., Wright, G. & Peattie, K. (2003)[vii] The greening of new product development process has been under scrutiny by researchers, but the attention has been limited to consumer products. Based on a survey, this paper investigates the environmental responsiveness in industrial new product development in 82 industrial firms. In comparison to traditional NPD process in the extant literature, the findings revealed additional activities in the greening of industrial NPD. These activities fall under the broader scope of life cycle assessment (LCA) for environmental impact including supplier evaluation and design for environment issues. The paper also investigates the relative impact of organizational antecedents on greening of industrial NPD activities. Organizational antecedents include functional interface of environmental specialists with design and product managers, environmental product policy, and top management support. Chen, C. (2001)[viii] found that success factors are structured according to six areas of concern: management, customer relationships, supplier relationships, developmental process, competence and motivation. By relating the factors to a number of product development elements that are generally claimed to be important for product development success, it is indicated that the integration of eco design to a great extent are related to the same elements. A few factors seem to be specific for the integration of eco-design. These factors are related to competence and motivation. As many of the eco design success factors relate to those elements that are acknowledged to affect product development success, this implies that a company that manages product development well increases the likelihood of being successful when integrating eco-design into product development. Simon, M. (2000)[ix].This paper develops a quality-based model for analyzing the strategic and policy issues concerning the development of products with conflicting traditional and environmental attributes. On the demand side of the problem, the framework of conjoint analysis is used to structure the preferences of the ordinary and green customers. On the supply side, theories in optimal product design and market segmentation are applied to analyze the producer's strategic decisions regarding the number of products introduced and their prices and qualities. On the policy side, the effects of environmental standards on the economic and environmental consequences of green product development are evaluated. By jointly considering the interactions among the customers' preferences, the producer's product strategies, and the environmental standards imposed by governments, some interesting findings that can be used to manage and regulate the development of green products are presented. Two major findings show that green product development and stricter environmental standards might not necessarily benefit the environment. Schlegelmilch, B.B., Bohlen, G. M., & Diamantopoulos, A. (1996)[x] found that attributes such as degradability, recyclability, lower pollution etc are considered to be environmentally friendly. Kilbourne, W.E. (2004)[xi] Green marketing is taking shape as one of the key business strategies of the future. The increasing environmental consciousness makes it incumbent on consumer marketers not just to respond to, but to lead the way in, environmental programs. Consumer marketers should: 1. recognize a product's environmental implications, 2. analyze the changing consumer and political attitudes while recognizing the role that companies can play in protecting the environment, 3. realize that green marketing is not purely altruistic - it can be a profitable Endeavour, and 4. recognize that green marketing must be a fully integrated part of a firm's strategic marketing plan. Increasing environmental consciousness also sets forth the need and specific recommendations for incorporating environmental concerns into the strategic marketing planning of the organization. De Boer, J. (2003)[xii] The increasing environmental concerns of consumers are leading to more information about the environmental characteristics of products being made available by producers through what is called "eco-labelling". Eco-labelling has thus become the medium promoting both the production and consumption of products that are "more environment friendly" than competing products available in the market. In the conclusions, attention is drawn to the way in which societal

pressure might interact with market forces to shape the information environment for products and services. As a result, the role of sustainability labels might become more differentiated, varying from direct shopping aids to background quality assurances. Ibanez, L. & Stenger¸A. (2001)[xiii]Green' marketing is not restricted to `green' products, and `green' consumers only adapt their purchasing habits some of the time. Ecolabelling schemes can be used as a means of ameliorating this inefficiency in information-transfer. Whether state intervention to make ecolabelling mandatory for `green' products is welfare-improving depends on the balance between the deadweight losses from the process and the gains in terms of facilitating the expression of `green' preferences.

OBIECTIVES OF THE STUDY

To know the underlying factor affecting the green marketing mix in hotel industry of union territory of Daman.

RESEARCH METHODOLOGY

The study was exploratory in nature. The target population was hotels in Daman. Individual managers of hotels were sampling element where 30 individual respondents were taken from hotels situated in union territory of Daman. The sampling technique was convenience sampling. The data was collected using the self-developed questionnaire through personal contacts to know the responses of hotel operators. Factor analysis was applied to know the Underlying factors.

RESULTS AND DISCUSSION

The data obtained for the study was analyzed by using-FACTOR ANALYSIS" for identification of key factor preferred by the respondents in the "Green Marketing Mix: Principle component analysis is the commonly used method for grouping the variable under the few unrelated factor. A factor loading is the correlation between the original variable with specified factor and is the key to understanding the nature of a particular factor. In this study, principal component has been used since the objective is to summarize most of the original information in a minimum number of factors for prediction. Here the factors are extracted in such a way that factor axis are maintained at 90 degrees, meaning that each factor is independent of original variables factors also represent the underlying dimensions that summarize for in account for the original set of observed variables. An important concept in factor analysis is the rotation of the factors. We have used Varimax rotation to simplify the factor structure. Only the factor having the Eigen value greater than one is considered. An Eigen value is the column sum of square for a factor. It represents the amount of variance in data. The elements having greater than 0.500 factors loading were only considered loaded on the factor. A factor loading is the correlation between the original variable and the factors, and is the key to develop by the factor analysis based upon the appropriate for representing the underlying dimensions of particular factors.

Table No:-1   Reliability Statistics

Cronbach's Alpha	N of Items
.876	16

Since the value of Cronbach's Alpha is higher than the accepted 0.70, we reject the null hypothesis and we may say that the instrument is reliable and can be used with factor analysis for further investigation.

Table No: 2   KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.875
Bartlett's Test of Sphericity	Approx. Chi-Square	1.0143
	Df	120
	Sig.	.000

The adequacy of the data is evaluated on the basis of the results of Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity (homogeneity of variance). The KMO measure of sampling adequacy is 0.733 indicating that the present data are suitable for factor analysis. Similarly Bartlett's Test of Sphericity is significant p<0.001 indicating sufficient correlation exists between the variables to proceed with the analysis.

Table No: 3 Factor Analyses

Factor	Eigen value		Variable convergence	Loading
	Total	**% of variance**		
Protection	6.067	37.916%	Biodegradable Waste	.737
			Fuel Saving	.730
			Packaging	.709
			Water Conservation	.671
			Energy efficient appliances	.662
Promotion	1.40	8.777%	Packaging Material	.788
			Interior of Hotel	.723
Location	1.224	7.652%	Green Garden	.765
			Location of Hotel	.546
Prolongation	1.098	6.861%	Recycling	.546
		61.206%		

FINDINGS

It is the first most important factor which is carrying the variances of 37.916% including sub variables water conservation, fuel saving, biodegradable waste, energy efficient appliances and packaging etc, which directs the managers towards cost efficiency with environmental crisis degradation prolonged with informative packaging which also educate the society to make less use of non-recycling materials. This factor also compels the managers to protect renewable sources.

Promotional activities of Hotel generates variance of 8.777% includes the sub variables promotional activities, interior of hotel, Packaging size and material. In packaging marketers should promote minimal packaging with material which can be recycled or reused. Promotion allows the marketers to build the brand image with green promotional tools to draw the attention of society towards environmental safety.

Location is also one of the most important factors with variation of 7.652% including sub variables location of hotel and Green Garden. Place is an important factor to finalize the location of hotel building on the criterion of environment safety, space for waste disposal which will be recycled and release in rivers.

Prolongation is the last most important factor carrying variance of 6.861% including sub variable recycling process in providing service. Its highest weight-age shows that this factor has to be considered

by the hotel managers to minimize the wastage and becomes an added part to enhance environmental safety.

CONCLUSIONS

In Hotel industry which is the combination of product and service provider it becomes more important to turn them as green. By this study we found four key factors which affect the building of green marketing mix of a hotel to fulfill the objectives of environment safety. These four factors contribute 61.00% variation in the green marketing mix of Hotels located in the union Territory. The four key factors are protection, promotion, location and prolongation.

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Title: Nanobiosensors: "Concept and Variations".

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Abstract:

Biosensing has been one of the hottest topic attracting scientific minds since long back. It is so as biological entities are very complex and are directly associated with the existence of a healthy environment. The design of biosensors also has witnessed significant changes in the recent past. Biosensors for applications as diverse as food quality estimation, environmental monitoring and diagnosis of clinical and metabolic complications have come to the fore. Nanotechnology has bestowed some highly exciting ingredients for the improvement of sensing phenomenon. The use of diverse nanomaterials ranging from nanoparticles, nanotubes, nanorods and nanowires has enabled faster detection and its reproducibility in a much better way. The unique properties of nanomaterials such as high electrical conductivity, better shock bearing ability and the sensitive responses such as piezoelectric and versatile color based detection mechanisms are only the results of congregation of nanomaterial properties. This paper highlights the different types of biosensors based on different types of nanomaterials and their developmental and implicational aspects.

Keywords: Biosensing, nanotechnology, nanotubes, nanorods, developmental, implicational, nanomaterials.

Introduction

Sensing the biological responses has assumed great significance in the current scenario of ever dynamic environmental developments and corresponding altered homeostatic happenings occurring at both *in vivo* as well as *ex vivo* levels. The analyzing of behavior of the ever changing materials has assumed great significance in the areas like pharmaceutical diagnosis, screening food quality and for environmental applications. In this reference, the development of efficient biosensors which can analyze the minutest details of the biological interactions even at a very small scale and with extreme precision and maximum ever possible sensitivities deserves urgent attention **[1].** A key component of the biosensing is the transduction mechanisms which are responsible to convert the responses of bioanalyte interactions in an identifiable and reproducible manner using the conversion of specific biochemical reaction energy into an electrical form through the use of transduction mechanisms. Nanomaterials can be wonderful incumbents in this dimension as they have high surface area to volume ratios which allow the surface to be used in a better and far more diversely functional manner. Moreover, their electromechanical properties are the wonderful assets for the biosensor technology. Nanostructural wonders provided by nanotechnology have revolutionized the happenings in the domain of molecular biology which has provided an opportunity for manipulation of atoms and molecules and monitor the biological phenomenon at the physiological level with far greater precision. The terminology nanobiosensor is a misnomer in the sense that it has the word nano prefixed to it. To get to the real technology, one must soundly gather the idea of what a biosensor is? As Nanoscience is interdisciplinary in nature so putting the word nano as prefix often implies the use or manipulation at a scale equivalent to one-billionth of a meter.

Definition and Conceptual Idea

A biosensor can be defined as a sensing device or a measurement system designed specifically for estimation of a material by using the biological interactions and then assessing these interactions into a readable form with the help of a transduction and electromechanical interpretation. Fig.1 gives us information about the three main components of a biosensor. In order of their functioning, these components are namely bioreceptor, transducer and the detector. The main function or purpose of a biosensor is to sense a biologically specific material. Often, these materials are antibodies, proteins, enzymes, immunological molecules and so on.
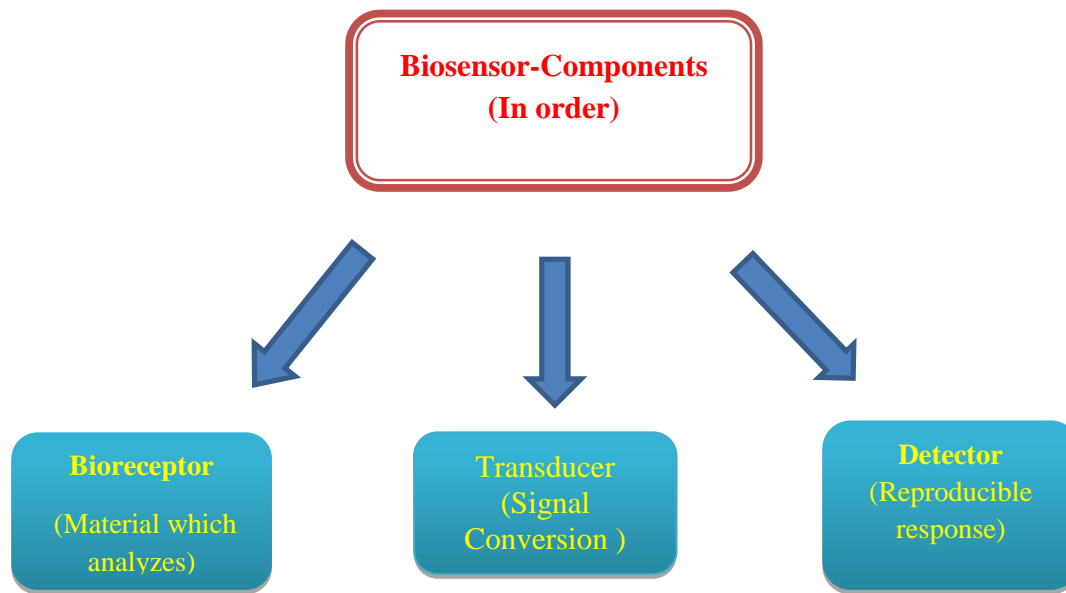
Fig.1. Depicts the Block Diagram of a Biosensor.

It is done by using another biologically sensitive material that takes part in the making of bioreceptor. So, a bioreceptor is that component of a biosensor which serves as a template for the material to be detected. There can be several materials which can be used as bioreceptors. For instance, an antibody is screened using antigen and vice-versa, a protein is screened using its corresponding selective substrate and so on. The second component is the transducer system. The main function of this device is to convert the interaction of bioanalyte and its corresponding bioreceptor into an electrical form. The name itself defines the word as trans means change and ducer means energy. So, transducer basically converts one form of energy into another. The first form is biochemical in nature as it is generated by the specific interaction between the bioanalyte and bioreceptor while the second form is usually electrical in nature. This conversion of biochemical response into electrical signal is achieved through transducer. The third component is the detector system. This receives the electrical signal from the transducer component and amplifies it suitably so that the corresponding response can be read and studied properly. In addition to these components, a very essential requirement of the nanobiosensors is the availability of immobilization schemes which can be used to immobilize the bioreceptor so as to make its reaction with bioanalyte much more feasible and efficient. Immobilization makes the overall process of biological sensing cheaper and the performance of the systems based on this

technology is also affected by changes in temperature, pH, interference by contaminants and other physicochemical variations **[2]**.

Nanobiosenors: The Merging of Nanotechnology with Biosensors

This understanding of biosensor lays the foundation for studying and developing the nanobiosensors. Nanobiosensors are basically the sensors which are made up of nanomaterials and not which can detect the nanoscale events and happenings. The question that sustains interest from the above description is that why nanomaterials are intended to be used in making biosensors or are they going to drive in any significant difference in the overall technology? Nanomaterials are a unique gift of nanotechnology to the mankind; these are the materials which have one of their dimensions between (1-100) nanometers. The size constraints of these materials makes them very special as they have most of their constituent atoms located at or near their surface and have all vital physicochemical properties highly different from the same materials at the bulk scale. They can play very efficient roles in the sensing mechanism of the biosensor technology. Integrated devices of the nanomaterials with electrical systems give rise to nano electro mechanical systems (NEMS), which are very active in their electrical transduction mechanisms. Several nanomaterials have been explored on the basis of their electronic and mechanical properties for their use in improved biological signaling and transduction mechanisms. Some of such materials that are widely employed include nanotubes, nanowires, nanorods, nanoparticles and thin films made up of nanocrystalline matter **[3].** Amongst these, the use of nanoparticles is best studied and analyzed till date. Nanobiosensors have served as very potent developmental inroads in the biosensor technology, which has been possible only due to the wonders of nanotechnological implications of the matter. A wide variety of biosensing devices that employ nanoparticles or nanostructures, have been investigated in a number of studies throughout the world. These can be as diverse as using amperometric devices for enzymatic detection of glucose to using quantum dots as fluorescence agents for the detection of binding and even using bioconjugated nanomaterials for specific biomolecular detection. These include colloidal nanoparticles which can be used to conjugate with antibodies for immunosensing and immunolabelling applications. These materials can also be used to enhance the electron microscopic detections. Further, metal based nanoparticles are very excellent

materials for electronic and optical applications and can be efficiently used for detection of nucleic acid sequences through the exploitation of their optoelectronic properties.

Sr.No.	Nanomaterial Used	Key Benefits	References
1.	Carbon Nanotubes	Improved enzyme loading, higher aspect ratios, ability to be functionalized, better electrical communication.	[4-6]
2.	Nanoparticles	Aid in immobilization, enable better loading of bioanalyte and also possesss good catalytic properties	[7-10]
3.	Quantum Dots	Excellent fluorescence, quantum confinement of charge carriers, size tunable band energy.	[11-13]
4.	Nanowires	Highly versatile, good electrical and sensing properties for bio and chemical sensing, charge conduction is better	[14-16]
5.	Nanorods	Good plasmonic materials which can couple sensing phenomenon well, size tunable energy regulation, can be coupled with MEMS, induce specific field responses.	[17-19]

Table1. Depicts the overview of Nanomaterials used for Improving Biosensor Technology.

Table 1 shows the main types of nanomaterials being employed for improvising upon the sensing mechanisms that are conventionally being employed in the biosensor technology. It highlights the potential advantages of several nanomaterials employed and some evidences witnessed their use so far (encoded by corresponding references). The details of different biosensors developed by the use of different materials at the nanoscale are mentioned further in the text. Even,

magnetic nanoparticles made up of iron and its oxides have been used for specific and efficient detection of magnetism based events and interactions like those of magnetic resonance imaging (MRI). These particles can be coupled with fluorescent molecules or can be made to deliver specific responses by coupling with externally applied magnetic fields. Similarly zinc and zinc oxide based nanostructures have been extensively used for sensing of biochemical phenomenon in a much more precise and sensitive manner. These have been used in optimized detection of cholesterol and many other metabolic intermediates. Continuing along the same direction, carbon nanotubes have also been used to optimize the biosensing events with reference to their ability to allow for rapid detection and much better interactions between the analyte and the bioreceptor molecule. Carbon nanotube based biosensors have been actively in use for the detection of glucose [20] and insulin [21]. The text ahead mentions the advantages and outcomes of the use of different nanomaterials and their inherent benefits and the critical parameters which they can have significant impacts and yield significantly better results.

Selection and Optimization of Nanomaterials for Sensor Technology

There are a multitude factors which govern or decide the use of a particular kind of nanomaterials for biosensing applications. These factors are the chief ingredients of their physical and chemical properties along with their energy sensitive and selective responses. Table 1 has already mentioned the main important nanomaterials employed for biosensing applications. Before exactly implementing or adding a nanomaterial for the sensing applications, we first focus on their desired manufacturing which is a part of experimental design known as "Nanofabrication". The technique of nanofabrication targets two vital operations, namely the manufacturing and design of nanoscale adhesive surfaces via the technology of integrated circuits and the engineering of nanomaterial surfaces through the process of micromachining. This technique thus developed for biosensing, uses the variations of four basic processes namely photolithography, thin film etching/growth, surface etching strategies and chemical bonding parameters.

Nanoscale electrodes which have come into picture as a result of lithography technique have enhanced the biosensing accuracy by providing much better and greater surface areas that in turn enable the immobilization to be achieved with greater precision [22]. Glucose biosensors, making use of enzyme glucose oxidase have been developed using these innovations. The

strategies involving the use of active nanoparticles of platinum over the sheets of carbon nanotubes have significantly enhanced the immobilization of enzyme systems required for the detection of the analyte materials. These systems have significantly much wider applications to biosensing technology, enabling the detection of glucose from several sources other than blood. In a similar manner, couple of immunosensors have also been developed which involve coating of thin films over the sensing surface that enables faster and better detection of the corresponding analytes [23].

Highly sensitive electrical and electromechanical properties are incorporated into several materials by engineering them with nano electro mechanical systems (NEMS), which have enabled the generation of complex electrical, mechanical, fluidic, thermal, optical and magnetic properties of the materials with sizes down to the nanometer level. NEMS technology has thus provided many materials with novel properties due to their nanoscale functionalization. NEMS and MEMS devices have enabled better and better sophisticated performance of the mechanical materials as the mechanical properties of a material are a critical function of its size. In addition, these devices have been coupled with biological systems and molecules to improve their bio adhesion characteristics and the response to a wide range of stimulii. With the implementation of NEMS and MEMS, surface forces like friction, adhesion, cohesive forces and viscous drag forces can be controlled in a very precise manner that enables the best modeling of the biochemical interactions taking part in the biosensing technology [24].

Another important factor considered while using nanomaterials for sensing application is the monitoring and optimization of their optical properties. The phenomenon like surface plasmon resonance are very interesting and in particular expected from nanoparticles so as to maximize the sharp and precise scale optical response of the sensing materials with the incident light. The surface plasmon resonance effect is concerned with the excitation of particle surface with the ionic species and charged particles which create ions and results in excitation of the fluidic state of charged particles. This property is highly suitable in case of nanoparticles due to their unique optical properties which give them photonic character and excellent ability to be used as fluorophores. This phenomenon makes the use of total internal reflection which takes place for angle of incidence reaching beyond a critical value. Here, the reflection of light through a thin film of metallic nanoparticles coated over a surface is optimized by the corresponding

adjustment of the critical angle of reflection. In case of nanomaterials, this phenomenon is highly logical and is especially named as localized surface plasmon resonance **[25]**. Surface plasmon resonance effect is also dependent upon the refractive index of a medium and it is the most fundamental property governing the flow of light through a medium. Due to surface plasmon resonance, it is possible to sense the surface morphology of the analyte material than those possible with normal optical luminescence with comparatively lower wavelengths of the incident light **[26-28]**.

In this way, nanomaterials, irrespective of their nature need to be optimized for their performance and effect as per the desired goal before being actually implemented for the biosensing purpose. Nanostructured semiconductor crystals can be efficiently used to improve the detection of neurological responses via coupling through the sensing molecule of biological nature. These can be coupled with peptide assembly of a range of nanomaterials so that efficient interaction can be generated by means of self-assembly and this also saves a lot of time that is being involved in the currently available technologies and methods. Moreover, these can rapidly detect the biological stimulus such as that of a DNA segment or a characteristic nucleotide sequence pertaining to proteins or even RNA **[29]**. Moreover a key strategy into shaping up of nanomaterials for desired applications involves the tuning and engineering of their surface by sophisticated inroads collectively termed as micromachining procedures. Factors like aspect ratios, functionalization with other materials and compatibility issues with respect to the material being analyzed for are highly critical for the use of nanomaterials in biosensing applications.

Nanobiosensors- Variations and Types

The classification of nanobiosensors is a very diverse area. This is so as it is based on the nature of nanomaterials incorporated in the biosensing operation. Moreover the classification here is not as simple as it is in the case of biosensors. In case of biosensors, we classify the sensors on two criteria, namely the type of material to be analyzed and the other is on the basis of signal transduction mechanism employed. For instance, if we are screening any antigen or enzyme through the biosensors we name them as antigen biosensors or enzyme biosensors as per the convention of naming a biosensor through the nature of the analyte. Similarly, if we arrive at the classification of biosensors with respect to their sensing mechanism, the main types are electrochemical, calorimetric, optical and acoustic. Each of these classes is based on the

transduction mechanism involved and includes a series of overlapping sensor categories under it. For instance, amperometric and potentiometric biosensors come under the category of electrochemical sensors, likewise optical biosensors carry optical fiber based sensors and surface plasmon resonance based sensors under them **[30]**.

Considering about the classification of nanobiosensors, we observe that the criteria for classification are the nature of nanomaterials being involved for improving the sensing mechanism. For instance, nanoparticle based biosensors include all the sensors which employ metallic nanoparticles as the enhancers of the sensing biochemical signals. Similarly, nanobiosensors are called as nanotube based sensors if they involve carbon nanotubes as enhancers of the reaction specificity and efficiency while biosensors using nanowires as charge transport and carriers are termed as nanowire biosensors. Likewise there are quantum dots based sensors which employ quantum dots as the contrast agents for improving optical responses. The text ahead enlists some of the major classes of nanobiosensors developed till date and those which are in practical use.

1. Nanoparticle based Sensors

Acoustic Wave Biosensors

Acoustic wave biosensors have been developed to amplify the sensing responses so as to improve the overall preciseness of the limits of biodetection. There can be so many stimulus based effects in these kinds of sensors. The mass based variant of these sensors involves the conjugation of antibody modified sol particles which bind themselves on the electrode surface that has been complexed with the particles of analyte conjugated in a manner that antibody molecules are immobilized over the electrode surface. The large mass of bound sol particles of the antibody result in a change in the vibrational frequency of the quartz based sensing platform and this change acts as the basis of detection. In general, the preferred diameter of the sol based antibody particles is between (5-100) nm. Particles of gold, platinum, cadmium sulphide and titanium dioxide are generally preferred **[31-32]**.

Magnetic Biosensors

Magnetic biosensors utilize the specially designed magnetic nanoparticles. These are mostly ferrite based materials, either used individually or in combined form. These types of sensors are very useful with reference to the biomedical applications. The magnetic materials enable a great

deal of diversity for several analytical applications. This is so because the magnetic compounds involved in screening are constituted of iron coupled with other transition metals, which are having different properties. With the incorporation of magnetic nanoparticles, the conventionally used biodetection devices have further become more sensitive and powerful. Alloys of transition metals with iron and other materials having unpaired electrons in their d-orbitals have been highly versatile in their magnetic behaviors. A very popular kind of materials that have come to the fore involving these employ magnetic bioassay techniques that are used for specific isolation of magnetically labeled targets with the help of a magnetometer[33]. Special devices such as superconducting quantum interference devices (SQUID) have been used for rapid detection of biological targets using the superparamagnetic nature of magnetic nanoparticles. These devices are used to screen the specific antigens from the mixtures by using antibodies bound to magnetic nanoparticles [34]. These make use of superparamagnetic effect of magnetic materials which is particularly observed in the nanoscale particles.

Electrochemical Biosensors

These sensors basically work to facilitate or analyze the biochemical reactions with the help of improved electrical means. These devices are mostly based on metallic nanoparticles. The chemical reactions between the biomolecules can be easily and efficiently carried out with the help of metallic nanoparticles, which help a great deal in achieving immobilization of one of the reactants. This ability makes these reactions very specific and eliminates any possibility of getting undesirable side products. In this reference, colloidal gold based nanoparticles have been used to enhance the immobilization of DNA on gold electrodes which has significantly increased the efficiency of an overall biosensor by further lowering the detection limit [35]. Biosensors have been designed using enzyme conjugated gold nanoparticles for the identification of glucose, xanthine, hydrogen peroxide [36-38]. In a significant study by *Xu et al (2003)*, the analysis of electrochemistry of enzyme systems horse reddish peroxidase immobilized on gold electrodes loaded with nanoparticles of carbon, has been put forward. The study predicted a faster amperometric response and faster and much better electrocatalytic reduction ability for horse reddish peroxidase. As a result, the biosensor developed showed improved sensitivity and much lower detection limit as compared to the one without using nanoparticles.

In a similar trend, nanosized semiconductor crystals can be used to improve the efficiency of photochemical reactions and can be tagged to biological entities like those of enzymes and

precursors to design novel photo electrochemical systems. In this dimension, *Curri et al* (2002) have used immobilized nanocrystalline CdS using self-assembly approach so as to prepare an enzymatic detection system based on immobilized formaldehyde dehydrogenase onto the gold electrodes in order to carry out the catalytic oxidation of formaldehyde **[39]**. In several other studies, metal based nanoparticles have been used for coupling themselves with biological probes and then carry out useful detection of the specific molecules from a mixture. Bioassays based on biotin-streptavidin specificity have been designed in this regard **[40]**.

2. Nanotube based Sensors

Carbon nanotubes are one of the most popular nanomaterials known right now in the world of material science and optoelectronic applications. Since their discovery in 90's they have attracted interest worldwide because of their extraordinary properties, the most vital of which are the electronic conductivity, flexible physical geometric features and the ever dynamic physico mechanical properties ranging from high aspect ratios to very good functionalization abilities along with having high mechanical strength and folding abilities. Because of these attributes, both single walled as well as multi walled nanotubes have been used in designing biosensors for better and better performances **[41-42]**.

The most popular sensing advances that have come to the fore are the developments in the design of glucose biosensors that involve the use of nanotubes as immobilizing surfaces for enzyme glucose oxidaze; this enzyme is used for estimation of glucose from the several body fluids. In convention, the sensors using enzymes predicted the presence of glucose from major body tissues but the use of nanotubes as assemblies for immobilization has led to the estimation of glucose from even scarce body fluids such as tears, saliva etc. In one such arrangement, single walled nanotubes have been wonderfully employed for enzymatic detection of glucose and this innovation has also yielded significant increase in the enzyme activity **[43].** The enhanced performance of the biosensor was analyzed and found so, largely due to the high enzyme loading and better electrical conductivities of the nanotubes. Not only with their structural flexibilities, carbon nanotubes have also been used for enhancing the electrical detection of the sensing phenomenon, owing to their better and smoother electron transfer flow characteristics. The significant improvements in the catalytic biosensors have been widely exploited in several studies and in one such study, this innovation resulted in better oxidoreductase performance in

both glucose oxidaze and flavin adenine dinucleotide precursors binding to their substrates more efficiently and in a much more controllable manner **[44]**. Likewise, chemoelectroluminiscence effect has been improved by coupling CNTs to the sensing molecules of a sensor through better conductance of charge carriers and controlling their required flow characteristics. In a significant and comprehensive review, biosensors based on carbon nanotubes have been extensively summarized for key breakthroughs and advantages that they get bestowed with, by the incorporation of nanostructured arrays of carbon nanotubes and the related structure sensitive assemblies. This review article highlights the functionalization potential of carbon nanotubes and their rapid friendliness for being coupled with biomolecules like DNA, proteins, oligonucleotide probes and their corresponding benefits in an excellent manner **[45]**.

3. Nanowire based Sensors

Nanowires are cylindrical arrangements just like those of carbon nanotubes, having lengths in the order of few micrometers to centimeters and diameters within the nano range. Nanowires are the one dimensional nanostructures with very good electron transport properties. Significantly, the motion of charge carriers in the nanowires is vigorously improved and different from those in bulk materials. Sensors based on nanowires are very less in number but literature reports some exciting examples where use of nanowires has significantly improved the performance and detection of biological materials. In one such study, *Cui et al* have reported the performance of biosensors based on silicon nanowires doped with boron and used them for the detection of biological and chemical species **[46]**. Semiconductor nanowires have been exploited in a great detail and have also been used for coupling a number of biomolecules for identifying their specifically linked substrates. In a study, silicon nanowires coated with biotin have been used for the detection and isolation of streptavidin molecules from a mixture. The small size and capability of these nanowires make them ideal candidates to be used for biodetection of pathogens and many other real time analysis of a wide range of biological and chemical species, thus vastly improvising the current accuracies of presently used *in vivo* diagnostic procedures. As these sensing materials work on very precisely defined dimensions, they can also be used to accomplish in vivo applications and operate in the smallest environments within the living cells. In one such study, *Wang et al* (2005) have used optical fibers with diameters in the nanosize and coated with antibodies to detect the presence of toxicants within the single cells **[47]**.In another

very closely related study, *Cullum et al* (2000) have reported the synthesis of ZnO nanowires, coated them over the gold electrodes and then using them for detection of hydrazine using amperometric responses **[48]**. They have proposed a high sensitivity, low detection limit and far lower response times than ever been reported in the conventionally used sensor systems. Nanowires are very versatile in their performance and are significantly better than nanotubes in two major ways. First, they allow a range of modifications in their design by control of operational parameters during their synthesis. Secondly, they possess a lot much more scope for the development of functionalized assemblies by virtue of the existence of compatible materials on their surfaces. Despite very well-known synthesis procedure for nanowire synthesis, their use in the development of sensing devices has met several challenges **[49]**. It has been reported by several related studies that it is difficult to incorporate nanowires into the sensing systems for the overall improvement in their electrical conductivities to be realized. In a very advanced study, *Lieber* group have rigorously worked on semiconductor nanowires and synthesized them by using combinations of previously known methods. They have developed a complex one dimensional architecture comprising of at least 200 independent electrical nanowire assemblies and have used them to perform a low level detection of serum-bone cancer antigens **[46]**. For the best analysis of rationale behind using nanowires or knowing about their qualities that can improve sensing mechanism, *Yang et al* provided a valuable insight by rigorously talking about nanowires and nanobelts as well as their structural aspects and features through which they can be used in sensing applications **[50]** . In a couple of related advancements, both *Cui et al* and *Huang et al* have explored the salient attributes of nanowires and explained their utility in better conduction and detection of biological stimulus **[51-52]**. *Huang et al* have particularly focused on surface plasmon resonance ability of nanowires; through which these can be incorporated into the sensing probes and significantly improves the sensitivity of sensing event.   To make the process little more simplified, *Stern et al* have developed nanowires through the complementary metal oxide semiconductor (CMOS) approach. This approach has proved to be very easy in terms of controlling and regulating the synthesis procedures for nanowires and has been used for analysis of serum fluids so as to enable the isolation of several pathogens and proteins in crude form **[53]**.

In this way, nanomaterials have proved to be highly prosperous for brightening the sensing technology and have improved the diagnostic and detection procedures by leaps and bounds. The

faster and quicker diagnosis enabled by still faster analysis and evaluation protocols through the nanomaterials has just revolutionized the biosensing mechanism. There are many other nanomaterials except those mentioned above that have been capitalized upon and made use for in biosensing applications. Nanodots resembling the morphology of quantum dots, nanosheets and many other structures of altered geometries such as nanocombs, nanobelts and nanoribbons have been used for improving the conventional procedures of sensing. The coupling of piezoelectric and cantilever systems have further added a new charm to this technology. Nanomaterials like quantum dots have been added as labels coupled with sensitive dyes and they have yielded thermochromic, photochromic and electrochromic materials which can show highly sensitive detections that can be monitored easily. They have significantly helped in improving electron transport mechanisms and also in the development of much more efficient actuating mechanisms to impose a particular state of observation on a system. The text ahead mentions some impact provoking applications of nanobiosensors in the different walks of life.

Applications of Nanobiosensors

The definition and description of the concept of operation of nanobiosensors does not leave any room for their applications as they are highly versatile and multifunctional so many and perhaps endless. From the estimation and diagnosis in the health related in vivo aspects, biosensors can also be used for environmental monitoring of pollutants, toxicants, physical aspects like humidity, heavy metal toxicity and even presence of carcinogens.

1. **Biomedical and Diagnostic Applications:** Biosensors have been used for biological detection of serum antigens and carcinogens and causative agents of so many metabolic disorders since time immemorial. The routine applications in diagnosis are best described by the use of biosensors in the detection of disorders like diabetes, cancer, allergic responses and so many other disorders on the basis of serum analysis. To talk about most of the studied and effectual applications of nanobiosensors from clinical point of view, there are numerous clinical applications that are principally being enabled using biosensors in routine. These applications include the detection of glucose in diabetic patients **[54-55]**, detection of urinary tract bacterial infections **[56-57]**, detection of HIV-AIDS **[58-59]** and the diagnosis of cancer **[60-62]**. Indeed, all of these are highly critical health problems affecting the mankind at present throughout the world. Prior to the use of

biosensors the detection and diagnosis of these diseases was very difficult, time consuming and costly. The advent of biosensors has really improved the diagnosis of all these diseases and related malfunctions. With the addition of nanoscale interventions this diagnosis has further been benefitted and made more precise. The incorporation of nanomaterials has enabled the detecting enzyme systems to be immobilized and this has allowed the recycling and reuse of costly enzymes. Besides, they have improved sensitivity and accuracies that make them hot candidates for being tapped upon. The implementation of nanoscale innovations like NEMS and MEMS has enabled several advantages to the overall testing procedures. Extremely sensitive inroads like those of lab-on-a-chip based assays have been developed using smart sensing nanoscale materials only. Biochips and microarray based testing has enabled the testing of more than one disease in perhaps no time. With controlled synthesis, even magnetic nanoparticles have been synthesized and used for isolating heavy metals resembling in properties with iron from the blood serum of living organisms. The evaluation of biochemical responses has been highly versatile and it has been so selective with the use of magnetic nanoparticles. This argues well for blood related disorders considering the involvement of iron protein hemoglobin. Such invasions have been collectively termed as diagnostic magnetic resonance as they use the optimization of magnetic coupling to the in vivo antigens of the body **[63]**.Much more sophisticated responses have been observed for detection via nanobiosensors using different ways of their incorporation in sensing mechanisms.

2. **Environmental Applications:** This is a relatively broader area of application. This is so as environment undergoes so many rapid scale changes almost every second. The detection of pollutants, toxic intermediates, heavy metals from waste streams and the monitoring of weather conditions like the estimation of humidity and many other vital features are really highly detailed and comprehensive tasks. The sensors based on nanomtaerials can be very versatile in terms of their detection and monitoring. The use of devices such as cantilevers, electronic probes and the provisions which require very little amount of analyte are very good invaders of the technology. The nanomaterials based sensing tools can be used to find the particular kind of damaging extent of a material present or prevailing in the environment. In one such study, a Chinese Hamster Ovary cell line has been coupled with fluorescent reporter system and used to monitor various

toxicants in highly diverse aqueous environments. Carcinogens and harmful intermediates leading to the disruption of proper hormonal systems in the living beings have been isolated through the use of highly sophisticated and specific compounds, particularly named as endocrine-disrupting compounds **[64]**. Similarly, in one such study, *Purohit et al* have used biosensors to monitor the abiotic conditions that are essential for optimization of biological recovery applications like those of bioremediation **[65]**. In this way, the technique of bioremediation can be scaled up and used to optimize the environmental quality and decontaminate the hazardous contaminants. These applications when engineered with the use of nanomaterials can be far more useful and beneficial. Using the substrate specific detection mechanism, biosensors have been developed for detection of nitrates **[66]**, inorganic phosphates **[67-68]**, biological oxygen demand like parameters and have been proved to be environmentally restoring in their working mechanisms. These applications can be integrated and a single sensor can be developed by the use of nanomaterials which can sense the different contaminants equally well in only a single operation. In this manner, there are endless environmental parameters for the evaluation of which the nanobiosensors can be used and developed. These applications are highly energy saving, economical and time saving in nature.

3. **Miscellaneous Applications:** Nanobiosensors can also be employed to optimize several other detections. In the industrial operations, feeding of nutrient media and substrate mixtures into the bioreactors for diverse applications can be regulated using these sensors. On an industrial scale, many commercial preparations and separations can be enhanced with these sensors. For instance, in the metallurgical operations requiring separation of impurities existing in a complexed form combined in the form of ores, nanobiosensors can be used to separate the impurities selectively by trying out different configurations of the sensing enzymes. Developing microbiological and biochemical assays coupled with bioengineering based innovations are really very handy applications of these sensing materials.

Conclusion and Future Prospects:

Nanotechnology has really proved to be a very significant blessing in the development of biosensors. It has revolutionized the case of biological detection. The overall mechanisms have

become quicker, smarter, less costly and user friendly. The transduction mechanisms have been significantly improved with the use of nanomaterials and nanostructures like those of quantum dots, nanoparticles for enzyme immobilization and hybrid nanostructures with multiple functionalities. Future argues very well for these dynamic, versatile and quick recognition systems considering their multidimensional potential. These materials are right now being increasingly considered for the merging of chemical and biological sensors to make the overall process fast, easy to execute and better in terms of performance **[69-70]**. The increasing advancement of miniaturization and nanomaterials research has stimulated the applications of these materials for sensing several key pathways and regulatory events.

With the current progress and exhaustive research pace of nanomaterial exploration, the sensing technology has become more and more versatile, robust and dynamic. No doubt, biosensor development for a task is still very cumbersome and costly due to its technical complexities but the incorporation of nanomaterials has proved to be a big boon for this technology, chiefly due to its friendly and result oriented experimental supports.

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Performance Evaluation Of Sewage Treatment Plant Based On Advanced Aerobic Biological Filtration And Oxygenated Reactor (BIOFOR) Technology- A Case Study Of Capital City -Delhi, India

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Abstract— India faces a number of water and wastewater issues and water related health hazards. Sewage Treatment Plants (STPs) have been constructed in most places to reduce the degradation of water quality of the receiving water bodies by reducing the total pollution load on the same and to ensure a healthy environment both aesthetically along with preserving the ecosystem involved. The BIOFOR process is an emerging advanced wastewater treatment technology that has been successfully applied at an ever increasing number of locations around the world. The work carried out in this research presents the results of the evaluation carried out for the techno-economical and environmental performance of STP based on advanced aerobic BIOFOR technology located in Delhi for handling and treating the domestic wastewater. The parameters which were monitored under the study included pH, Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Mixed Liquor Suspended Solids (MLSS), Total Coliform (TC) and Fecal Coliform (FC). In addition to the evaluation of the performance of the STP, same was also analyzed for the capital cost, operation and maintenance costs, energy requirements and land +++requirement, which is primarily based on the data as obtained from various STPs in the River Action Plans and information collected as well as compiled from sewage treatment technology provider.

Index Terms —Wastewater, Performance Evaluation, STP, BIOFOR.

I. INTRODUCTION

The typical domestic wastewater treatment system is a centralized municipal-sized facility that treats wastewater to specified discharge limits, to protect human health and the environment [1]. Treatment of any kind of wastewater to produce treated water of good quality is necessary. Treatment technologies are based on varying levels of mechanization, energy inputs, land requirements, costs, skilled manpower etc. Therefore, choice of an effective treatment system is important. Though well proven and reliable, conventional aerobic treatment processes usually require large surface areas and react slowly to high-load variations. In order to provide compact plants and to assure greater treatment efficiency and reliability, biological aerated filtration technique has been developed [2]. *BIOFOR Technology* (Biological Filtration and Oxygenated Reactor) is a patented technology of Degremont includes Intensified Aerobic treatment with Dense-Deg & BIOFER**.** Even though BIOFOR is a relatively new technology, installations treating from 0.1 to 110 MGD are in operation at over 100 locations worldwide, thereby implying its increased usability in shorter span of its inception. *The first municipal installation for the same occurred in 1997 at the 1.7 MGD Woodstream-Evesham Wastewater Treatment Plant in Marlton, New Jersey* [5]. The BIOFOR technology can be applied to aerobic carbonaceous BOD_5 removal and to nitrification and Denitrification. Aerated biological filtration combines in a single step both biological degradation of biodegradable soluble matter and solids retention by mechanical filtration of suspended solids. The biological filtration is achieved in up-flow filters loaded with a suitably sized granular supporting media, thus giving rise to an efficient filtration effect. The filter media provides adequate support for biomass attachment and a mechanical filtration capability. The processes working with water and air in concurrent are particularly advantageous and clearly superior to process of counter current with regard to the nitrification capacity. The reason being that, in

concurrent method the partial pressure of oxygen in the gaseous phase is higher in the filter areas of the highest oxygen demand then in the use of counter current and that the reduction of the oxygen concentration in the liquid film can be kept minor due to superior supply of oxygen from the gas phase [3].

II. STUDY AREA

In capital city of India, study area covers Sewage Treatment Plant (STP) based on BIOFOR technology and situated on the north bank of Dr. Sen Nursing Home drain, East of Ring Road, Delhi. Satellite image indicating Layout plan of the said Plant is shown in Fig. 1. Process Flow Diagram of Sewage Treatment Plant with BIOFOR Technology installed at Dr. Sen Nursing Home drain is given in Fig. 2. The STP is designed to handle an average flow of 10 MLD from Dr. Sen Nursing home drain flowing with average flow of 60-70 MLD. The plant was constructed by M/s Degremont Pvt Ltd for Delhi Jal Board under Yamuna Action Plan and was commissioned during the Year 2003. This research work evaluated the performance of the STP based on advanced aerobic BIOFOR technology in terms of wastewater characterization to derive a comparative account between the pollution load before and after the treatment processes, besides, discerning their efficiency.

Fig.1 Satellite image of STP based on BIOFOR Technology at Sen Nursing Home, Delhi (Acquired from Google Earth)
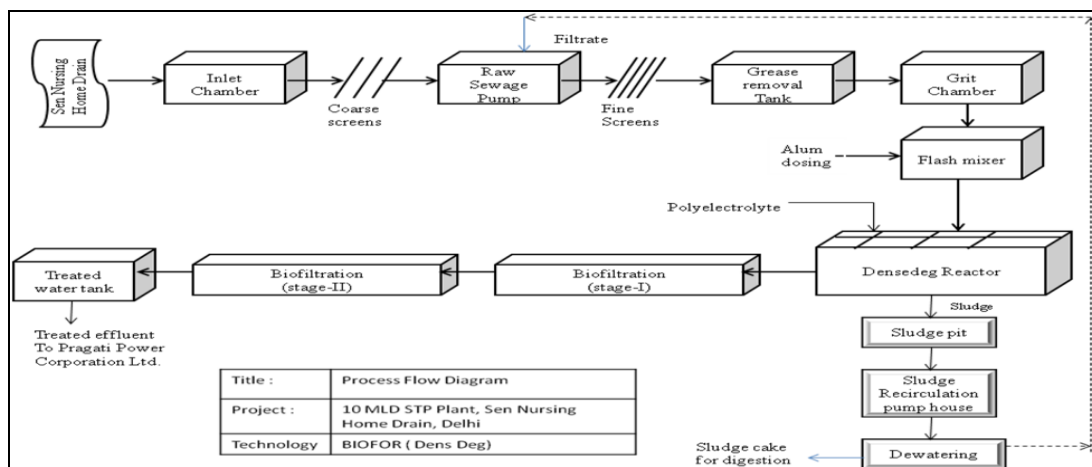
Fig.2 Process Flow Diagram of STP based on BIOFOR at Sen Nursing Home Drain, Delhi

III. MATERIALS & METHODS

The experimental method for the work comprised a combination of desk research, field visits to the STP, Collection of grab samples, interaction with project implementing agency and technology provider. The source for the collection of wastewater samples throughout the present studies was the Sewage Treatment Plant based on BIOFOER Technology located at Dr. Sen Nursing Home, near Indraprastha Metro Station, Delhi. Samples of the treated/partially treated effluent from the STP during the period from January 2013 to May 2013 were collected, preserved and analyzed. All the precautions as per the standard procedures were followed in sampling and analysis. Samples were analyzed for various parameters like pH, BOD, COD & TSS and depending on the results, performance of STP was evaluated. Analysis of most of the parameters have been carried out using Standard Methods (APHA, 2000). Details of various parameters studied and the procedure adopted are briefed in Table 1.

Table 1: Parameters measured for monitoring

S. No.	Parameter	Bottle Type	Preservation	Analysis Method	Reference
1.	pH	PET carboy	Ice box	pH meter	APHA, 2000
2.	TSS	PET carboy	Ice box	Gravimetric	APHA, 2000
3.	MLSS	PET carboy	Ice box	Gravimetric	APHA, 2000
4.	BOD	PET carboy	Ice box	5 day BOD at 20° C	APHA, 2000
5.	COD	PET carboy	Ice box	Dichromate Reflux	APHA, 2000
6.	Total Coliform	Sterilized Glass bottle	Ice box	MPN	APHA, 2000

IV. BIOLOGICAL FILTRATION AND OXYGENATED REACTOR (BIOFOR)

A. Technology Description

Biological Filtration and Oxygenated Reactor is one of the patented technologies of M/s Degremont Ltd. which include Intensified Aerobic treatment with Dense-Deg & BIOFOR. BIOFOR filters are aerobic biological reactors that use attached growth technology. BIOFOR employs a proprietary dense granular support media that acts as a biological contactor as well as a filter, thus eliminating the need for a separate clarification step. Both the influent wastewater and process air required, flows into the system from the bottom of the unit in an upward direction. Process air provides the necessary oxygen for aerobic biological activity and is introduced in the media through a network of diffusers located at the base of the reactor. Exceptionally high oxygen transfer is achieved in the media due to the up-flow pattern of air bubbles. The biological filtration process is of the submerged bed type. The effluent to be treated enters continuously from the bottom of the reactor and is distributed over the entire filter surface area by the nozzle under drain. Co-current up-flows of air and water allow for the finest particles to pass to the upper reaches of the *Biolite* filter support media; suspended matter becomes attached through the full height of the media which allows for long filter runs. Carbonaceous and nitrogenous pollution is eliminated through the high concentration of fixed-film biomass which is retained on the filter media during the filtration cycle. Process air is introduced continuously into the lower part of the reactor by air diffusers. According to the present full scale experiences, the oxygen transfer in the BIOFOR depends on the nature of the filter material. Schematic Diagram of BIOFOR is shown in Fig.3. The Biological filtration can be described as a system of three phase with

   a) A solid phase:- the filter material with attached biomass
   b) A liquid phase:- the wastewater that passes through filter material
   c) A gas phase:- the oxygen to assure oxidative process or the gaseous nitrogen at denitrification.

B. BIOFOR Media Description

The filter material is chosen that way that a possibly high attached biomass concentration and a can have high retention of solids. BIOLITE filter material with rough & porous surface are particularly used in BIOFOR for treatment. BIOLITE filter media is shown in Fig. 4.
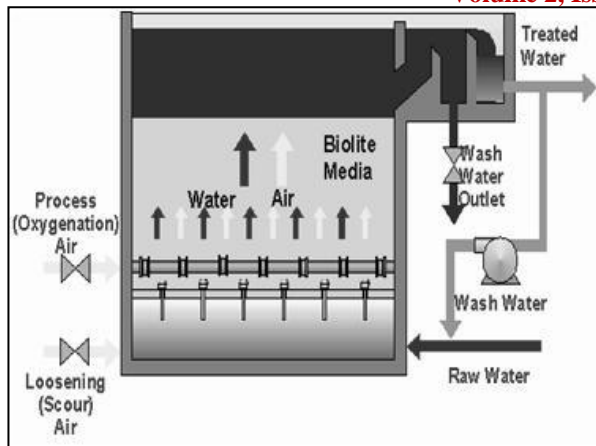
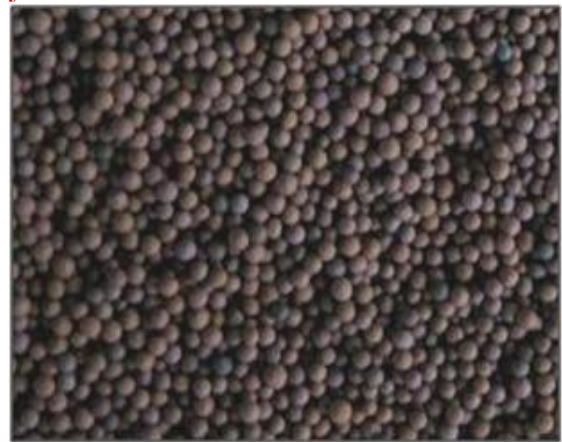Fig. 3 Schematic Diagram of BIOFOR Tank

Fig. 4 BIOLITE media used in BIOFOR

BIOLITE is made from natural silicate at a higher temperature. Its stable chemical characteristics accord with the primitive living environment where micro-organisms live in. The space structure is optimal for micro-organisms colonization and growth. The multi-porous structure provides 6-8 times larges surface compared to other bio-media. Its highly penetrative porous structure enables the aerobic nitrifying bacteria's nitrification and anaerobic denitrifying bacteria's denitrification.

Advantages of BIOFOR technology
- Easily adapts to variable flows and pollution loads
- Modular construction allows for easy plant expansions in the future
- Elimination of secondary clarifiers removes all of the associated costs and operational problems that can accompany traditional treatment processes

Disadvantages of BIOFOR technology
- Continuous and high chemical dosing in primary clarification
- Undigested sludge from primary clarification requires post treatment.
- High Energy requirement

Dimensional details of various units and facilities of the STP based on BIOFOR at Dr. Sen Nursing Home Drain, Delhi are shown in Table 2.

Table 2: Dimensional Details of BIOFOR STP located at Dr. Sen Nursing Home drain, Delhi

Unit	No.	Dimensions
Flow		**10 MLD**
Raw Sewage Sump	1	20m X 7.95m, Rectangular shape
Raw Sewage pump House	1	20m X 11.9m
Grit & grease removing Unit	1	7m X 4m X 3.5 m Surface Loading rate = $30 m^3/m^2/d$ Settling Velocity = 0. 95m / Sec Grit Extraction: by air lift Blower = (1 duty / 1 standby) Roots type Capacity= 250 Nm^3 / hr @ 6 bar
Densadeg Reactor	1	Tube clarifier Flocculating Reagent = Polyelectrolyte Rising Velocity = 10 $m^3/m^2/hr$. at Avg.Flow 20 $m^3/m^2/hr$. at Peak Flow
Flocculent Chamber	1	1.5mX 1.5m, Rectangular with baffles
Clarifier	1	Type = Tube clarifier, Capacity= 8.3mX 8.3m
Dewatering equipment	1+1	Continuous Belt press filter Belt width = 2m,Cake dryness = 30 %

BIOFOR	2X4	Type = Fixed Film Biological Filter Surface flow rate = 7.1m/hr at peak flow. Filter Medium = Biolite Media level = 2.9 m(with gravel)
Treated effluent Tank	1	Flow-rate = 300m^3

V. RESULTS & DISCUSSION

Colmenarejo *et al.,* (2006) determined the general efficiency indicator to compare overall performances of the different plants in terms of average TSS, COD, BOD$_{(5)}$ and ammonia removal efficiencies. Similarly, the efficiency of plants is generally measured in terms of removal of organic matter [4]. The pH directly affects the performance of a secondary treatment process [7] because the existence of most biological life is dependent upon narrow and critical range of pH. During the course of the study period, samples were collected from the Inlet & Outlet point of the treatment plant to evaluate the overall performance of the plant to reduce the pollution load on the receiving waters. Samples were collected once in a month for the period starting from January to May 2013 and the analytical results as obtained are summarized in Table 3.

Table 3: Physico-chemical analysis of STP with BIOFOR technology

Parameters	pH		TSS		BOD		COD	
Month- 2013	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
January	7.03	6.8	969	17	306	3	925	13
February	7.4	7.3	448	14	115	10	296	36
March	7.3	7.2	324	12	140	8	460	32
April	7.4	7.3	328	14	100	9	368	32
May	7.4	7.3	344	14	145	8	324	44
Maximum	7.4	7.3	969	17	306	10	925	44
Minimum	7.03	6.8	324	12	100	3	296	13
Average	**7.3**	**7.2**	**483**	**14.2**	**161.2**	**7.6**	**475**	**31.4**
Percentage Reduction	-		97%		95.2%		93.4%	

The variation in pH, TSS, BOD and COD in different months is shown in Fig. 5, Fig. 6, Fig. 7 and Fig. 8 respectively. Samples at inlet and outlet of were also examined for Fecal Coliform and Total Coliform parameter in order to assess microbial contamination removal once in a study period. Results of the microbial analysis are summarized in Table 4.
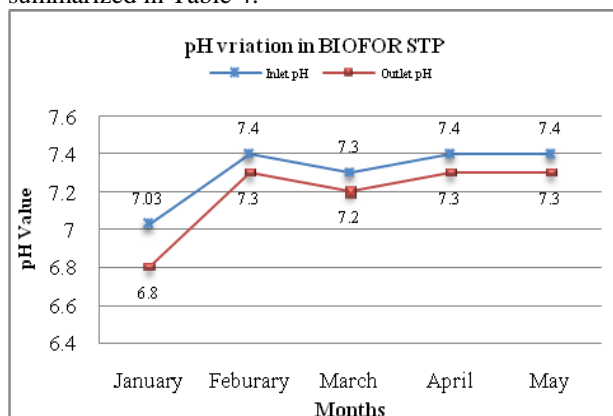
Fig. 5 pH variation in BIOFOR STP
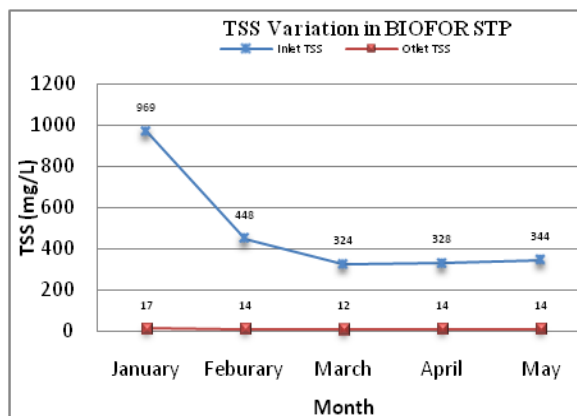
Fig. 6 TSS variation in BIOFOR STP
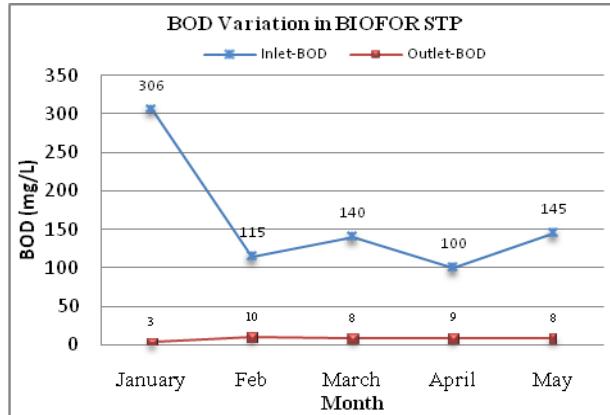
Fig. 7 BOD variation in BIOFOR STP
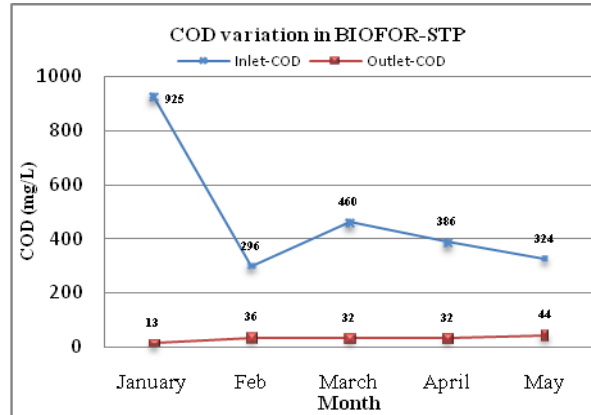
Fig. 8 COD variation in BIOFOR STP

Table 4: Microbial Analysis of BIOFOR based STP

S. No.	Parameter	Inlet	Outlet
1.	Total Coliform (MPN/100ml)	97×10^6	42×10^5
2.	Fecal Coliform (MPN/100ml)	24×10^7	23×10^4

As known, filtration or biological filtration can lead to reduction of pathogens. In a test conducted for BIOFOR STP at Dr. Sen Nursing Home Drain, it was found to eliminate the Total Coliform (TC) and Fecal Coliform (FC) values from the wastewater. From Table 4, it can be seen that, at the inlet of BIOFOR plant TC & FC value was found 97×10^6 and 24×10^7 respectively. No disinfection was employed for pathogen removal. After Treatment High TC level was observed at the outlet which was in order of 42×10^5, however observed value of 23×10^4 for FC removal in the effluent from the STP represents better results in FC removal. From the Fig. 5, it can be seen that pH value at the outlet of the plant is lowered as compared to the inlet of the plant.
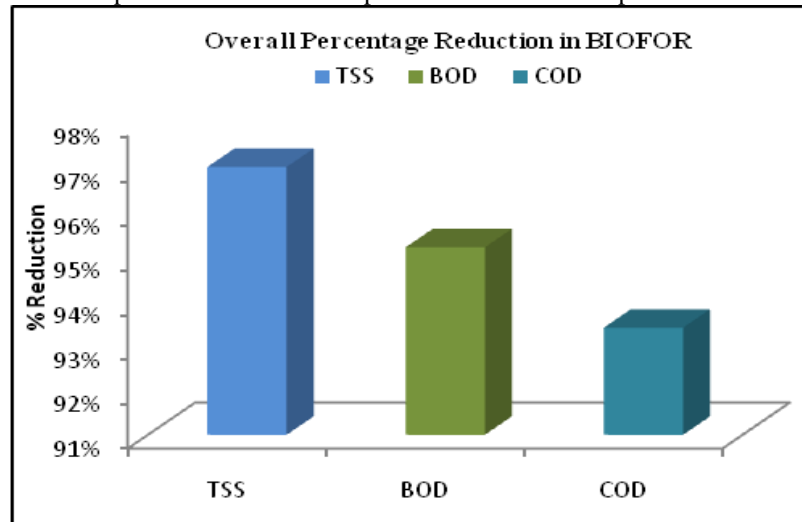
Fig. 9 Overall percentage removal efficiency of BIOFOR STP

Throughout the study pH value at the outlet was almost consistent at the value range between 7.2-7.3. However, in the month of January it was found slightly varied upto 6.8 that created acidic conditions in the system. Bacteria that treat wastewater to reduce the COD and BOD are extremely sensitive to pH. Therefore, pH can also have a huge effect on activated sludge COD and BOD reduction rates. From Fig. 6 above, it is depicted that, in the month of January, the value of TSS was quite high at the inlet of the Plant which is 969 mg/L and at the outlet it was found 17 mg/L, thereby pointing to efficient removal with regards to TSS. Due to DENSADEG primary clarifier, the removal efficiency of TSS is very high in BIOFOR Plant. Fig. 7 & Fig. 8 show the BOD & COD variation of

BIOFOR plant respectively from the month of January to May 2013. It can be seen that, in the month of January BOD & COD values are high which 306 mg/L and 925 mg/L respectively and throughout the study it ranges between 100 mg/L to 145 mg/L for BOD and 296 mg/L to 460 mg/L except in the month of January. Due to advanced aerobic two stages Biofiltration, BOD& COD removal rate is also noted to be very high in BIOFOR Plant. Overall percentage removal efficiency of BIOFOR based STP for TSS, BOD & COD removal is shown in Fig. 9.

VI. ECONOMICS OF BIOFOR

A. *Space requirements*

As compared to conventional Activated Sludge Process, Space requirement is very less. Space saving can upto 75% can be achieved if purely BIOFOR plant can be installed. Area Requirement in BIOFOR plant is 500 m^2/MLD. 40% space savings can also achieved when plant installed with in combination with the Activated Sludge Process for which area requirement is 900 m^2/MLD.

B. *Cost*

The economic efficiency of the process is reflected in capital cost of the installation and Operational & Maintenance (O&M) costs. Some of the technologies not only require initial cost to establish the system but the O&M Cost (Cost of Energy requirement, repairing cost, cost of chemical required and cost for manpower. It is variable according to location, time and quality of treated effluent.) plays an important role in selection of the technology in terms of evaluating the future prospects of the same. Capital cost for BIOFOR plants upto Tertiary treatment ranges from Rs. 100-105 Lacs/MLD. Capital cost ranges between Rs 6-8 Lacs/MLD of treated water. The cost factor is also based on the local conditions, property prices and material availability, etc.

VII. CONCLUSIONS & RECOMMENDATIONS

The results from the study illustrates that BIOFOR technology which is patented technique of Degremont, is being used as an advanced aerobic method for sewage treatment as an alternative to conventional aerobic treatment technologies. Results of STPs based on BIOFOR Technology indicate that BOD, COD & Suspended Solids removal efficiencies were noted to be 95.2%, 93.4% and 97% respectively, that indicates efficient removal of the parameters. As compared to other treatment technologies, area requirement is lowest for BIOFOR which is around 500m^2/MLD. Energy requirement is 220 kWh/d/MLD which is high as continuous high rate aeration is required to be provided in Biofiltration tank. Also, the technology was found to be quite satisfactory in removal of Fecal Coliform from the wastewater though not efficient enough in removal of Total Coliform. However, after disinfection high quality of microbial population reduction can be achieved. Conventional Treatment technology such as ASP not only involves higher initial investments but also incur higher O&M Costs to run the system based on the same. Thus, BIOFOR systems open up further possibilities for a more economically and secure sewage treatment process in India.

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AUTHOR BIOGRAPHY

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An Environmental Engineer by Profession, Ms. Charu Sharma has done her Masters in Environmental Engineering (M.Tech – Part Time) from Delhi Technological University (Formerly Delhi College of Engineering). Ms. Sharma has over four (5) years of diverse industrial, teaching as well as consultancy experience in both Government and Private Organizations located in Delhi, India. She has completed her Bachelors in Environmental Engineering (B.Tech) from Guru Gobind Singh Indraprastha University (GGSIPU) with distinction. She has also successfully completed Certificate Course in Disaster Management from Indira Gandhi National Open University (IGNOU). She has undergone Industrial Training on Air & Water Pollution Monitoring in Badarpur Thermal Power Station under the ownership of National Thermal Power Corporation (NTPC) and Civil Division of Bharat Sanchar Nigam Limited (BSNL) for dissertation work entitled "Wise Water Management and Solar Efficient Buildings", as a part of the successful completion of the B.Tech Degree. She has presented various review/research papers in National/International conferences on topics such as "Occupation Health and Hygiene Control Practices in Construction Sector" in National Conference organized by Indian Association of Occupational Health (IAOH) at Indian Habitat Center, Delhi; "Comparative study of Common Effluent Treatment Plants at Delhi- A Case Study" and "Disposal and Harmful Effects of Plastic Waste: An Overview" in 27th Indian Engineering Congress, organized by Institution of Engineers (India); "Bio-filtration: An Emerging Air Pollution Control Technology", "UASB Technology: An approach for Wastewater Treatment with Methane Recovery and Energy Conservation" and "Global Scenario and Economic Benefits of Carbon Sequestration Techniques" in proceedings of the International Conference on Civil Engineering-iSPACE 2013 organized by ITM University located in Gurgaon, Haryana. As a potential knowledge building prospect, she has participated in National Seminar on "Sustainable and Innovative Solutions for Water Woes", organized by DTU in association with Green Institute for Research and Development (GIRD). She has also attended Pre-conference National Workshop on "Office Ergonomics and Occupational Health", organized by IAOH. She has received positive reception for the term projects on topics such as "Different Wastewater Treatment Technologies", "Regenerative Breaking System in Delhi Metro for Greenhouse Gases (GHG) Emission reduction" and "Sustainable Development in Transportation Sector".

2. Dr. S. K. Singh

A renowned Professor, Dr. S. K. Singh has over 25 years of Academic Experience in the field of Civil and Environmental Engineering. He's at present endowed with the responsibility as Head of the Department of Environmental Engineering, Delhi Technological University with an additional responsibility of Dean, International Collaboration, Delhi Technological University. Dr. Singh is an elected Executive Member of Environmental Engineering Division of Delhi State Centre, Institution of Engineers (India) and has Professional Memberships of about 22 Institutions spread across the country. Dr. Singh has published about 75 Journal Papers in various Publications both at National and International Stages and about 49 Conference Papers have been presented under his able guidance. He has been a continuous mentor and a source of inspiration for his students which can be inferred from the fact that Dr. Singh has successfully guided many PhD students as well as M.Tech Students apart from guiding the B.Tech. Students in their Project Work. He has been conferred with Honourary appointment to MEMBER OF THE RESEARCH BOARD OF ADVISORS by the Board of Directors and Governing Board of editors of the American Biographical Institute, Inc., Raleigh, North Carolina, USA. In his earlier years in academic excellence, Dr. Singh was awarded International Felicitation and WEC-IIEE-IAEWP Environment Award-1997 for outstanding work done in the field of Environmental Engineering presented in the 6th World Environment Congress (New Delhi), 21-23 December 1997. The award was given by His Excellency Dr. Shankar Dayal Sharma, former President of India.

Accepted Manuscript

Studies of Poly(lactic acid) based Calcium Carbonate Nanocomposites

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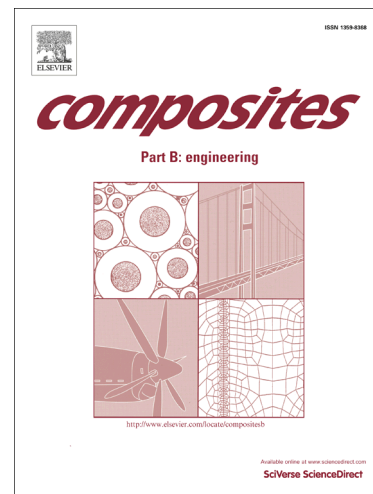Please cite this article as: Kumar, V., Dev, A., Gupta, A., Studies of Poly(lactic acid) based Calcium Carbonate Nanocomposites, *Composites: Part B* (2013), doi: http://dx.doi.org/10.1016/j.compositesb.2013.08.021

Studies of Poly(lactic acid) based Calcium Carbonate Nanocomposites

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Abstract

The effect of nano-calcium carbonate on chain linked poly(lactic acid) was investigated. In order to improve inorganic nanofillers/polymer compatibility $CaCO_3$ nanoparticle surface was treated by stearic acid. The nanocomposites were prepared by means of solution blending and further studied by using dynamic mechanical analysis, Fourier transform infrared spectroscopy, scanning electron microscopy and thermogravimetric analysis. Morphological analysis performed on nanocomposites fractured surfaces has revealed that the $CaCO_3$ modification induces homogeneous and fine dispersion of nanoparticles into polymer as well as strong interfacial adhesion between the two phases. An increase in the Tg and storage modulus of the resulting nanocomposites was observed with the increase of Calcium carbonate ratio.

1. Introduction

Now a day's biodegradable materials are of prime interest for both environmental reasons and for biomedical applications. Poly(L-lactide) (PLA), a typical linear aliphatic thermoplastic polyester, has been viewed as the most popular commercial biodegradable material because it is biodegradable, compostable, and nontoxic to the human body and to the environment; moreover, it can be produced from renewable plant resources (mainly starch and sugar) [1, 2]. This polymer possesses reasonably good mechanical and optical properties, thermal plasticity, and processability, so it has tremendous market potential for packaging materials, fibers, agricultural films, and biomaterials [3, 4]. In order to have redeemable mechanical properties the molecular weight should be higher. A high molecular weight PLA can be synthesized by a number of methods including, ring opening polymerization, azeotropic condensation polymerization, solid state polymerization and chain linked polymerization. In this work chain linked polymerization have been studied since this method for the synthesis of PLA requires lesser time and energy [5-7].

Over the last few years, a new class of mineral reinforced thermoplastics known as nanocomposites has attracted increasing interest for researchers in the field of polymer and materials science from both academia and industry [8, 9]. Fillers as dispersed phases in nanocomposites are nanometer sized, preferably with at least one of its dimensions on the order of a few nanometers (1–100 nm). Because of the small particle size and extremely high surface area, the incorporation of nanoparticles into a polymer creates a great amount of interphase and changes the intermolecular interaction of the matrix, thus obtained materials is characterized by a lower density and a better processability. As a result, dramatic improvements in the physical and mechanical properties, including stiffness and toughness, thermal stability, gas barrier properties, and electrical and thermal conductivity, can be achieved by the incorporation of a few weight percentages of particulate fillers into polymer matrices.

On the basis of these advantages of nanocomposites, many excellent studies have been reported on the preparation and properties of PLA nanocomposites. PLA/layered silicate nanocomposites have been

extensively studied, including some reviews [10, 11]. PLA nanocomposites incorporating hydroxyapatite, carbon nanotubes, Fumed silica and titanium dioxide have also been reported [12-14] the crystallinity, thermal stability and mechanical, gas barrier, degradation, and flame-retardant properties of PLA have been greatly improved. (SiO_2) has also been widely used as a nanofiller the preparation of polymer/SiO_2 nanocomposites. A few studies on PLA/CC (calcium carbonate) nanocomposites have been reported [15]. In the present work the effect of calcium carbonate on the chain linked poly(lactic acid) have been studied. Since $CaCO_3$ is the cheapest commercially available inorganic material and is extensively used as a particulate filler in the manufacture of paint, paper, rubber, plastics, and so forth [16]. Recently, nanosized $CaCO_3$ has received a lot of attention because of its wide range of potential applications and its low cost. Various methods, including high gravity reactive precipitation, have been developed to prepare nanosized CaCO3 particles with a narrow size distribution [17]. The introduction of $CaCO_3$ in PLLA matrix improves the modulus of elasticity and the composite shows no brittle fracture [18]. $CaCO_3$ can be modified with different surfactants such as fatty acids, phosphonate, and titanate through the reaction of adsorbed hydroxy on the particle surface. In this study, $CaCO_3$ nanoparticles were pretreated with stearic acid, which provided them with high compatibility between the nanofillers and CLPLA.

2. Experimental

2.1 Material

Lactic acid (90% aqueous solution) was purchased from Merck, ethylene glycol, polyethylene glycol (6000), Na_2CO_3, $CaCl_2$ and stearic acid from Thomas Baker and tin octoate from Sigma Aldrich. Chloroform (Thomas Baker) was distilled over calcium chloride before used. Methylene diphenyldiisocyanate (MDI) from BASF. Calcium chloride was synthesized by the in situ deposition method.

2.2 Method

Chain linked poly(lactic acid) (CL-PLA) was synthesized as discussed in our previous work [5, 6], briefly hydroxyl terminated poly(lactic acid) was synthesized using ethylene glycol. It was further chain linked by MDI as a chain coupler in the melt using tin octoate as a catalyst.

Nano-$CaCO_3$ was synthesized with in situ deposition described elsewhere. Briefly the complex of $CaCl_2$ was prepared with PEG in a 4:1 molar ratio in distilled water. Another solution of Na_2CO_3 was prepared in distilled water. The first complex was kept for 12 h, and then the second complex was slowly added to it; the mixture was kept for 24 h. The precipitate was filtered, washed with water, and dried *in vacuo* [19]. In order to make hydrophobic surface the dried calcium carbonate was further treated with stearic acid. The solution mixing technique was employed for the preparation of CLPLA/CC nanocomposites. Nano calcium carbonate in the ratio of 1.5, 3.0, 5.0 and 7.0 % (w/w) was used for the preparation of nanocomposites. Chloroform was added to the predired calcium carbonate. Then this mixture was added to the solution on predried CL-PLA solution and mixed, the solvent was first evaporated at room temperature, followed by in vacuum at room temperature for two days.

2.3 Measurements

Dynamic mechanical studied were performed on Parkin Elmer DMA 8000 using compression molded samples with dimension 30×5×4 mm, analyzed at frequency of 1 Hz from -20 to 65 °C at ramp of 2°C/min in single cantilever mode. Liquid nitrogen was used to lower the temperature.

The FTIR spectra of the nanocomposites were recorded using a Nicolet 380 FTIR spectrophotometer in absorbance mode as a function of wavenumber using KBr. A scan from 4000 cm-1 to 400 cm-1 with a resolution of 4 cm-1 was recorded. To reduce the noise 64 scans was recorded.

Morphological study of nanocomposites was investigated with Hitachi S-37000 Scanning electron microscope at 5 KV. The specimens were frozen under liquid nitrogen, and then fractured, before

running the samples; a fine gold coating was given by using the Biorad fine gold coat ion sputtering-coating instrument under the vacuum of about 10-3 torr.

Thermal degradation of nanocomposites was analyzed on Mettler Toledo thermal Analyzer in the dynamic mode and weight loss of samples was subjected to controlled temperature program. The sample were taken in the crucible situated in the electric furnace and heated from room temperature to 500ºC at the controlled heating rate of 10 ºC/ min in the nitrogen atmosphere. The approximate 6 to 10 mg of each sample was used for analysis.

3. Result and discussion

3.1 Nano-calcium carbonate

Figure 1 shows the FTIR of calcium carbonate in transmittance mode. The different crystal form of $CaCO_3$ shows different absorption band in FTIR spectrum. The reference bands observed at 714, 874, 1435 cm^{-1} can be assigned to the in-plane bending, out-of-plane bending and asymmetric stretching modes of CO_3^{2-} respectively. Figure 2 shows the SEM picture of calcium carbonate. From the SEM picture the particle size of the calcium carbonate particles are well in the nanorange (500 to 50 nm). The presence of $CaCO_3$ particles were confirmed by XRD analysis, the spectra are shown in Figure 3. In the pattern, the diffraction peaks were observed at 2θ values of 29.35, 48.62, 39.42, and 47.5^{o}, which corresponded to $CaCO_3$ crystals as calcite.

3.2 CLPLA/CC Nanocomposites

3.2.1 Dynamic Mechanical Analysis (DMA) of calcium carbonate composites

Dynamic mechanical analysis has been used widely to characterize the PLA. DMA is a method with great sensitivity for detecting changes on internal molecular mobility. Typical dynamic mechanical spectra's of loss factor tan δ and storage modulus for various CL-PLA/CC nanocomposites was recorded in the range of -20°C – 70°C (Figure 4).

From the graph distinct broad transitions were observed for CL-PLA/MMT nanocomposites. The high temperature loss transitions centered in the range from 38°C to 41°C has been clearly identified as the

glass transition temperature (Tg), also known as the α-relaxation in which polymer-chain segments acquire considerable mobility. In examining the influence of CC on comparing the dynamic mechanical properties of CL-PLA, no pronounced low temperature transition was observed. However, pronounced changes in the loss factor tan δ were observed for temperatures higher than room temperature with changes in the CC ratio. This effect is a direct consequence of the influence of CC at the onset of the glass transition. In common with other CL-PLA/CC nanocomposites, the increase in Tg with increasing CC content as shown in (Figure 4) suggests good dispersion of CC in the polymer matrix.

But just the opposite trend was observed for the loss factor intensities, since it decreased up to a CC ratio of 7.0. This behavior indicates that an increased dispersion of CC, and therefore a higher restriction on molecular mobility, was obtained for compositions containing a lower ratio of CC , in agreement with the literature [20].

Plots of the storage modulus of different CC ratio the increase in Tg with the corresponding effect in peak heights becomes evident if we examine the storage modulus (E') as a function of temperature. The onset of the glass transition of the systems can be seen by the decrease in E' and increase in tan δ. As the temperature is increased, the material becomes softer as E' continues to decrease along with a corresponding rise in tan δ, indicating increased segmental mobility in the polymer chains. However, upon further increase in temperature the modulus E' start decreasing while the tan δ reaches a maximum at the same temperature, indicating that the material is becoming harder and that the mobility of the macromolecular chains is decreasing. For CC nanocomposites for different ratio the storage modulus was increase from 8.25 GPa to 11.7 GPa, 6.07 to 9.42 GPa. and 1.86 to 3.57 GPa at -20, 0 and 20°C respectively (Table 1).

The effectiveness of fillers on the moduli of the composites can be represented by a coefficient C such as

$$C = \frac{\left(E_g' / E_r' \right) \text{composite}}{\left(E_g' / E_r' \right) \text{resin}}$$

…..Equation 1

Where E'_g and E'_r are the storage modulus values in the glassy and rubbery region respectively. The higher the value of the constant C, the lower the effectiveness of the filler. The measured E' values at -20 and 50°C were employed as E'_g and E'_r respectively (equation 1).

The values were obtained for the different systems at frequency 1 Hz. In this case the lowest value has been obtained for 7.0% and the highest value for 1.5 % CC loading (Figure 5). The effectiveness of the filler is the highest at 7.0 % fiber loading. It is important to mention that modulus in the glassy state is determined primarily by the strength of the intermolecular forces and the way the polymer chains is packed.

3.2.2 Fourier Transform Infrared (FTIR) spectroscopy of calcium carbonate composites

FTIR results showed ester peak at 1751 cm^{-1} (C=O *stretching*), 1089 cm^{-1} for -O- linkage , methyl absorption band (CH$_2$, CH$_3$) at 2997cm^{-1} and CH$_2$ bending at 1452 cm^{-1}, C-H twisting vibration of CH$_2$ at 1185 cm^{-1}. FTIR spectra of all CL-PLA showed peak at 3352 cm^{-1} for -NH with a peak at 1534 cm^{-1} and 755 for N-H def. however the characteristic peak of calcium carbonate 1428, 875 and 713 cm^{-1} are overshadowed with the peak of CL-PLA and could not be clearly identified in the resulting nanocomposites (Figure 6).

3.2.3 Scanning electron microscope (SEM)

In order to evaluate the nanocomposite morphology and the interfacial adhesion between the two components, SEM analysis was performed on cryogenically fractured surface of samples. Moreover a strong interconnection between the phases was also evidenced due to a presence of a homogenous matrix with the uniform distribution of filler and absence of voids and debonding phenomena between the two phases after the applied mechanical load (Figure 7). However some regulative cracks were observed with the increase in the filler ratio suggesting that the crack propagated with minimal hindrance.

3.2.4 Thermogravimetric analysis (TGA) of calcium carbonate nanocomposites

Table 2, shows that the presence of fatty acid coated nanoparticles strongly affects the thermal stability of CL-PLA. In fact, a marked decrease of the CL-PLA degradation temperatures for all the investigated nanocomposites was observed. Two parameters, T_{10} and T_{50} (Temperature at 10% and 50 % degradation respectively), are listed in Table 2 shows that with the incorporation of CaCO3 in the CL-PLA, there is regular decrease in the T_{10} value. CC 1.5 showed the maximum thermal stability among the all $CaCO_3$ nanocomposites whereas $CaCO_3$ 7.0 showed the least. However in second step, the thermal stability of CC/CL-PLA nanocomposites is increased as compared to the pure matrix. In this case the degradation of CC/CL-PLA is almost independent of filler concentration (Figure 8). These results suggest that fatty acid coated nanoparticles increase the degradation rates and can lead to a change in the degradation mechanism. The basic nature of $CaCO_3$ may have catalyzed the depolymerization of the ester bonds of CL-PLA. Moreover, as it can be observed from the Table 1, by adding 5% by weight of nanoparticles the curve shows a lower slope, suggesting that the degradation process occurs in a broader temperature range and the rate of this phenomenon is slowed down. These results are in agreement with some previous studies on calcium carbonate [21, 22]. As reported in recent studies, the presence of a low thermally stable nanoparticle surface modifier (less stable than polymer matrix) is responsible for a significant decrease of thermal stability of polymer based nanocomposites [23].

4. Conclusions

Calcium Carbonate is a good candidate for the preparation of CLPLA/calcium carbonate nocomposites. CLPLA/CC nanocomposites were prepared by solution compounding to investigate the effects of nanofiller loadings on the phase morphology, thermomechanical and properties, of the nanocomposites. A good dispersion of the CC nanoparticles in PLA was observed with uniform distribution of the filler into the polymer matirx. The DMA results reveled, because of the better interaction between the PLA and CC nanoparticles, an increasing trend in the glass transition temperature and storage moduli of the nanocomposites. Effectiveness of the filler was also calculated with a constant C. It was found that with the increase in the filler ratio the efficiency of filler was

increased. However the thermal stability of the nanocomposited was reduced due to the incorporation of fatty acid modified calcium carbonate which is attributed to the basic $CaCO_3$ catalyzed the depolymeization of the ester bond in CLPLA. However in second step of degradation, CC showed an increase in the thermal degradation temperature.

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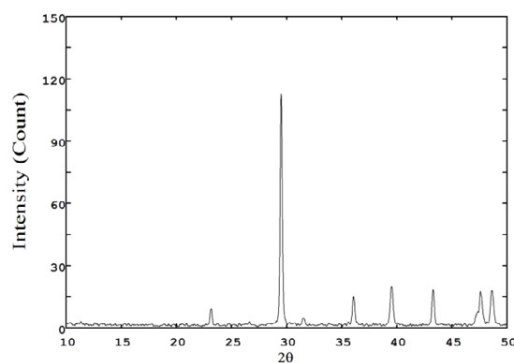
FIGURES
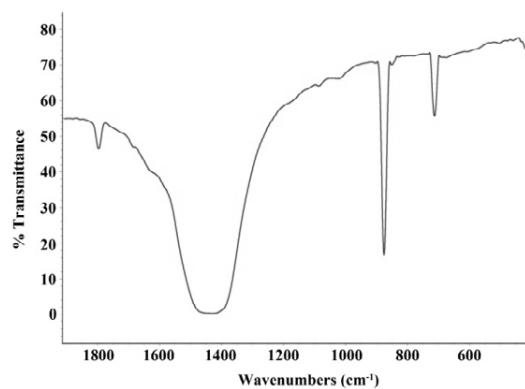
Figure 1: FTIR spectrum of Calcium Carbonate.
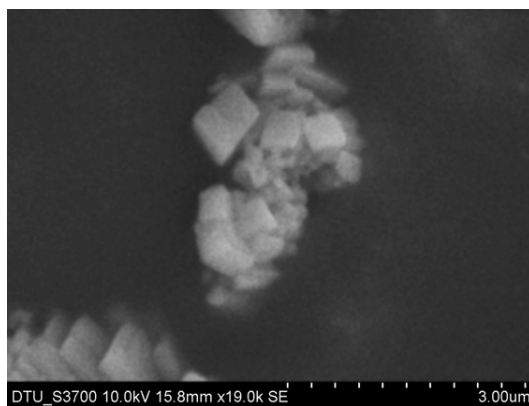
Figure 2: SEM image of modified Calcium Carbonate.
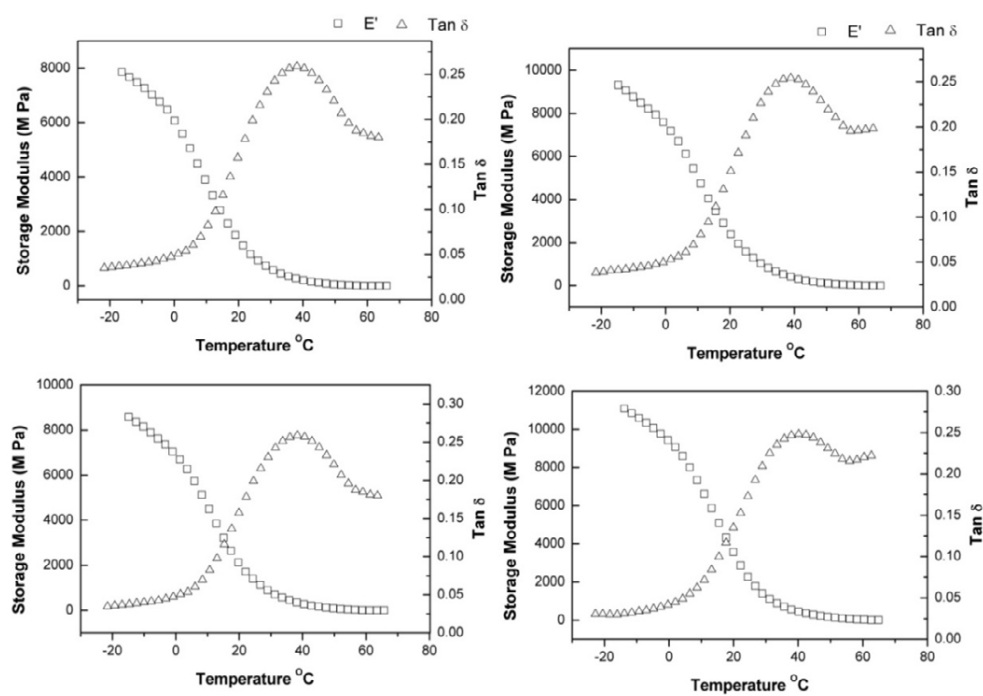
Figure 3: X-Ray pattern of Calcium Carbonate.
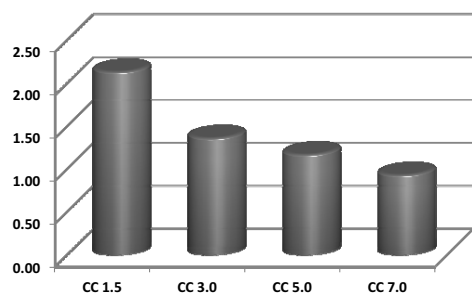
Figure 4 : DMA of CLPLA/CC nanocomposites

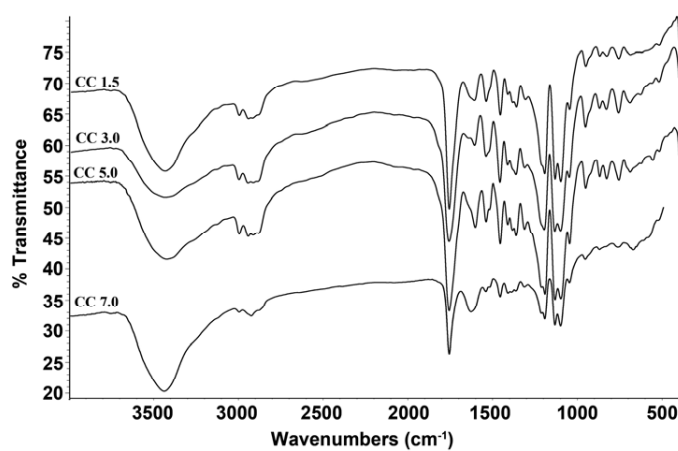**Figure 5: Values of constant 'C' for different CC nanocomposites.**

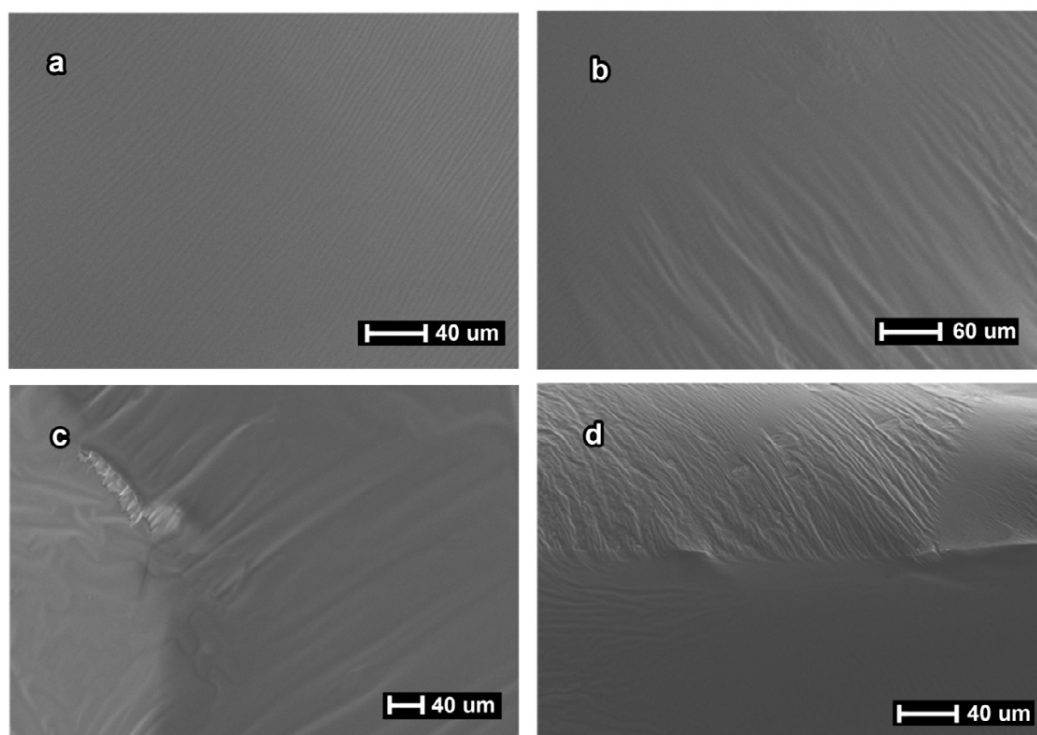**Figure 6 : FTIR spectra of CL-PLA/CC nanocomposites.**

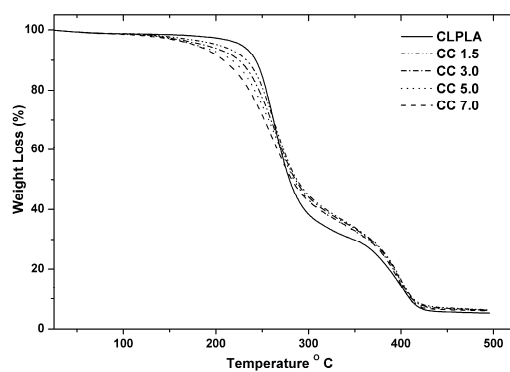**Figure 7 : SEM micrograph for CLPLA/CC nanocomposites (a) CC 1.5 (b) CC 3.0 (c) 5.0 (d) 7.0**

Figure 8 : TGA thermogram for CLPLA/CC nanocomposites

TABLES

Table 1 : Glass transition temperature and Storage Modulus of CL-PLA/CC nanocomposites.

Samples	Storage Modulus (Pa)			Tg (°C)
	-20 °C	0 °C	20 °C	
CC 1.5	8.254E+09	6.076E+09	1.868E+09	38.17
CC 3.0	9.025E+09	7.052E+09	2.128E+09	38.5
CC 5.0	9.751E+09	7.578E+09	2.386E+09	39.4
CC 7.0	1.176E+10	9.424E+09	3.570E+09	41.14

Table 2: TGA data of CL-PLA/CC nanocomposites.

Sample	T_{10}	T_{50}
CC 1.5	238	282
CC 3.0	231	281
CC 5.0	224	281
CC 7.0	213	279
CLPLA	246	278

Study of Microstructure, Impact Strength on Manual Metal Arc Welding Of Gray Cast Iron Using Enife–Ci Filler Metal

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Abstract: - The effect on the microstructure obtained in the heat-affected zone (HAZ) and the carbide zone in the weld metal properties of Casted grey cast iron plates (grade-GJLEN 1561) are used as base material. The welding was carried out with manual shielded metal arc welding using ENiFe–CI filler metal. The welds were prepared by using the arc welding process and filler Nickel base filler materials are used in welding as electrode, which is ductile in nature 85 ENiFe-CI is the grade of nickel base filler electrode. For knowing the effect of preheat treatment, the plates were firstly heated to near about 400- 450˚C by the help of gas cutting torch and the post weld heat treatment (PWHT) was limited only for 45 minute at 810°C. The welds were characterized by micro structural analysis, impact test, and tensile test. The Charpy-impact properties of the weldment specimens improved with the PWHT and were somewhat lower than previously developed data on the wrought material.

Keyword: - gray cast iron, impact test, microstructure, post weld heat treatment (PWHT), tensile test.

I. INTRODUCTION

Weld ability of cast iron has been found to be very poor due to the heterogeneity of matrix phase and non-wet ability of the graphite phase. These phases undergo a series of microstructure changes in the HAZ during weld repairing by fusion welding the project discusses the nature of these changes occurring in the vicinity of the weld zone as well as method of controlling these to get satisfactory weldment. It further discusses the practical aspect of weld joint preparation, the selection of welding process and procedure, the choice of filler metal-composition etc. and degree of pre as well as post weld heat-treatment to obtain defect and stress free welding. The welding of ductile cast iron is not normally practiced in the foundry industry for the reclamation or fabrication of castings, due to the inconsistency of the mechanical and physical properties achieved. Grey irons contain higher amounts of carbon compared to steels which diffuses into the austenite during welding, forming hard brittle phases, namely martensite and carbides at the weld interface. These give rise to poor elongation properties and high hardness values. Weldability of ductile cast iron depends on its original matrix, chemical composition mechanical properties and structure of welding process and working condition. The preheating temperature range depends on the hardenability of the iron chemical composition or carbon equivalent, the size and complexity of the weld and the type of filler materials.

II. LITERATURE SURVEY

Pascual et al. [1] have studied welding nodular cast iron with oxyacetylene (OAW) and shielded metal arc welding (SMAW) using 98.2% Ni and Fe-Cr-Ni alloy filler materials respectively. They have concluded that welding ductile cast iron with or without preheat is possible but preheating almost always increases weld quality and ductility. OAW results very poor weld metal properties whereas SMAW yields an amount of ductility in the weld metal. Furthermore, using Ni electrodes is another factor increasing the ductility which hinders the carbide formation. **El-Banna et al.** [3] restoration properties of pearlitic cast iron using SMAW with various filler materials as Ni, Fe-Ni alloy, Ni-Cu alloy, stainless and ferrite steel is studied. Also subcritical annealing at 677°C is applied. Effect of heat input, preheating and filler materials was examined. When using the ferrite filler material, preheating at 300°C becomes the best option for narrowing the 20 melt region and HAZ with discontinuous carbide and bainite. It is seen that PWHT has reduced the maximum hardness values slightly and finally multipass welding lowers the width of melt region and micro hardness of HAZ. Using filler materials with Ni content can overcome carbide formation however; with ferrite filler a continuous carbide network is observed around the fusion line and HAZ yielded a martensitic structure. **Pouranvari** [4] carried out a study on welding cast iron using SMAW with Ni based electrodes. He also applied PWHT to the welded pieces. Due to possibility of increasing amount and continuity of carbides preheating is not used and formation of cracks was not reported. Material was fully annealed and a nearly uniform hardness profile is achieved. Again nickel based filler is used to prevent ledeburitic carbide formation in the structure of the weld piece but due to dilution very high carbon contents are come across which cannot be compensated with Ni. This excess amount precipitated as

graphite in fusion zone. **Voigt et al. [5]** have studied general HAZ structures of ductile cast irons. SMAW with ENi-CI filler material used with about 300°C of preheating. Sub-critical annealing and full annealing is applied to the specimens. In as weld specimens carbides are formed surrounding the graphite nodules and in intercellular regions between nodules. It is concluded that this formation cannot be effectively prevented in PMZ. Martensite, observed in HAZ, cannot be overcome if the preheating temperature is sustained for sufficient times after welding. By application of subcritical annealing martensite was decomposed to ferrite and secondary graphite.

III.   EXPERIMENTAL WORKS

3.1Materials used for experiment

Casted grey cast iron plates (grade-GJLEN 1561) are used as base material, the chemical composition of main constituents are given below in table

Element	C	Si	P	S	Mn	Cu
% Composition	3.5	1.25	0.14	0.101	0.64	0.48

chemical composition is obtained by XPS machine. Nickel base filler materials are used in welding as electrode, which is ductile in nature. The chemical compositions of main constituents are:

Element	C	Ni	Si	Fe
% Composition	1.2	54.0--		44.8

85 FN-ENiFe-CI is the grade of nickel base filler electrode, these electrodes have high machineability. In experimental work, process involved during the fabrication of defect free test specimen like casting, cutting and welding etc. are discussed.

IV.   WELDING OF PLATES

    Providing the plate appropriate fixturing before welding so, that bending of the weld can be avoided which occurs due to sudden contraction weldment. Bending of plates after welding should be avoided. For knowing the effect of preheat treatment, the plates were firstly heated to near about 400- 450˚C by the help of gas cutting torch. Providing flame on the welding surface for a duration of time so that such a temperature range can be obtained. The preheat temperature was measured with the help of thermocouple (range 100 0-1200°C) by touching the thermocouple wire to the welding surface. After flame heating of the plate, the temperature was measured with the help of thermocouple wire. If the temperature is below the required, then again flame heating is done so that required temperature will obtained. Soon after, welding was done on the plate with proper alignment of electrode. For normal welding no pre heating is done and the welding is performed at the atmospheric temperature (26°C).

Figure: 1 Welded plate

V. PREPARATION OF TEST SPECIMENS VARIOUS TEST SPECIMENS

1. Tensile test specimen
2. Charpy test specimen
3. Microstructure test specimen

5.1 Tensile test specimen

For making the tensile test specimen from welding plates, plates were cut with the help of hand saw, of 25 mm width and 105mm length in the fitting shop. For reducing the thickness of whole welded plates the plate were cut on machine through its surface so that reinforce material of weld get remove. Removing the excess material with the help of grinding machine and hand grinder. For giving the exact shape of tensile test specimen exact drawing was made on plate then, by the help of hand saw cutting was done. Filing was the last job done to get desired dimension only two samples were made one for normal weld and one for preheated.

Figure: 2.Tensile test specimen

5.2 Charpy impact test

To obtain a more accurate impact strength, (i) the loss due to the positioning needle and (ii)the loss due to air resistance and friction due to machine bearings as factors comprising the loss due to the test machine (ΣL) were excluded from the absorbed energy. The specific method used to determine factor (ii) was as follows.
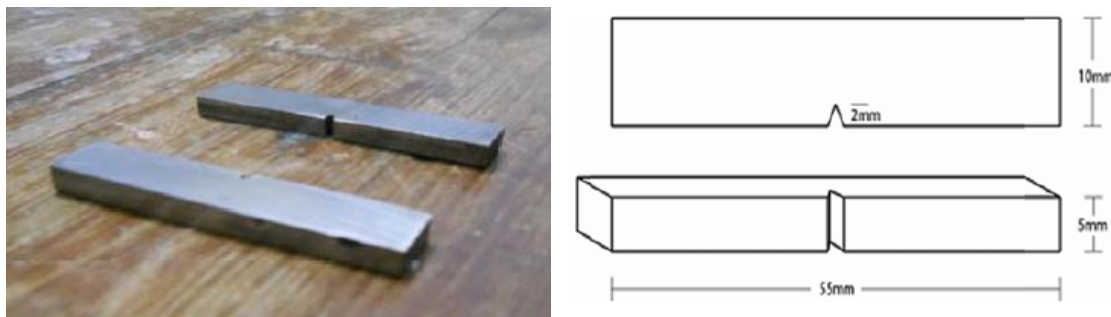

Figure 3: Specimens for impact test and dimension of specimen.

Without any impact test piece being loaded on the test machine, the pendulum was raised to the prescribed angle of elevation (α) and allowed to swing idly. The angle of upward swing (β) was then measured and the energy loss calculated. The energy U required to rupture the specimen may be directly read on the graduated scale of machine dial, or may be calculated using relation

$U = U_i - U_f = WR(\cos\beta - \cos\alpha)$.

This rapture energy or fracture energy is a measure of toughness of the material

Notch impact strength

The notch impact strength Is is how determine from the following relation $I_s = U/A_e$
Where A_e is effective cross-sectional area of the specimen below the notch before test

Modulus of rapture

Once the rapture energy U is known the modulus of rapture is obtain from $U_r = U/V$
Where V_e is the effective volume of specimen.
Result obtain after test for simple test specimen
1. Rapture energy =26Jor 2.651kgf-m
2. Modulus of rapture = 12.05×10^5 kgf/m^2
3. Notch impact strength = 6.6×10^5 kgf/m^2
Result obtain after test from preheated test specimen

1. Rapture energy =30J 3.0591 kgf-m
2. Modulus of rapture = 13.5×10^{15} kgf/m^2
3. Notch impact strength =7.6×10^4 kgf/m^2
Result obtain after test from PWHT test specimen
1. Rapture energy =28J 2.855 kgf-m
2. Modulus of rapture = 12.97x10x5 kgf/m^2
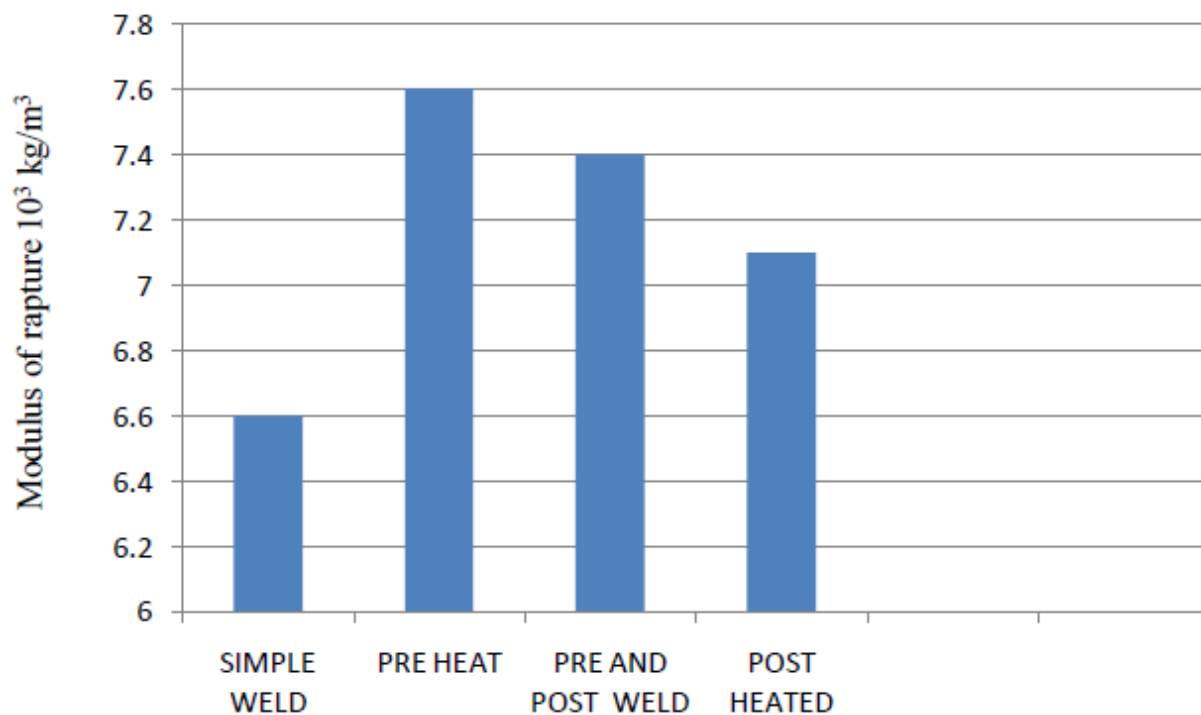3. Notch impact strength =7.13x10x4 kgf/m^2

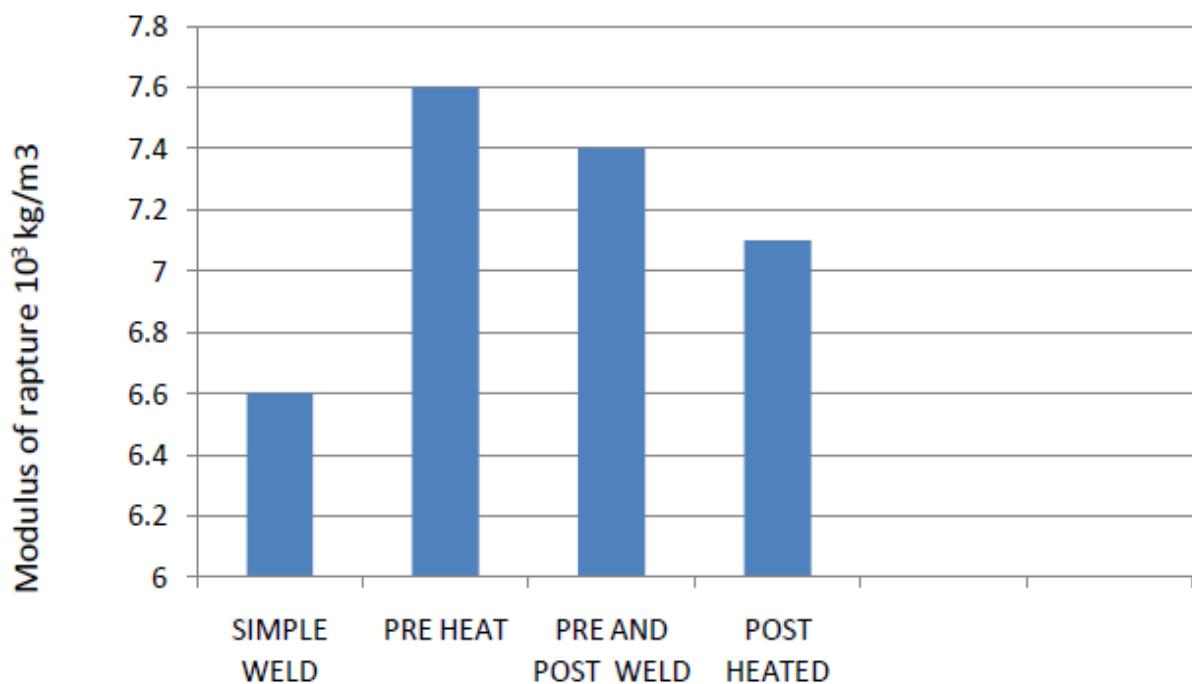Figure 4: Graph between notch impact strength and various conditions

Figure 5: Graph between modulus of rapture and various weld condition

VI. RESULTS AND DISCUSSION

6.1 Microstructures

Microstructures of different region of welded specimen (base metal, welded zone, heat affected zone and partially melted zone) for different welded condition are given below
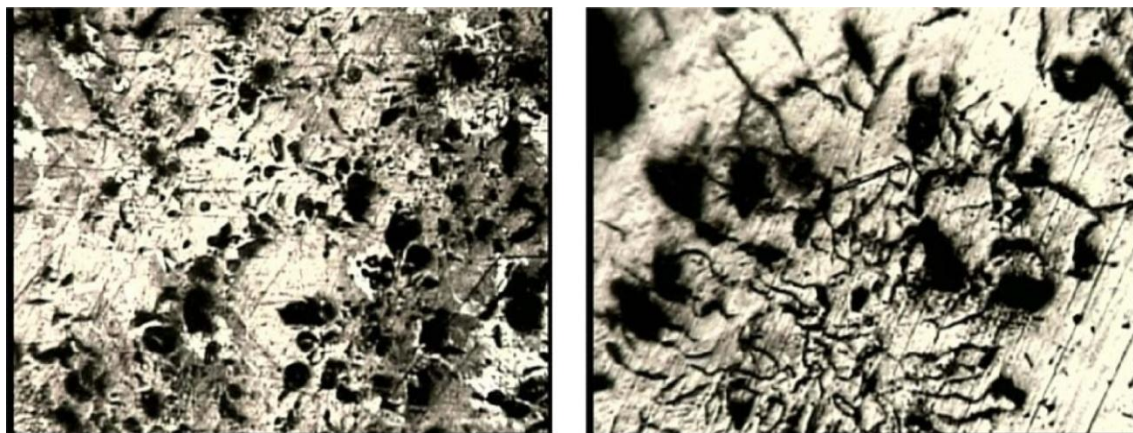

Figure 6.1 (a) Base material (simple weld) 10X, 50X (magnification) microstructure of grey cast iron showing graphite in ferrite matrix and pearlite matrix.
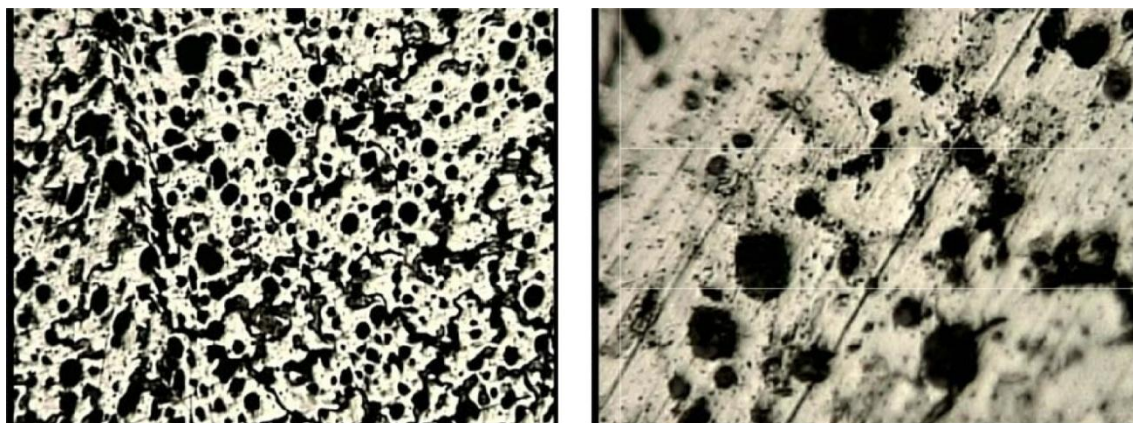

Figure 6.1 (b) welded part (simple weld) 10x, 50x (magnification) welded part showing Graphite in the form of nodules in ferrite matrix and it is ductile nature.
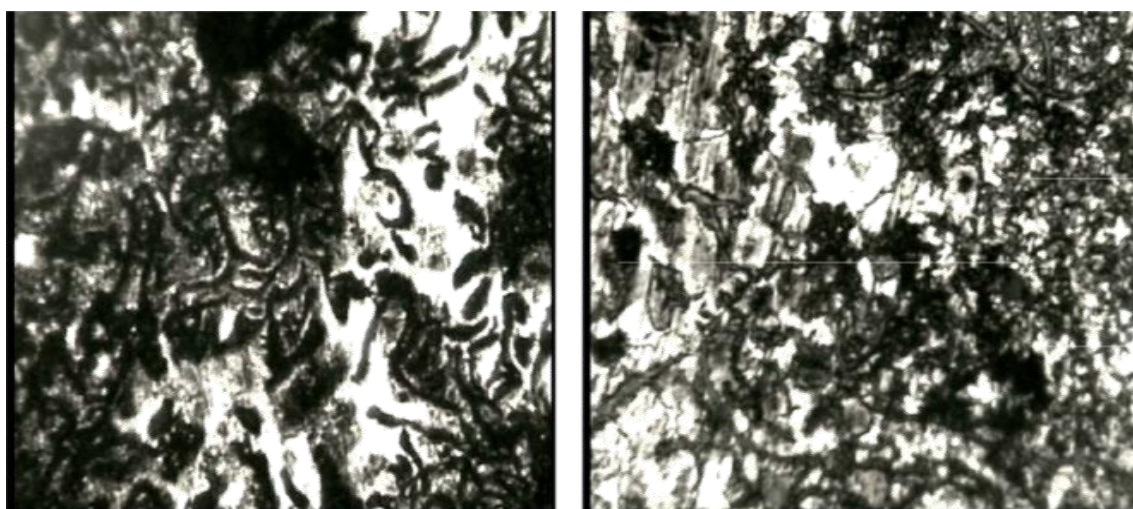

Figure 6.1 (c) Welded and heat affected zone (simple weld) 10X, 50X (magnification) microstructure showing heat affected zone consisting of martensite and fusion part consisting graphite nodules in ferrite matrix.

VII. CONCLUSIONS

In this study it is observed that formation of martensite and carbide in fusion zone can be controlled via controlling of cooling rate and chemical composition of fusion zone. Result of the current study showed that by using nickel base filler material, the formation of brittle martensite and carbide in fusion zone is prevented. It is of note that, the nickel base filler material has low coefficient of thermal expansion therefore it strains the cast iron HAZ much less than other filler metals, helping in reducing the risk of HAZ cracking. It was shown that HAZ microstructure of grey cast iron contains martensite. Also, PMZ microstructure contains hard eutectic carbide and martensite. To resist against this problem it is advisable to reducing cooling rate via preheating to prevent martensite and carbide formation or post heat treatment to decompose martensite and carbides to softer micro constituents.

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SYNTHESIS AND CHARACTERIZATION OF NANO-HYDROXYAPATITE POWDER USING WET CHEMICAL PRECIPITATION REACTION

Syed Sibte Asghar ABIDI[1], Qasim MURTAZA[2]

The hydroxyapatite (HA) nano powder was synthesized via wet chemical technique in a precipitation reaction, in which Ca (OH)$_2$ and H$_3$PO$_4$ were used as precursors, respectively. Deionisked water as a diluting media for the reaction and ammonia as pH adjuster were used. The synthetic HA nano powder has been proved to have medical applications such as coating material in orthopaedic and dental implants. There has been studied HA powder at different temperatures from (100-800) $^\circ$C to achieve the stoichiometric Ca/P ratio 1.667. The optimum temperature was found to be 600 $^\circ$C. Above this temperature, the HA powder is decomposed to CaO. The crystallite size of HA powder was found to be in the range 8.47-24.47 nm. The crystallographic properties have been evaluated by XRD, FTIR, EDX and SEM.

Keywords: Nano-HA powder; Chemical reaction, X-ray analysis

1. Introduction

Hydroxyapatite (HA) [Ca$_{10}$(Po$_4$)$_6$(OH)$_2$] is a naturally occurring mineral in the inorganic component of human bone and tooth enamel. The crystal size of HA in natural human bone is in nano range. The constituent elements of HA are primarily calcium and phosphorus, with a stoichiometric Ca/P ratio of 1.667. Hydroxyapatite (HA) is composed primarily of calcium and phosphorous with hydroxide ions that are eliminated at elevated temperatures. HA and other related calcium phosphate minerals have been utilized extensively as implant materials for many years due to its excellent biocompatibility and bone bonding ability and also due to its structural and compositional similarity to that of the mineral phase of hard tissue in human bones (Itokazu et al.1998;Minguez et al.1990). HA coatings have good potential as they can exploit the biocompatible and bone bonding properties of the ceramic, while utilizing the mechanical properties of substrates such as Ti$_6$-Al$_4$-V and other biocompatible alloys. While the metallic materials have the required mechanical properties, they benefit from the HA which provides an osteoconductive surface for new bone growth, anchoring the

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implant and transferring load to the skeleton, helping to combat bone atrophy (Liu, Y., et al., 2005). Their Ca/P ratio of 1.52±2.0 makes them an excellent choice for most dental and orthopaedic applications in the form of bioceramic coatings. The quality of a coating is closely dependent on the overall attributes and characteristics of the synthesized powders. Such attributes include phase composition, purity, crytsallinity, particle size, particle-size distribution, specific surface area, density and particle morphology. These important factors determine the resulting success of the HA coating deposited onto orthopaedic implants through plasma thermal spraying due to poor mechanical properties of HA the recent trend in bioceramic research is focused on improving their mechanical and biological properties using nanotechnology(K.P.Sanosh et al.2009). Common methods used to produce synthetic nano-crystalline HA include precipitation (Saeri et al., 2003), hydrothermal (Masahiro et al., 1994), hydrolysis (Shih et al., 2004), mechanochemical (Silver et al., 2003) and sol gel (Kim and Kumata, 2004).

In the present work nano-sized HA powder was synthesized via wet chemical precipitation method using calcium hydroxide, orthophosphoric acid and ammonia as precursors.

2. Experimental

In the present work, calcium oxide (CaO)(Make S d Fine Chem Limited), orthophosphoric acid (H_3PO_4) (Make Fisher Scientific), and ammonium hydroxide (NH_4OH) (Make Fisher Scientific) were used as starting materials. Firstly, an analytical weighing scale was used to accurately weigh CaO powder. 1.42 mol (79.55g) CaO powder was added to 500 ml of deionised water in a 1000 ml beaker and vigorously stirred at 1000 rpm at the $20^{°}$ C for 24 hrs to react and form a suspension of $Ca(OH)_2$ in an excess of deionised water. The beaker was covered in order to avoid possible contamination via contact with atmospheric conditions. The temperature of the reaction ($20^{°}$ C) was maintained by a thermostat-controlled water bath.

An analytical weighing scale was used to accurately weigh the required quantity of orthophosphoric acid. 97.32g of 85% H_3PO_4 was added to $Ca(OH)_2$ solution at a rate of 1.5 ml/min. During the course of the acid addition, the pH of the solution was monitored via a handheld pH meter with an accuracy of ± 0.2. The reactants were stirred for further 24 hrs to aid the maturation stage, under continuous stirring conditions at 1000 rpm, held at the respective reaction temperature of 20^{0} C. 0.28 mol (9.94g) NH_4OH, was added to the HA slurry after 24 hrs ripening period to stabilise the pH of the super saturation solution to above 9.

Assay samples were taken for analysis of the composition of mixture in the barrel. A small crucible was filled with a sample of the mixture in the mixing barrel and dried in a drying oven for 1hr at 100° C. The dried samples were then placed in a furnace and sintered at 1200° C for 1 hr. When the assays were cooled, they were removed from the furnace and ground using a motor and pestle. Scanning electron microscopy (SEM) (HITACHI model S-3700N at DTU) was used to observe the morphology and the particle size of calcined HA powder. Elemental phase composition of the HA powder was analysed using energy dispersive X-ray (EDX) (HITACHI model S-3700N at DTU). The X-ray diffraction (XRD) pattern of the final HA nanoparticles was obtained with CuKα radiation (λ= 1.5406 Å) on (RIGAKU MINIFLEX at AMU). The XRD patterns were recorded in the 2θ range of 20° -$60^°$ with a step size of $0.02^°$ and a step duration of 0.5 sec. The mean crystallite size (D) of the particles was calculated from XRD line broadening measurement using the Scherrer equation (Azaroff, 1968):

$$D = \frac{0.89\lambda}{\beta cos\theta}$$

where λ is the wavelength CuKα , β the full width at half maximum of the HA line and θ the diffraction angle.

3. Results and discussion

The following reactions were involved in the formation of HA during the precipitation reaction: b

$$CaO + H_2O \longrightarrow Ca(OH)_2 \qquad\qquad (1)$$
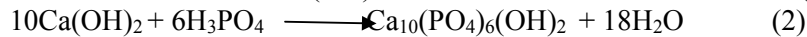$$10Ca(OH)_2 + 6H_3PO_4 \longrightarrow Ca_{10}(PO_4)_6(OH)_2 + 18H_2O \qquad (2)$$

Fig. 1 shows the XRD pattern of HA from $100^°$-$800^°$ C. The crystallite size calculated by Scherrer equation with most intense plan that is 211 of eight calcined HA samples for each temperature are given in table 1.
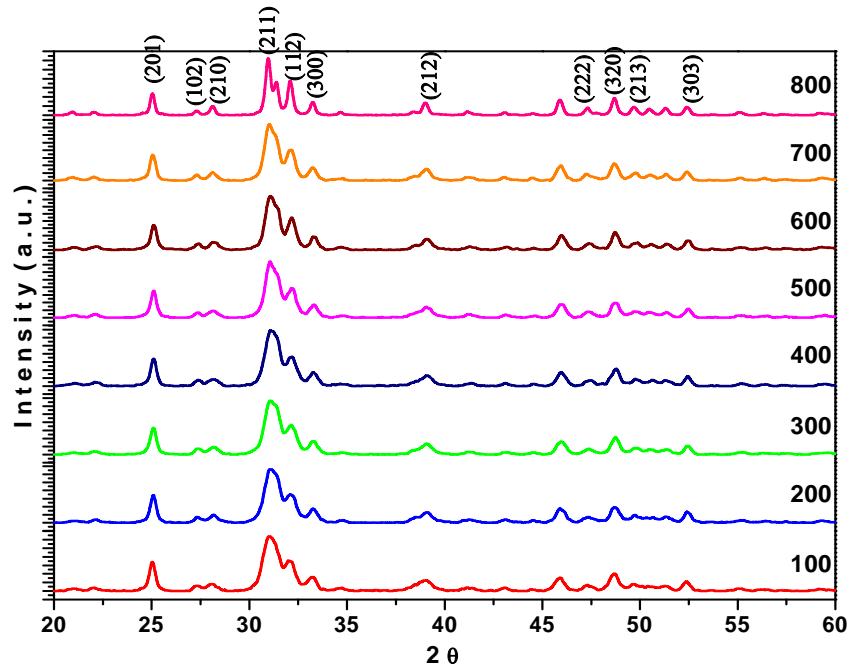
Fig. 1. XRD patterns of HA powders calcined at different temperatures

Table 1

Crystallite size at different calcination temperatures

S. No.	Different Calcination Temperature (^{0}C)	Crystallite Size D (nm)
1	100	8.4
2	200	12.1
3	300	12.4
4	400	12.6
5	500	14.5
6	600	14.5
7	700	14.6
8	800	24.4

It can be observed that with the increase in the calcination temperature the crystallite size also increases. Similar phenomenon was observed by Bouyer et al. (2000) and K.P.Sanosh et al. (2009). It has also been reported that HA calcined at higher temperatures exhibiting good crystallinity. Also, it shows little or no activity towards bioresorption which is important for the formation of chemical

bonding with surrounding hard tissues (Aoki, 1994, Currey, 2001 and K.P.Sanosh et al., 2009). Thus the amorphous HA powders that were obtained at lower temperatures in this study are expected to be metabolically more active than the fully developed crystalline hydroxyapatite structure which otherwise is insoluble in physiological environment (Kim et al., 2000 and K.P. Sanosh et al., 2009).
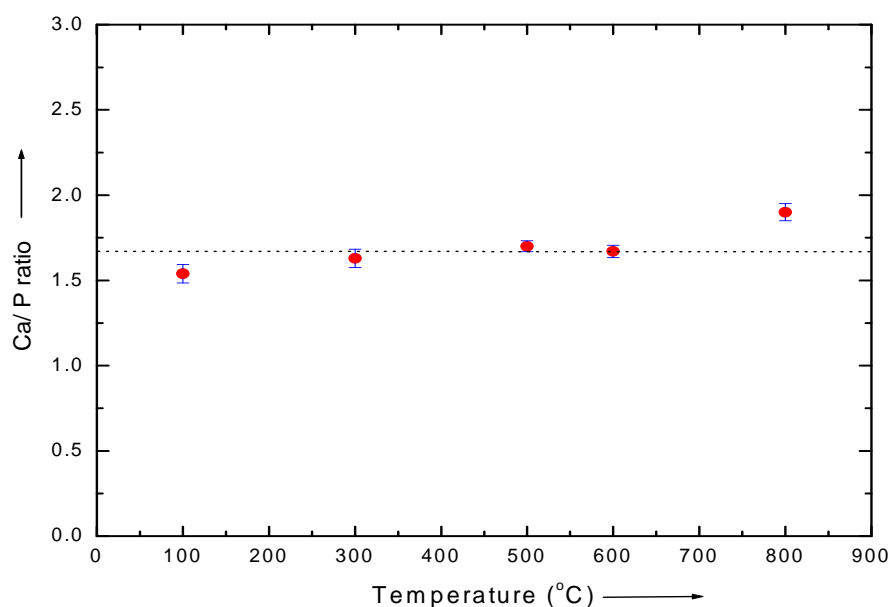

Fig. 2. Plot of variation of Ca/P with calcinations temperature

The XRD spectra of the different calcinated HA powders studied are shown in figure 1. The spectra found are typically in agreement with those published in literature; all XRD spectra obtained have characteristics peaks consistent with the International Centre for Diffraction [JCPDS 2001] files for calcium phosphate. The predominant HA phase was confirmed with JCPDS files number 09-432.

This suggests that no foreign elements, such as sodium (Na^{2+}), ammonium (NH_4^+), potassium (K^+), chloriode (Cl^-) and nitrate (NO_3^-) ions, were involved in the synthesis reaction, as there is strong evidence to suggest that these ions are easily incorporated into the crystal lattice leading to the formation of known stoichiometric HA. These elements are usually introduced into the precipitating systems with the reactants. The absence of these elements can be attributed to the nature of the raw materials used as precursors. In fact, it has been shown that chloride ions enter into the crystal lattice substituting hydroxyl groups while

potassium ions are found to substitute calcium ions into the HA crystal lattice forming locally non-stoichiometric (i.e. impure) HA islands in the bulk crystal. Sodium ions also show evidence of substitutions. In order to avoid contamination of the products, use of calcium nitrate and phosphoric acid instead of calcium chloride salts and potassium dihydrogen phosphate, respectively is advantageous because the presence of potassium ions is avoided and the nitrate ions are too large to substitute hydroxyl groups in the crystal lattice of HA. These substitutions were avoided while preparing our samples when $Ca(OH)_2$ and H_3PO_4 reactants were used. For all of the HA studied no CaO was observed. This indicates that there has occurred either small or no carbonation of HA during the synthesis of HA tested although no foreign element were found.

The Ca/P stoichiometry of calcined HA at different temperatures was analysed using EDX.
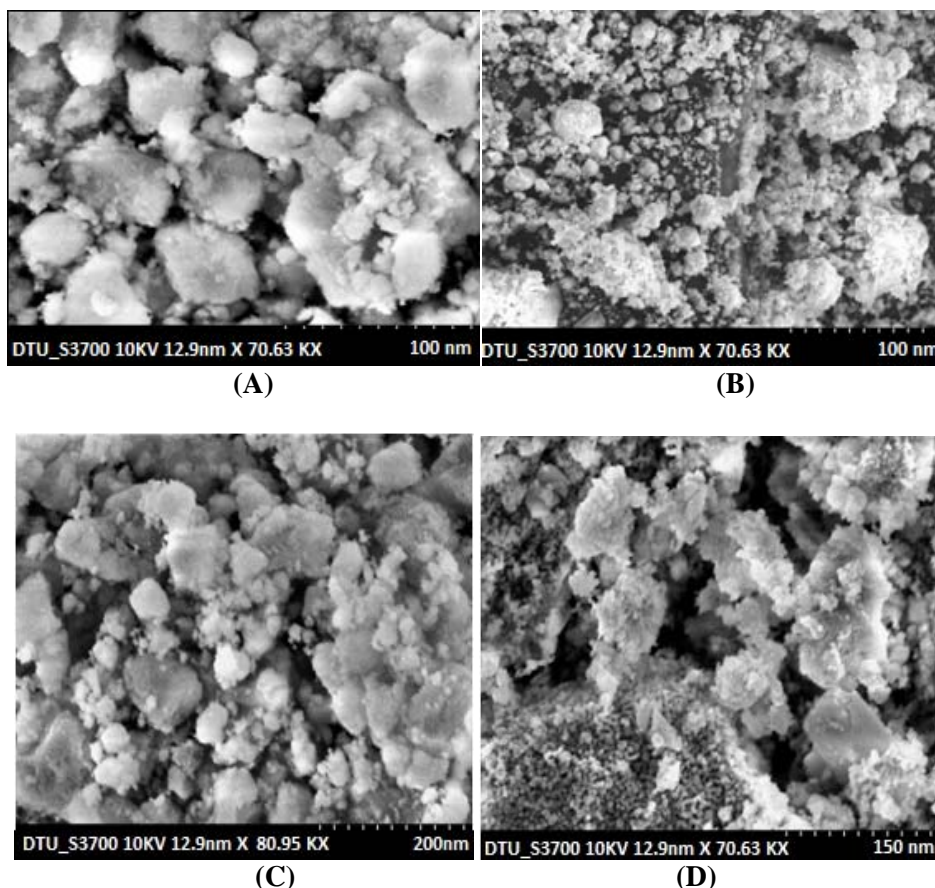

(A)

(B)

(C)

(D)

Fig. 3: SEM images of HA Powder at different temperatures

Analysis of figure 2 shows that HA powder with a Ca/P ratio near to 1.67 that is at temperature 600° C and below, showed no CaO content and that with a Ca/P ratio near to 1.75 and above, showed the formation of minor amounts of CaO for calcined samples at 800° C.

Other researchers have also reported similar formation of CaO in sol-gel processing of HA (Lopatin et al., 1998, Varma et al., 1998 and Sanosh et al., 2009).

SEM was performed at Delhi Technical University (DTU), Delhi in Nanoscience and Technology Centre. The sample (HA) is coated with gold and placed in the SEM machine (HITACHI MODEL-S-3700N). The images were recorded at different temperatures ranging from 100- 800° C. It is known that spherical powders, in general, have better rheological properties than irregular powders and, thus, produce better coatings for hip implants. In order to produce dense, high-quality materials for special-purpose, it is very important to predict or control granule morphology. Kothapalli et al. also demonstrated that an increase in synthesis temperature increases the size of HA precipitates.
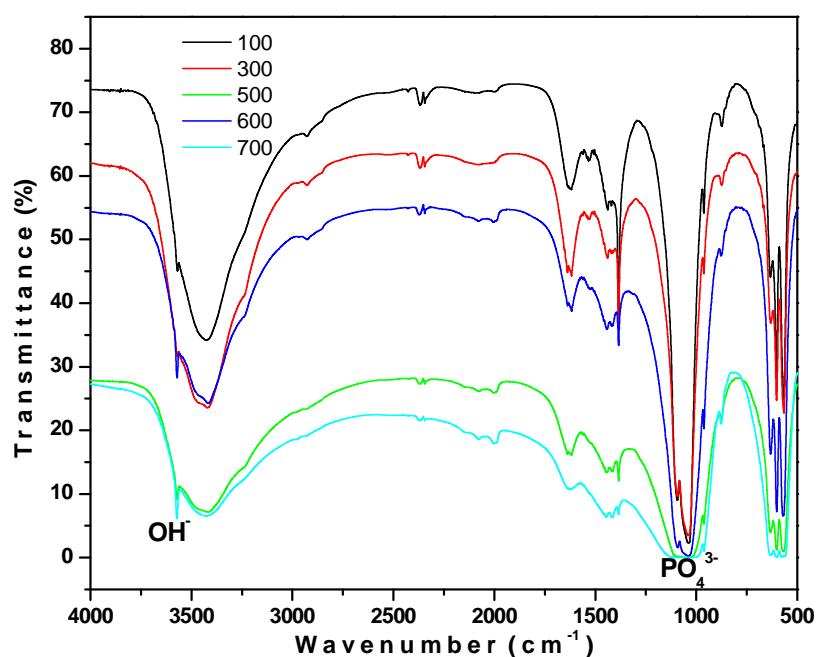

Fig. 4. FT-IR spectrum of HA calcinated at different temperature

FT-IR patterns presented in figure 4 confirm the formation of HA calcinated at different temperature 100-700° C. The spectra possessed an $(OH)^{-1}$ group in the region of 3577 cm^{-1} and $(PO_4)^{3-}$ group comes out in the region of 1075 cm^{-1}. From this analysis the formation of HA is confirmed. The peaks are quite sharp at intermediate temperatures (500-600° C) and as the temperature increases peaks are going to be weak as shown in figure 4.

4. Conclusions

The above presented work used the wet chemical precipitation method due to its high reproducibility, simplicity and also on account of the economical benefits it offers on industrial scale. One of the main advantages of the method is that the water is its only byproduct. The reported method used calcium hydroxide and orthophosphoric acid as precursors. This process shows that high purity of nano-hydroxyapatite powders could be obtained at low temperatures. The crystallinity, crystallite size and Ca/P ratio of the resulting nano particles were found to be dependent on the calcination temperature. When Ca/P ratio exceeded 1.75, formation of CaO phase was observed.

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Accepted Manuscript

Please cite this article as: P.K. Roy, R. Mathur, D. Kumar, C. Rajagopal, Tertiary recycling of poly (ethylene terephthalate) wastes for production of polyurethane-polyisocyanurate foams., *Journal of Environmental Chemical Engineering* (2013), http://dx.doi.org/10.1016/j.jece.2013.08.019

1 **Tertiary recycling of poly (ethylene terephthalate) wastes for production of polyurethane-**

2 **polyisocyanurate foams.**

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1

20 **Abstract**

21

22 The present work aims at tertiary recycling of poly (ethylene terephthalate) (PET) wastes to

23 derive raw materials for production of polyurethane-polyisocyanurate foams. The first step

24 involves glycolytic depolymerisation of PET in the presence of diethylene glycol (DEG), under

25 the influence of microwave irradiation with an aim to reduce the energy intensiveness of the

26 process. Experimental conditions like PET: DEG ratio and reaction time were optimized to

27 maximize the extent of PET conversion. Multiple extrusion of PET led to reduction in its

28 molecular weight, which increased its reactivity towards glycolysis. The time required for

29 glycolytic depolymerisation of PET could be significantly reduced by employing microwave

30 irradiation instead of conventional thermal process. The glycolysate was subsequently reacted

31 with two different diacids: adipic acid (AA) and sebacic acid (SA) to obtain aromatic oligoesters.

32 For the purpose of comparison, analogous aliphatic oligoesters were also prepared by reacting

33 AA and SA with DEG under similar reaction conditions. The oligoesters were subsequently

34 employed as a raw material for the preparation of polyurethane foams by reacting with

35 diphenylmethane diisocyanate. The hydroxyl: isocyanate ratio in the formulation was decreased

36 to introduce isocyanurate linkages, which resulted in the formation of polyisocyanurate foams

37 with high compressive strength. Various characterization techniques were employed to

38 determine the effect of the aromatic phenyl group and chain length of the diacid on the

39 mechanical and structural properties of the resultant foams.

40

41 Keywords: microwave; poly(ethylene terephthalate); polyurethane; polyisocyanurate, recycling

42

2

Introduction

43

44   Successful demonstration of blow moulding technique for the production of Poly

45   (ethylene terephthalate) (PET) bottles, way back in the 1970's, has led to a massive increase in

46   the overall usage of this polymer for packaging purposes[1]. Because of its excellent barrier

47   properties against oxygen and carbon dioxide [2], PET has become the choicest of materials for

48   bottling beverages, particularly mineral water and carbonated soft drinks. In addition, it finds

49   extensive application in the textile industry, which consumes more than 60 % of all the PET

50   produced worldwide [3]. Unfortunately, irresponsible usage of this non degradable thermoplastic

51   over the last few decades has led to its accumulation in the environment [4,5]. Of all

52   thermoplastics, the practice of recycling PET is very common, but the cost of the recycled

53   product is rather high [6]. It is thus highly desirous to adopt technically & economically feasible

54   routes towards recycling of PET into industrially important products.

55   Primary and secondary recycling of PET involves thermal reprocessing of the polymer

56   which reduces its molecular weight substantially [7], thereby setting up an upper limit on the

57   maximum number of recycling steps. There is abundant academic and practical studies on

58   tertiary recycling of PET, whereby it is converted into basic chemicals [8], by processes like

59   glycolysis [9], aminolysis [10], hydrolysis[11], alkalolysis [12] and alcoholysis, out of which

60   only the former two have reached the level of commercial maturity [8,13]. Glycolysis of PET

61   leads to formation of oligomers which have the potential to be used as a raw material for

62   preparation of unsaturated polyesters [14], alkyd resins [15-17] and polyurethanes [18-20] etc.

63   At present, oligoesters used for the preparation of flexible polyurethane foams are

64   essentially derived by reacting low molecular weight diols e.g. Diethylene glycol (DEG) with

3

65 adipic acid (AA) in the presence of glycerol [21]. For rigid PU foam applications, the polyol is

66 obtained by the reaction of AA with ethylene glycol (EG) or diethyleneglycol (DEG) in the

67 presence of phthalic anhydride[19]. Interestingly, such polyols can also be derived by

68 transesterification of PET, which in turn can be further reacted with aliphatic diacids for

69 preparation of either type of PU foam, depending on the type of spacer employed. The polyester

70 polyol obtained from PET is expected to render advantageous characteristics to the final product,

71 particularly in terms of better mechanical properties, high thermal stability, resistance to major

72 chemical solvents due to the presence of aromatic phenyl group [22]. Thus, synthesizing polyols

73 by transesterification of PET waste is a process of preserving natural resources, and this in fact is

74 the driving force for the present study.

75 It has been previously reported that the time and energy requirements for PET glycolysis

76 can be significantly lowered by using microwave as an alternate energy source[23]. We have

77 reported previously that the reactivity of PET is inversely proportional to the molecular weight of

78 diol used for glycolysis. We observed that complete conversion of PET under microwave-

79 assisted glycolytic conditions could be achieved in the presence of DEG, the polyurethane foams

80 obtained there from are rather rigid [24]. By reacting the glycolysed polyol with suitable diacids,

81 it is possible to introduce spacer molecules, with increased flexibility. In this context, the

82 reaction of glycolysed PET with AA has been reported to form oligoesters, which inturn leads to

83 flexible foams[19]. However, literature is scarce on the effect of soft segment chain length of the

84 diacid on the final foam properties. We hypothesize that a higher molecular weight diacid, like

85 sebacic acid (SA) can be used to increase the flexibility of the aromatic polyester polyol based

86 foam further.

4

87   In this article, we propose a combination of microwave-assisted PET depolymerisation

88   process, which was used to prepare low molecular weight oligomers, followed by

89   polycondensation with aliphatic diacids to prepare oligoesters with desired properties. We also

90   hypothesise that it should be relatively easy to adopt chemical recycling for recycled PET grades,

91   which have been subjected to a few thermal processing steps. In this regard, we have

92   demonstrated the potential of this process for recycled PET grades. The oligoesters have been

93   used as a raw material for production of flexible foams, where the rigidity was increased by

94   varying the amount of isocyanate in the composition.

95

96   **Experimental**

97   *Materials*

98   Disposed off PET bottles were collected, washed, dried and cut into small pieces (6 mm x

99   6 mm) after removal of the polyethylene caps and the polypropylene label. Zinc acetate

100   dihydrate [Zn $(CH_3COO)_2$. $2H_2O$, Merck] with a purity of 99% was employed as the trans-

101   esterification catalyst. Adipic acid (Central Drug House (CDH)), sebacic acid (CDH), p-toluene

102   sulfonic acid (PTSA) (CDH), potassium acetate (CDH), diethylene glycol, glycerol (CDH),

103   diphenylmethane 4, 4'-diisocyanate, a mixture of di- and triisocyanates (MDI) (Merck) and

104   dibutyl tin dilaurate (DBTL) (Merck) were used without any further purification. Double

105   distilled water was used throughout the course of this work.

106

107   *Microwave aided glycolysis*

108   A domestic microwave oven (LG) with a magnetron source for microwave generation

109   (2.45 GHz, maximum power: 900 W) was used for performing glycolytic experiments. PET

5

110   pieces (10 g) together with requisite amount of DEG and zinc acetate (0.5 % w/w PET) were

111   introduced into a loosely stoppered reaction flask which was placed in the microwave reactor. To

112   increase the functionality of the glycolysate, a trifunctional alcohol (glycerol) was introduced in

113   the reaction medium along with PET and DEG [21]. The effect of increasing triol concentration

114   on the properties of the resultant glycolysate has been discussed in our previous paper [24], and

115   based on the previous studies, 5%w/w of glycerol was employed in the present investigation.

116   Experiments were performed at different molar ratio of PET: DEG:: 1:2, 1:4 and 1:6 and was

117   allowed to proceed at 450 W for extended time periods, leading to the formation of a viscous

118   liquid, which did not solidify on cooling. After predetermined periods, the reaction mixture was

119   filtered through a copper wire mesh (0.5 × 0.5 mm pore size), and the remaining unreacted PET

120   flakes were weighed to estimate PET conversion % as follows.

121     $$\text{PET conversion (\%)} = (\frac{m_{PET,\,Initial} - m_{PET,\,Remaining}}{m_{PET,\,Initial}}) \times 100 \dots\dots\dots\dots\dots\dots\dots.1$$

122   where, $m_{PET,\,initial}$ refers to the mass of PET initially taken for the experiment and $m_{PET,\,remaining}$

123   refers to the mass of solid PET flakes which remained unreacted in the reaction medium. For

124   comparison purposes, glycolysis was also performed at 180-190 °C in an oil bath, under inert

125   atmosphere in a four-necked round bottom flask, connected to a reflux condenser, N_2 gas inlet,

126   thermometer and stirrer, the concentration of reactants being same. The results in terms of PET

127   conversion were compared with those obtained under microwave irradiation.

128   *Secondary recycling: Multiple extrusions*

129   Studies were performed to investigate the effect of multiple extrusions on the intrinsic

130   viscosity of PET, which is expected to affect its reactivity towards glycolysis. For this purpose,

6

131   approximately 15 g of dried PET flakes was loaded into the plastometer barrel of an MFI

132   instrument (International Equipments) and extruded under a load of 2.16 kg at 260 °C and the

133   extrudate was loaded into the plastometer barrel for re-extrusion. This process was repeated 10

134   times and the effect of extrusion on the intrinsic viscosity of the sample was measured, before

135   being subjecting the degraded PET to glycolytic experiments. The thermally degraded PET will

136   be referred to as RPET in the subsequent text.

137   *Polyesterification of glycolysed products*

138   The DEG glycolysed product, obtained by employing a PET: DEG :: 1:4, was used

139   without any further separation.   The obtained glycolysate was reacted with two different

140   difunctional carboxylic acids, namely AA and SA (hydroxyl: acid ratio:: 1:1). For comparison

141   purposes, aliphatic oligoesters were also prepared by reaction of AA and SA with DEG under

142   similar conditions. Esterification catalyst, PTSA (0.1 %), based on the moles of diacid, was

143   introduced in steps into a reaction kettle (500 mL capacity) containing the glycolysed product

144   and the diacid. The reactor was equipped with a stirring assembly, a thermowell and a dean stark

145   apparatus. The reaction was initially heated to 170 ^{o}C and maintained for a period of 3 h, after

146   which the temperature was increased to 200 °C. The reaction was allowed to proceed at 200 °C

147   till the required acid number (< 30) was achieved. Water formed as a result of the esterification

148   process was collected and quantified.

149   *Preparation of polyurethane foams.*

150   In order to assess the effect of the aromatic phenyl group on the properties of PU foams,

151   both aromatic as well as aliphatic oligoesters were reacted with isocyanates to prepare

7

152 polyurethane foam. For this purpose, weighed amount of the oligoester, silicone oil surfactant

153 (2% w/w oligoester), DBTL catalyst (1% w/w oligoester) and foaming agent (water) were mixed

154 in a flat-bottom teflon beaker and stirred mechanically for 1 min. Requisite amount of MDI,

155 calculated according to the following formula was added and stirred vigorously, which led to the

156 formation of a viscous liquid. This was poured into cylindrical Teflon molds (60 mm diameter,

157 36 mm length) and allowed to foam within.

$$m_{iso}.n_{eq,iso} = [m_{H_2O}.n_{eq,H_2O} + m_{poly}.n_{eq,poly}]i_{NCO} \qquad \text{.............2}$$

158

159 where m_{iso}, m_{H_2O} and m_{poly} refer to the mass of polyisocyanate, water and oligoester respectively

160 and $n_{eq,iso}$, n_{eq,H_2O} and $n_{eq,poly}$ are the equivalent number of polyisocyanate (7.4 mmol/g), water

161 (111.1 mmol g^{-1}) and oligoester (estimated from the hydroxyl number) and i_{NCO} is the desired

162 NCO index (1.05) maintained for the preparation of flexible PU foam formulation [25].

163 Under similar conditions, polyisocyanurate foams (PIR) were also prepared, where the NCO

164 index was increased to 2. In addition, the PIR formulation also contained requisite amounts of

165 potassium acetate, which reportedly catalyses the rate of trimerisation of isocyanate [19]. The

166 process of foam formation was monitored by measuring characteristic parameters including

167 cream time, gel time and tack-free time.

168 The polyurethanes and polyisocyanurates were designated as PETPU and PETPI followed by

169 the acid used for its preparation, i.e. AA and SA for denoting adipic acid and sebacic acid

170 respectively. For example, the polyurethane foam derived from glycolysis of PET followed by

171 esterification with AA will be referred to as PETPU-AA and the isocyanurate foam derived from

172 the same will be referred to as PETPI-AA respectively in the subsequent text. The naming of

8

173 polyurethanes and polyisocyanates derived from aliphatic oligoesters follows similar naming

174 pattern where DEG is used instead of PET.

175

176 *Characterisation techniques*

177   The viscosity-average molecular weight of PET was determined by solution viscometry.

178 Samples were dissolved in a mixture of phenol and 1,1,2,2-tetrachloroethane (60/40 w/w) under

179 heating, and the intrinsic viscosity [η] was measured using Ubbelohde suspension level

180 viscometer at 25 °C. For determination of [η] of residual PET, the samples were washed with

181 acetone to remove the adhering DEG and EG. The viscosity average molecular weight of PET

182 was calculated using the following equation [26].

183 $$[\eta] = 75.5 \times 10^{-3} \text{ mL/g } M_v^{0.685}\ldots\ldots\ldots\ldots\ldots.(3)$$

184 The intrinsic viscosity of the glycolysate was determined in methanol at 25 °C. The Hydroxyl

185 number (HN) was determined using acetic anhydride, as per test method A, described in ASTM

186 D 4274 – 99. For the purpose of acid number determination, the solution was titrated against

187 standard methanolic KOH solution in acetone medium, as per the procedure reported previously.

188   Thermal characterization was performed using Perkin Elmer Diamond STG-DTA-DSC in

189 N_2 atmosphere in the temperature range of 50-550 °C. A heating rate of 10 °C/min and sample

190 mass of 5.0 ± 0.5 mg was used for each experiment. Percentage crystallinity was calculated from

191 the DSC traces as follows.

$$\% \text{ Crystallinity} = \frac{\Delta H_{f \text{ (observed)}}}{\Delta H_{f \text{ (100\%crystalline)}}} \times 100 \quad \cdots\cdots\cdots\cdots\cdots(4)$$

9

193 where, $\Delta H_{f(observed)}$ is the enthalpy associated with melting of the material and $\Delta H_{f(100\% \ crystalline)}$ is

194 the enthalpy of 100% crystalline PET reported in the literature to be 135.8 J/g [27].

195 The surface morphology of samples was studied using a Scanning Electron Microscope

196 (Zeiss EVO MA15) under an acceleration voltage of 20 kV. Samples were mounted on metal

197 stubs and sputter-coated with gold and palladium (10 nm) using a sputter coater (Quorum-

198 SC7620) operating at 10-12 mA for 60 s. The average cell dimensions and standard deviations

199 were determined by measuring the diameters of about 20 cells using inbuilt image processing

200 software.

201 The density of the PU foam was determined by averaging the mass: volume ratio of five

202 specimens per sample following ASTM D1622–98 standard. The average value along with the

203 standard deviation has been reported in the paper. The compressive mechanical properties of the

204 foams were determined using a Universal Testing Machine (International Equipments) as per

205 ASTM D1621–00. Compressive load was applied at a cross-head speed of 3.6 mm/min, till the

206 foam was compressed to ~ 15 % of its original thickness. The compressive strength was

207 calculated based on the "10 % deformation'' method as per the standard procedure. At least,

208 three identical specimens were tested for each composition and the average results along with the

209 standard deviation values have been reported.

210 FTIR spectra of samples were recorded in the wavelength range 4000 - 600 cm^{-1} using

211 Fourier Transform Infrared (FTIR) spectroscopy on a Thermo Fisher FTIR (NICOLET 8700)

212 analyser with an attenuated total reflectance (ATR) crystal accessory. The isocyanurate content

213 was estimated as the ratio of intensity of the isocyanurate absorption band at 1412 cm^{-1} to

214 intensity of the aromatic absorption band at 1597 cm^{-1} [19]. Waters (1525) gel permeation

215 chromatograph (Milford, MA) equipped with styragel (HR-3 and HR-4, 7.8 x 300 mm^2) columns

10

216 along with Evaporating Light Scattering Detector (ELSD-2420) was used for determination of

217 the molecular weight and molecular weight distribution of the glycolysate. Narrow molar mass

218 polystyrene standards were used for calibration purposes.

219

220 **Results and Discussion**

221 *Microwave assisted glycolysis*

222   The TG and DSC trace of the PET used for the present study is presented in the

223 supplementary section (Figure S1). It can be seen that the PET samples exhibit a sharp melting

224 point peaking at 246 °C and undergoes a single step pyrolytic decomposition commencing at 400

225 °C. The DSC crystallinity as determined from the area of the endotherm is ~27.2 % and the

226 molecular weight (M_v) of PET, as determined from viscometric studies was 27,431. Glycolysis

227 of PET with DEG leads to the formation of liquid oligomers, which do not solidify on cooling.

228 The reaction was followed by monitoring the extent of PET conversion, the variation of which is

229 presented in Figure 1. It can be seen that the PET conversion reached a maxima after 30 minutes

230 of irradiation, after which even traces of PET could not be detected in the medium.

231   It can be seen from the figure that complete conversion of PET is achievable under these

232 conditions (PET: DEG :: 1:2). However, the effect on the PET conversion due to increasing the

233 PET: DEG ratio is quite pronounced, especially during the initial periods of reaction (Figure 1).

234 Under a PET: DEG::1:2, PET conversion is rather low (~3%) in the initial periods (t<10 min),

235 which can be attributed to the reduced availability of DEG on the surface of PET.

236   Pardal et.al [28,29] have extensively studied the kinetics of the glycolytic

237 depolymerisation process, in which the mechanism behind the evolution of an initially

11

238 heterogenous phase of liquid glycol and the solid polymer into a single homogeneous liquid

239 phase has been discussed. It has been suggested that initially, the liquid glycol diffuses into the

240 bulk of the solid polyester which leads to the swelling of the matrix. This followed by glycolysis

241 of the amorphous interlamellar chains. Subsequently, the reaction products diffuse from the

242 surface, leading to a rough texture as evident from the SEM images presented in Figure 2. Being

243 a two phase reaction, the susceptibility towards glycolysis is highly dependent on the availability

244 of glycols on the surface of the solid, which increases with the increasing amount of DEG in the

245 reaction medium, which accounts for the increase in the rate of PET conversion with increase in

246 the PET : DEG ratio.

247 Although complete PET conversion could be achieved even under PET: DEG ratio of

248 1:2, the glycolysate obtained were comparatively viscous (intrinsic viscosity = 0.02 dL/g). With

249 increase in the amount of glycol in the reaction medium, the intrinsic viscosity decreased to

250 0.016 and 0.012 dL/g for PET: DEG of 1:4 and 1:6 respectively, which was reasonably easy to

251 handle for the subsequent polycondensation step. Since, excess of glycol (PET:DEG ::1:6) is

252 expected to the incorporation of less amounts of aromatic moieties in the oligoester, it was

253 decided to perform the polycondensation reaction with the glycolysate obtained using an

254 optimized PET:DEG ratio of 1:4.

255 In view of the above, large scale glycolytic reactions with PET (50 g batch) were

256 performed under the optimized ratio of PET:DEG ::1:4. There was not much variation in the HN

257 after ~30 min of reaction, which was of the order of 430 ± 15 after 30 min. Size exclusion

258 chromatography was performed to determine the molecular weight distribution of the glycolysed

259 product. The M_n, M_w, and M_z of the PET glycolysate was 330, 456 and 564 respectively. It is

12

260   interesting to note that the glycolytic depolymerisation of PET does not take place in the absence

261   of catalyst in the time frame of reaction (60 min), as is evidenced in Figure 1.

262   The viscosity-average molecular weight of PET was determined by solution viscometry,

263   which revealed that the M_v of the PET films decreased from an initial value of 27,431 to 1521 $\pm$

264   130 after glycolysis for 30 min in the presence of DEG. This was also associated with an

265   increase in the DSC crystallinity increased from 27.2 % to 37.1 % after 30 min of glycolysis,

266   which clearly indicate that the amorphous regions are preferentially eroded as compared to the

267   crystalline regions.

268   Under conventional heating (T=180-190°C) and similar PET: glycol concentrations

269   (PET:DEG::1:4); the reaction took ~ 9 h to reach the same level of de-polymerization. The

270   effect of characteristic parameters like temperature, catalyst and polymer morphology has been

271   discussed in detail by Pardal et.al previously[29]. It has been reported that the reactivity of PET

272   with DEG is substantially low at 190 and 200 °C that the liquid phase remains heterogeneously

273   white even after 270 min of reaction, and our studies confirmed the same.

274   One of the main problems associated with the primary and secondary recycling of PET is

275   linked with the decrease in quality of the recycled product, which occurs as a result of

276   degradation due to the moisture content and contaminants in the feed. Exposure of PET to 10

277   extrusion cycles at 260 °C led to a significant decrease in the molecular weight to 19,329 $\pm$ 132,

278   which in turn is expected to result in its increased susceptibility towards glycolysis. As can be

279   seen from Figure 1, complete conversion of this thermally reprocessed grade could be achieved

280   within 20 min.

13

281   The FTIR spectra of PET, DEG and glycolysed PET is presented in Figure 3. The

282   spectrum of DEG exhibit characteristic absorption bands due to ether stretching (C-O) at ~1050

283   to 1150 cm^{-1}, with maxima at 1150 cm^{-1}. Characteristic alkyl (R–CH$_2$) stretching at ~2850–3000

284   cm^{-1} was also observed, along with hydroxyl group absorption ranging from ~3200–3600 cm^{-1}.

285   In comparison, the glycolysed product exhibit absorption at 1715 cm^{-1} due to –C=O stretching,

286   which can be attributed to the presence of ester group, formed as a result of glycolysis of PET

287   and this peak could also be observed in the spectra of PET. The absorption band at ~3200–3600

288   cm^{-1} can be attributed to the presence of free hydroxyl groups present in glycolysed PET

289   oligoesters.

290   *Microwave assisted heating: Role of Diethylene glycol*

291

292   The energy associated with the microwave frequency (2.45 GHz, 0.0016 eV) employed

293   for the glycolytic depolymerisation is too small to cleave covalent chemical bonds, which leads

294   us to believe that the enhanced efficiency of the microwave assisted glycolytic process can be

295   attributed to the efficient heating of the medium under the reaction conditions employed, a

296   feature more commonly known as the "microwave dielectric heating" effect. In the present

297   study, DEG plays an extremely important function of an efficient microwave absorber, apart

298   from serving its primary role as a reactant. Due to its exceptionally high loss factor (tan $\delta_{,DEG}$ =

299   1.2, 30 ^{o}C) [30] it is capable of effectively converting electromagnetic energy into heat, which

300   leads to rapid PET depolymerisation under the experimental conditions employed. However, in

301   the conventional process, the reaction mixture in contact with the vessel wall is heated first,

302   which is then conducted through the medium to the PET flakes. In the latter, the potential of

303   DEG as an effective microwave absorber is not tapped, and this can be used to explain the

304   difference between the observed rates of the two processes.

14

305   *Polycondensation of glycolysed PET*

306   The PET glycolysate was esterified with two difunctional acids (AA and SA) over

307   extended periods and the variation in the acid number (AN) of the liquid oligoester as a function

308   of time is presented in Figure 4. As expected, the AN decreases as a result of the condensation

309   reaction and the extent of decrease is higher initially, after which it tends to level off. It has been

310   reported that the catalyst degrades over a period of time and in view of the same, it was

311   introduced in steps, (initially and after 9 h), the total amount remaining same (0.1 % mol) [31].

312   Interestingly, the oligoesters prepared by polyesterification of glycolysed oligomers with AA

313   exhibit slightly lower AN, which is indicative of its higher reactivity as compared to SA. The

314   polymerization process was also associated with an increase in the viscosity, which was

315   quantified by viscometric techniques. On the basis of the higher reactivity of AA, the oligoesters

316   prepared by reaction of glycolysate with AA exhibit higher viscosities (intrinsic viscosity 0.16

317   dL/g) as compared to sebacic acid based oligoesters (intrinsic viscosity 0.12 dL/g) after 15 h of

318   reaction.

319   The FTIR spectra of the products obtained post-esterification with adipic acid is

320   presented in Figure 5. Characteristic hydroxyl group absorption ($\sim$3200–3600 cm^{-1}) was

321   observed in the spectra of DEG glycolysed PET. Due to polyesterification reaction, the hydroxyl

322   groups are consumed as a result of which the absorption in this region decreases. In view of the

323   similar functional groups, the FTIR spectra of both types of oligoesters is similar, irrespective of

324   the type of diacid used for its preparation, and hence only adipic acid containing oligoester has

325   been included as a representative in the figure. The hydroxyl number decreases from an initial

15

326 value of 430 ± 15 for DEG glycolysed PET to 20 ± 2 and 28 ± 2 after reaction with AA and SA

327 respectively.

328

329 *Polyurethane foams from oligoesters*

330 The oligoesters, obtained after reaction of glycolysate (PET:DEG::1:4) with diacids were

331 further reacted with MDI in varying amounts to prepare polyurethane-polyisocyanurate foams,

332 and the foaming process was monitored by measuring the duration of cream time, gel time and

333 tack-free time, the results of which are presented in Table 1. The exothermic foaming process

334 initiated almost instantaneously upon mixing of the reagents and the viscous mass continued to

335 expand till the resulting foamed mass solidified due to progressive cross-linking. The isocyanate

336 index for PU formulations is normally varied between 105 - 125, while for PU–PIR foams, it is

337 increased to 180-350. In the present study, the same was maintained at 200 to obtain PIR foams,

338 which were mechanically much stronger as compared to their PU analogues.

339 The entire process of foam formation is a delicate balance between two reactions. The

340 initial blowing step involves the reaction of the isocyanate group with water to yield a thermally

341 unstable carbamic acid, which decomposes to forms amine, carbon dioxide and heat. This is

342 followed by a gelation step, which leads to the formation of a solid cellular foam. These two

343 steps involve several reactions, the details of which are presented in the supplementary section. It

344 is to be mentioned that if the rate of gelation is slow in comparison to the initial blowing step, it

345 amounts to the collapse of the reticular structure. On the contrary, the reverse scenario leads to

346 formation of foams with closed cells, both of which are undesirable, for practical applications. It

16

347   is in this context that cream time and gel time become critical for industrial formulations. For all

348   practical applications in injection technology, the cream time has to be more than the injection

349   time. The foam should expand and fill the form in approximately the same time as the gel time.

350   The cream time and gel time recommended by reactivity profiles of injection technology are 4–8

351   and 30–60 s respectively [32]. In the present study, the foam rising (cream time) begins

352   approximately within 15 s of mixing and solidifies completely (tack-free time) within 52-62 s

353   (Table 1).

354   The apparent density of foams, as determined by mass volume ratio are reported in Table

355   1. PIR foams exhibit higher density than PU foams, which was also evident from the smaller cell

356   sizes, as determined from SEM images (Figure 6). The average cell size of the foam along with

357   the standard deviations was also determined and is reported in Table 1. As can be seen from the

358   SEM images, all the foams possessed cells with almost uniform sizes.

359   The isocyanurate content was quantified in terms of the ratio of intensity of absorption

360   band at 1412 cm^{-1} to intensity of the aromatic absorption band at 1597 cm^{-1}, [19] the results of

361   which are presented in Figure 7. The representative FTIR spectra of PIR foams are also

362   presented in the figure. As can be seen, the PIR samples exhibit increased absorption at 1412 cm^{-1}

363   ^{1} due to presence of isocyanurate groups.

364

365   *Mechanical properties of foams*

366   The mechanical properties of the foams were evaluated under compression mode and

367   representative stress-strain curves are presented in Figure 8. The compressive modulus and

368   strength (at 10% strain) of the foams are reported in Table 1. It can be seen from the figure that

17

369 all the samples exhibit similar profiles i.e. an initial linear elastic region at low stresses, followed

370 by an extended plateau. This feature is more pronounced in rigid foams with increased

371 isocyanurate content. The observed elastic region arises primarily from the bending of cell struts,

372 and stretching of the membranes in the cell walls. The subsequent broad plateau is a result of the

373 plastic collapse or cell wall buckling of the foam, which is more commonly referred to as the

374 collapse stress [33]. It is this extended plateau, which endows the foams with their high

375 compressibility and enables them to exert a relatively constant stress up to high strain levels.

376 As expected, the use of higher molecular weight acid i.e. SA, led to formation of foams

377 with lower compressive strength. The initial linear region was used to determine the modulus of

378 the foams, the results of which are reported in Table 1. As expected, the modulus of samples

379 prepared using glycolysed PET was much higher, due to the introduction of aromatic phenyl ring

380 in the main chain.

381 *Thermal characterization of PU foams*

382 In view of the higher stability of isocyanurates in comparison to urethanes, a considerable

383 improvement of thermal stability is expected [34]. The TG trace of polyurethane and

384 polyisocyanurate foams under N_2 atmosphere is presented in Figure 9. Interestingly, the thermal

385 degradation profiles was not affected with the type of spacer soft segment present in the

386 polymeric chain and for the sake of brevity, only the TG traces of foams prepared from adipic

387 acid based oligoester are presented. As can be seen, the decomposition of PU foams initiates at

388 slightly lower temperature than PIR foams. It can also be seen that the presence of aromatic

389 groups in the foams derived from glycolysed PET lead to higher char yields. The moisture

390 content was highest in PU foams derived from the polycondensation of aliphatic acids and diols

18

391   (DEGPU-AA), and as expected, the presence of hydrophobic phenyl rings resulted in lower

392   moisture content in foams derived from PET glycolysates.

393   The thermal decomposition of polymeric materials usually initiates with the cleavage of

394   the weakest bonds in the chain. It has been reported that the decomposition of PU foams starts

395   with the thermal dissociation of urethane linkages, which leaves behind a char ~ 20 % [6]while

396   the PIR foams containing isocyanurate rings are much more stable with a char yield of ~30 % –

397   50 % [34]. Slightly lower char yields obtained in the present study can be attributed to the

398   presence of higher amounts of aliphatic acid in the composition, which was introduced to

399   achieve flexibility. The studies clearly indicate that all the foam samples could be safely used in

400   service till a maximum of 270 °C, without undergoing any major thermal degradation, and the

401   presence of aromatic rings in the chain leads to enhanced thermal stability.

402

403   **Conclusion**

404   PET bottles were glycolyzed with DEG under microwave irradiation in the presence of

405   zinc acetate (0.5% w/w). The reaction time required for glycolysis could be significantly reduced

406   (~30 min) by the use of microwave as compared to the conventional thermal glycolytic process

407   (T = 180-190 °C), which requires a minimum of 9 h to reach the same level of depolymerisation.

408   The increased rate of glycolysis under microwave irradiation was attributed to efficient

409   microwave absorption characteristics of DEG. To determine the effect of degradation resulting

410   from 1° and 2° recycling on the extent of PET conversion, multiple extrusions were carried out

411   in a plastometer, and the degraded product was found to be more susceptible to glycolytic

19

412 depolymerisation. The glycolysates obtained after 30 min of microwave assisted glycolysis

413 (PET : DEG:: 1:4) were found to possess optimum viscosity, to be used for further

414 polycondensation reaction with diacids. Oligoesters were prepared by reacting glycolysed PET

415 with difunctional acids like sebacic acid and adipic acid with an aim to introduce soft spacer

416 segments within the polymeric chain. The oligoesters hence obtained were used as a raw material

417 for preparation of polyurethane-polyisocyanurate foams by varying the isoyanate index. The

418 effect of soft segment chain length, and the aromatic phenyl group on the compressive

419 mechanical properties of the foams was evaluated. All the foams possessed cells of uniform

420 dimensions, and the flexibility of the foam was found to be directly proportional to the chain

421 length of the spacer molecule used for its preparation. The use of PET glycolysate in the

422 formulation led to an improvement in the thermal stability of the resultant foams due to the

423 introduction of phenyl rings within the polymeric chain.

424

425 **Acknowledgements**

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429

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504

22

List of Figures

504

505   Figure 1: Effect of glycolysis time and PET: DEG ratio on the extent of PET conversion.

506   Figure 2: SEM images of the PET surface a) initially, b) after 30 min of glycolysis.

507   Figure 3: FTIR spectra a) poly(ethylene terephthalate), b) diethylene glycol, (c) glycolysed PET

508   Figure 4: Variation of acid number with progress of polyesterification reaction.

509   Figure 5: FTIR spectra a) DEG glycolysed PET, b) oligoester obtained after polyesterification

510   with Adipic acid

511   Figure 6: Scanning electron micrograph of representative polyurethane foams (a) DEGPU-AA

512   (b) DEGPI-AA c) PETPU-AA and d) PETPI-AA

513   Figure 7: a) FTIR spectra of representative isocyanurate foams b) Isocyanurate content of PIR
514   and PU foams.

515   Figure 8: Compressive stress-strain relationship for foams in compression mode a) DEGPU-SA

516   b) DEGPU-AA c) PETPU-SA d) PETPU-AA e) DEGPI-SA and f) DEGPI-AA g) PETPI-SA h)

517   PETPI-AA

518   Figure 9: Thermogravimetric traces a) DEGPU-AA, b) PETPU-AA, c) DEGPI-AA and d)

519   PETPI-AA

520

List of tables

521

522   Table 1: Characteristics of polyurethane foam derived from glycolysed PET

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525   **Table 1**: Characteristics of polyurethane foam derived from glycolysed PET

Foam	Cream time (s)	Gel time (s)	Tack free time (s)	Density (kg/m^3)	Cell size (μ)	Compressive strength (kPa)[a]	Young's Modulus (kPa)
DEGPUAA	15	36	62	225 ± 21	230 ± 21	5.27 ± 0.24	0.5 ± 0.02
DEGPUSA	15	39	60	187 ± 12	322 ± 42	1.35 ± 0.04	0.15 ± 0.01
DEGPI-AA	13	36	63	354 ± 29	198 ± 24	80.76 ± 3.41	102.7 ± 4.3
DEGPI-SA	14	40	67	312 ± 21	296 ± 22	21.4 ± 1.01	27.4 ± 1.2
PETPU-AA	14	33	52	233 ± 18	210 ± 23	18.3 ± 0.97	1.84 ± 0.04
PETPU-SA	14	34	60	198 ± 16	309 ± 31	7.39 ± 0.26	0.73 ±0.03
PETPI-AA	15	38	61	376 ± 31	196 ± 25	158.86 ± 6.41	189.8 ± 8.34
PETPI-SA	15	36	62	348 ± 26	281 ± 32	122.7 ± 5.22	154.3 ± 7.43

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528   a. Values at 10 % strain

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Figure 1

Figure2

100μ

100μ
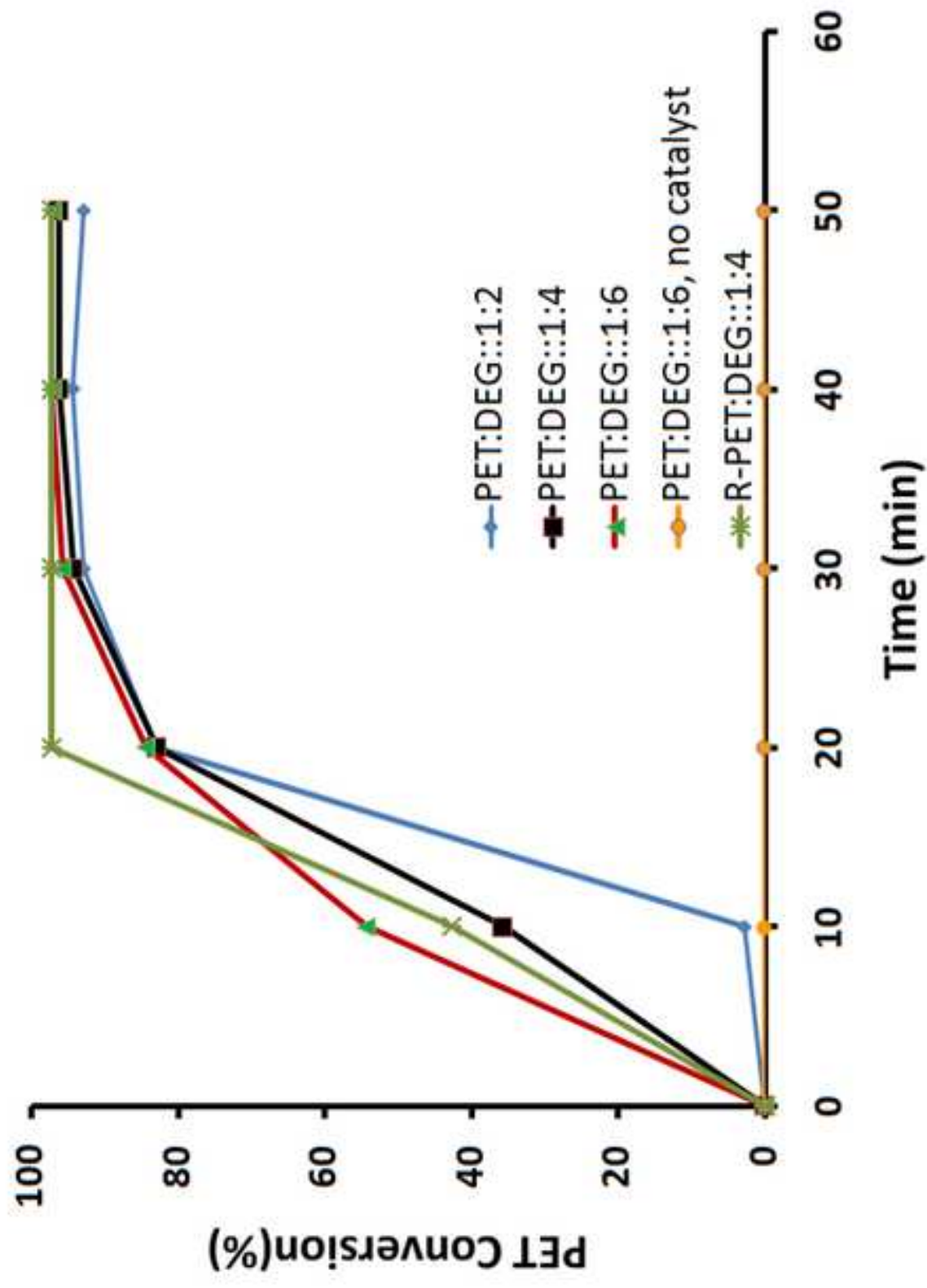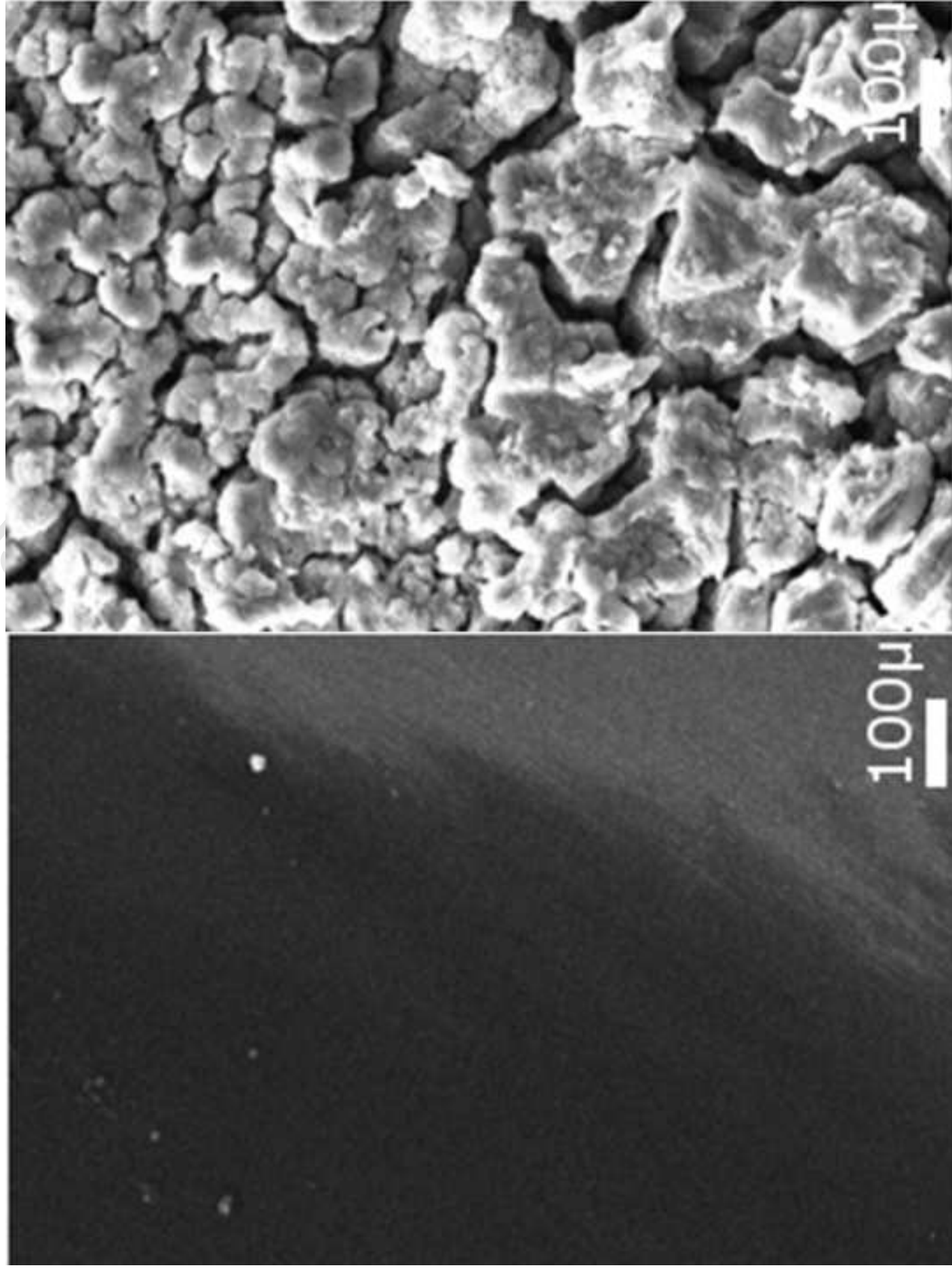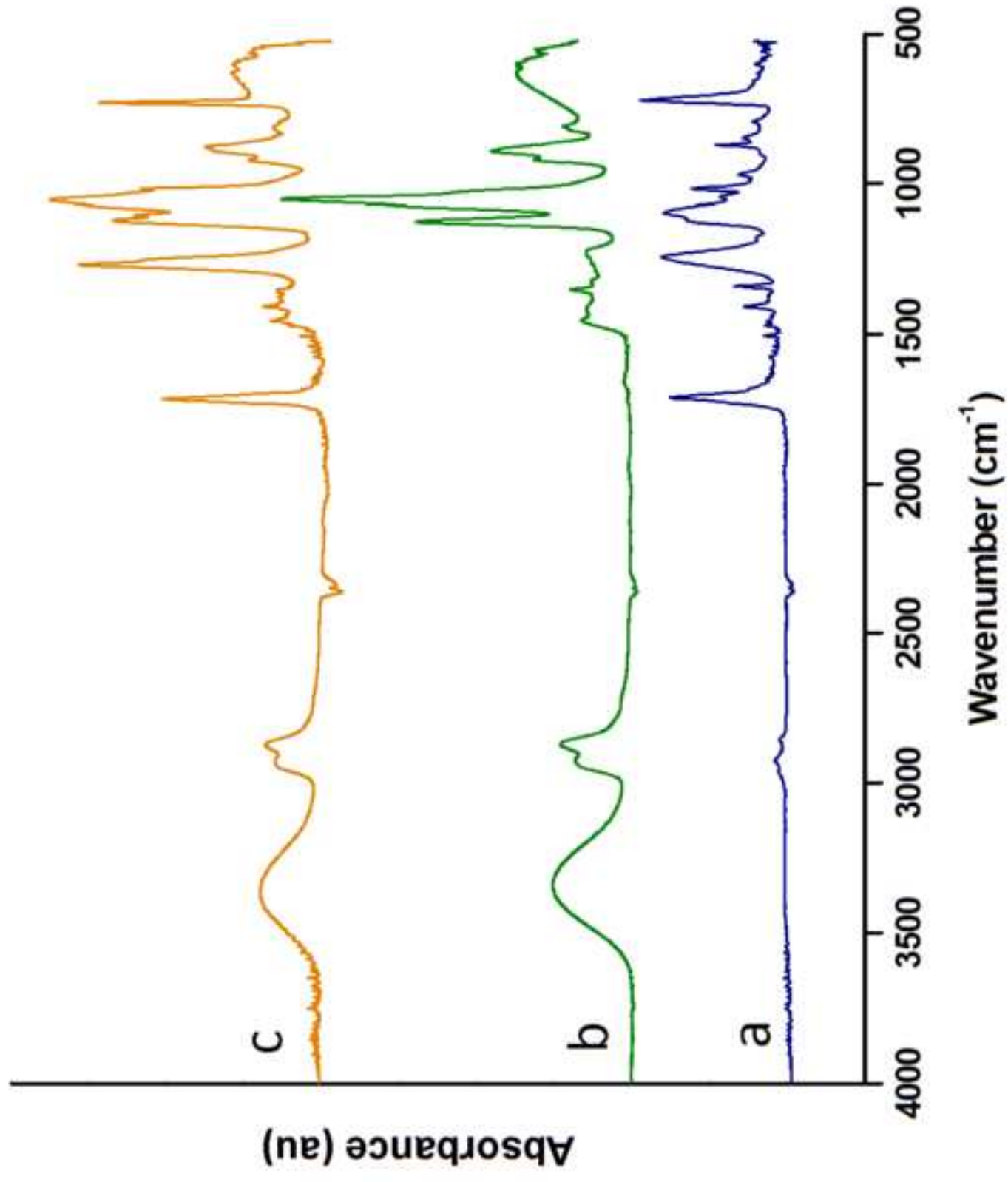
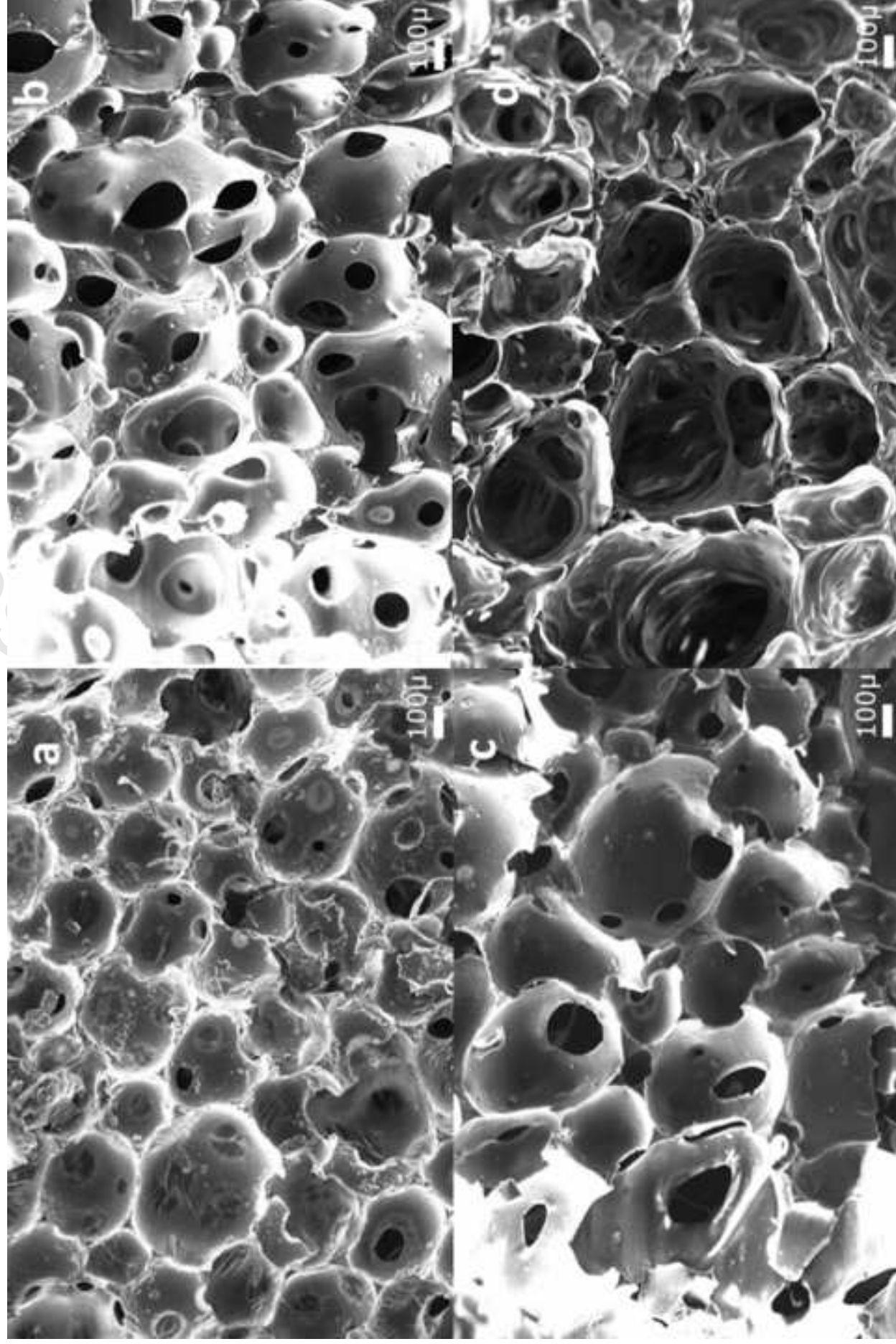**Figure3**

Figure 4
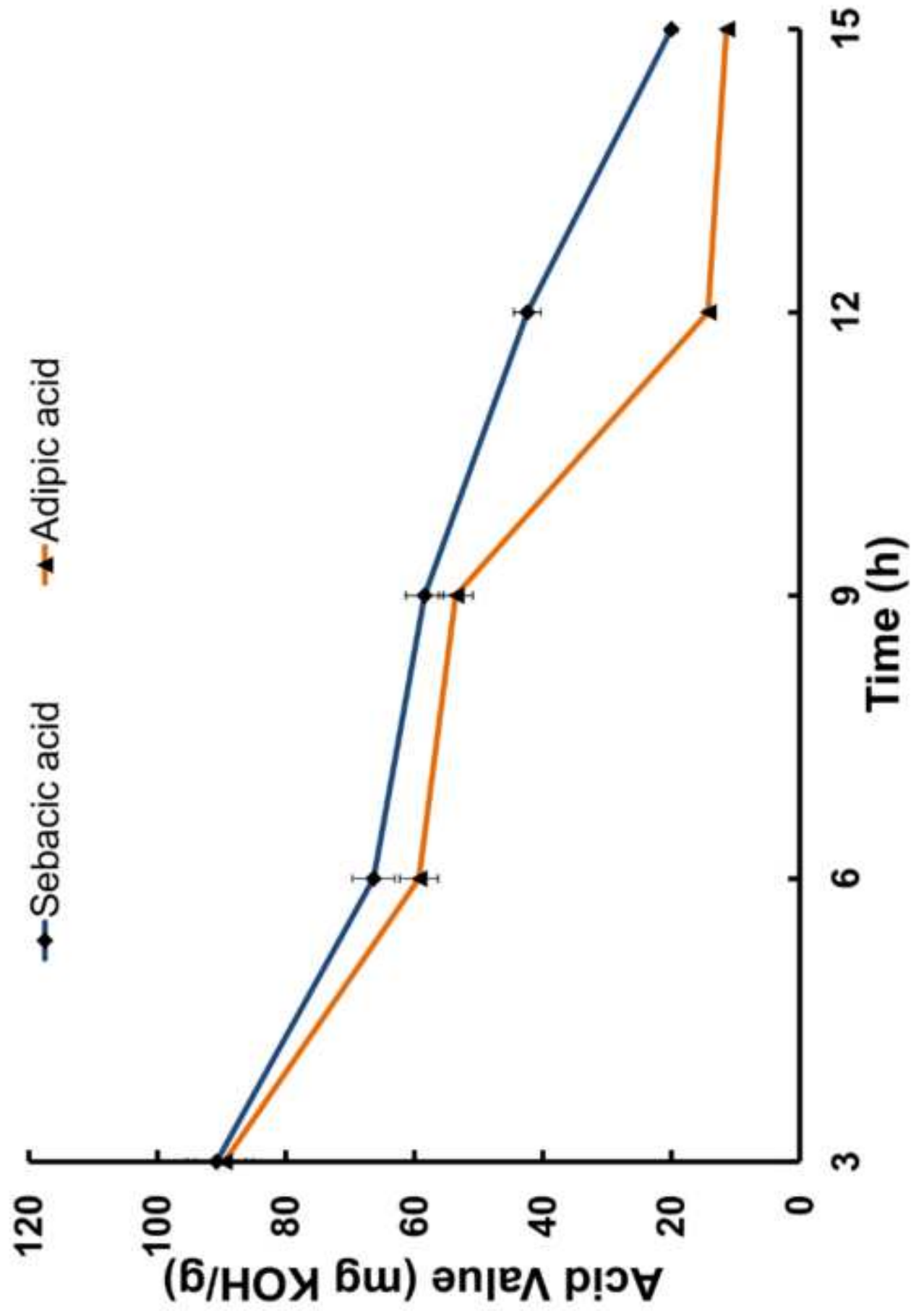
Figure 5
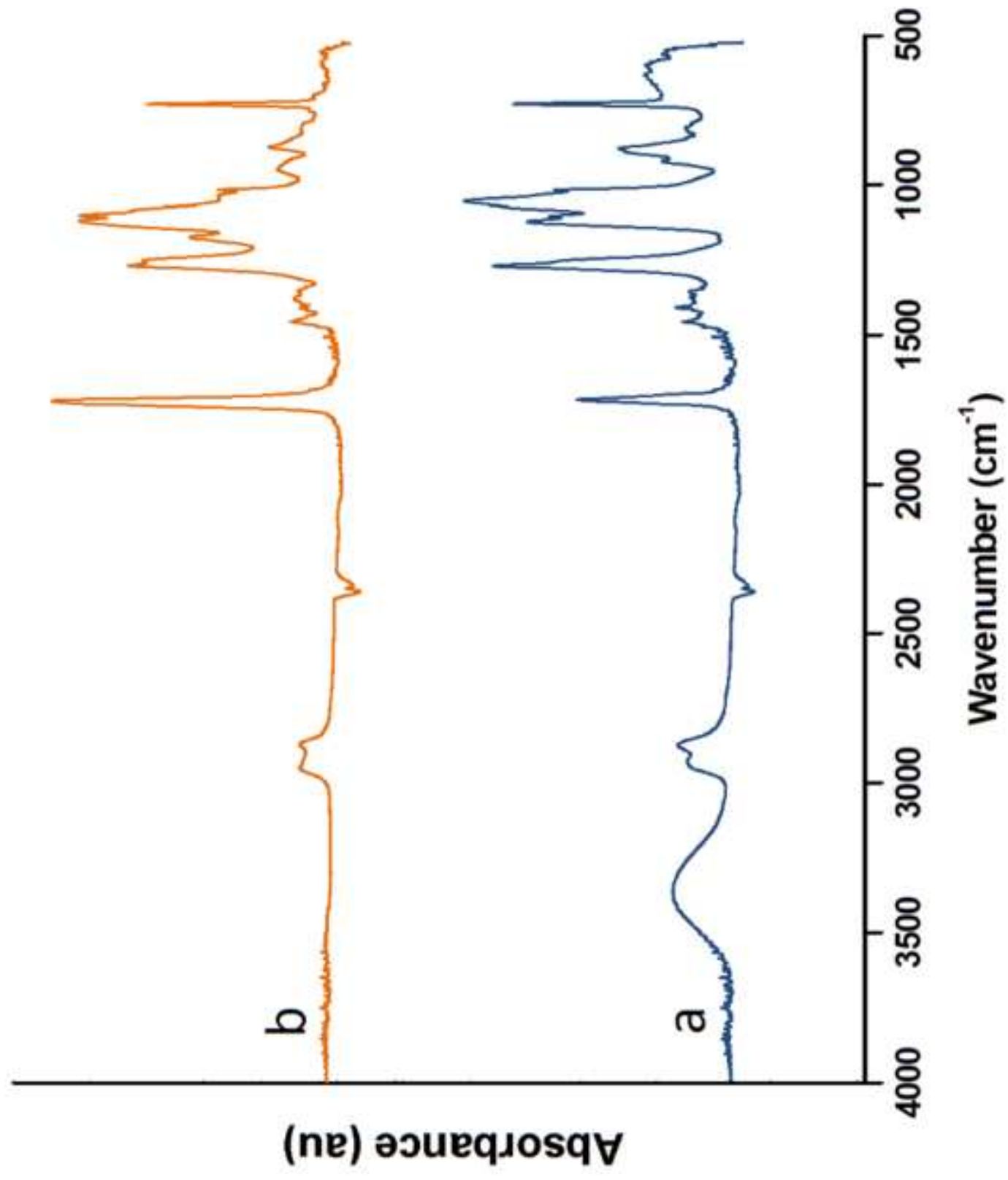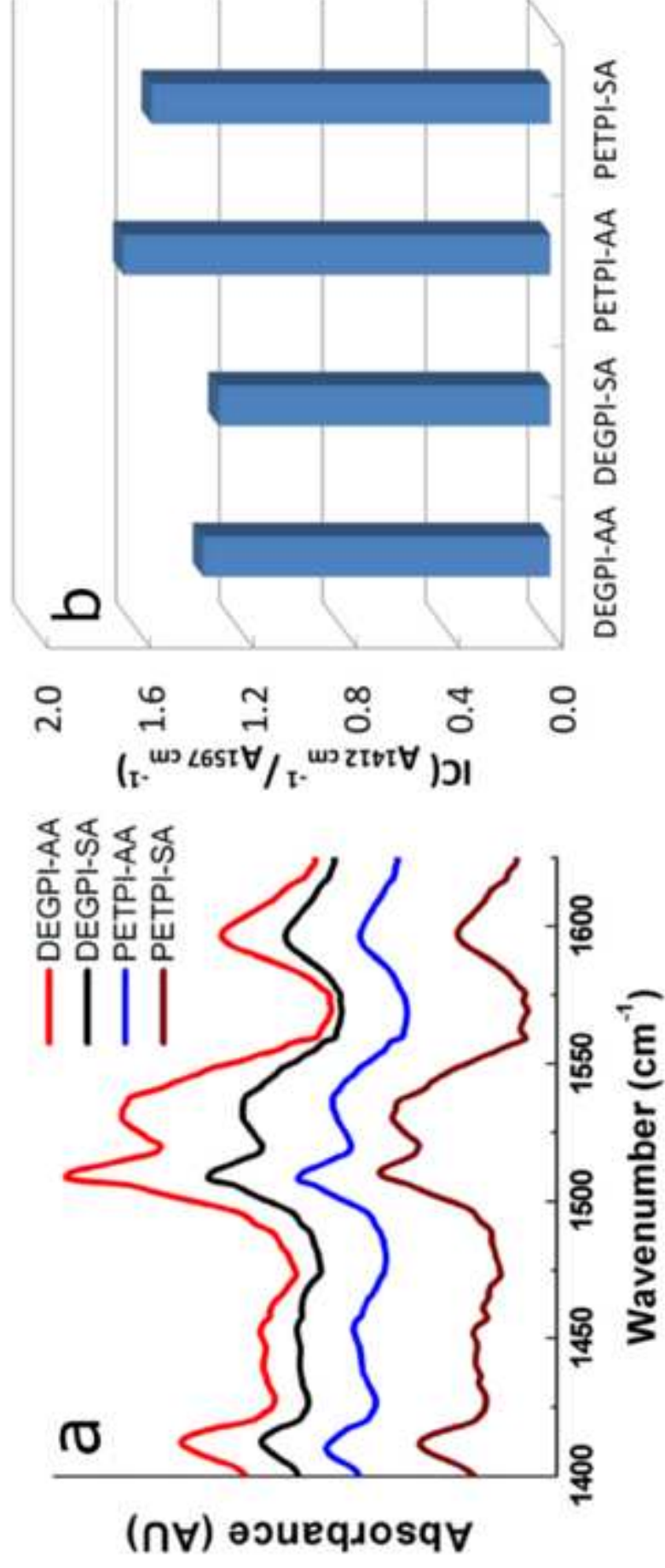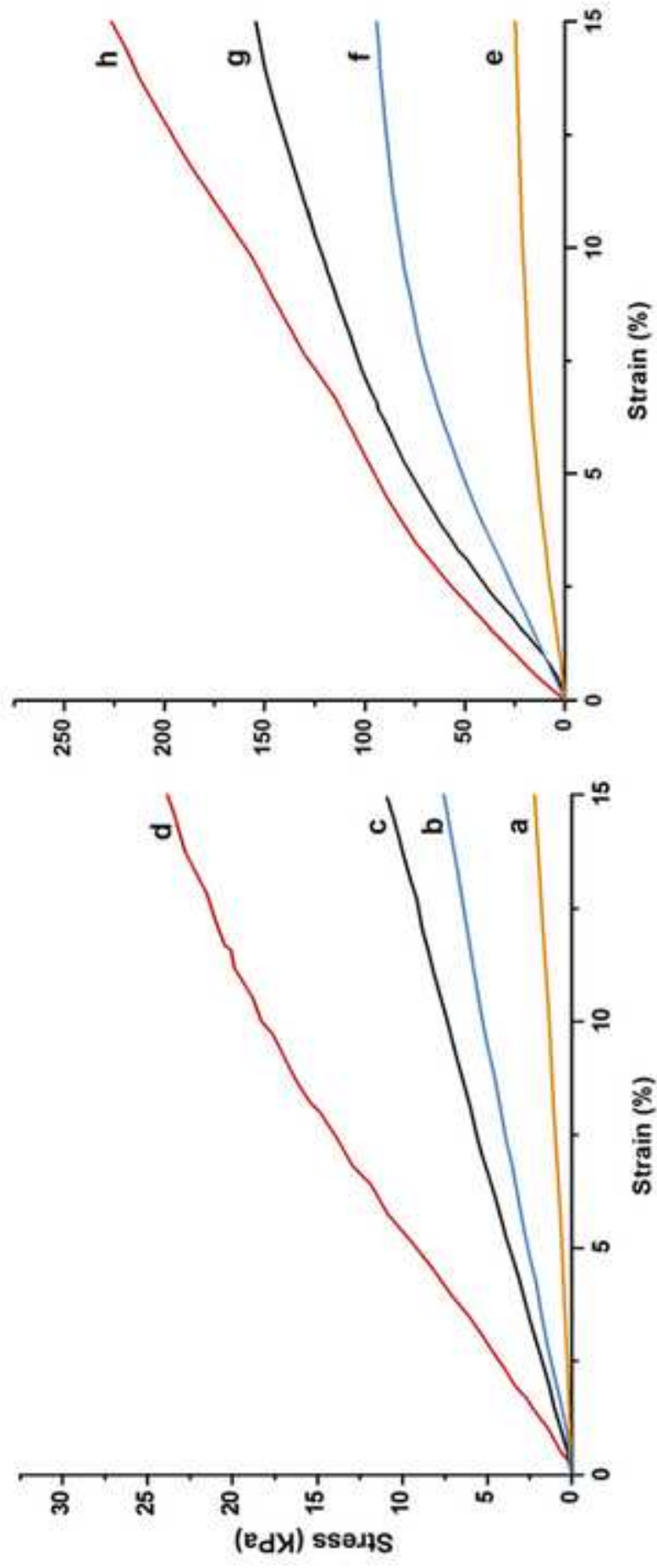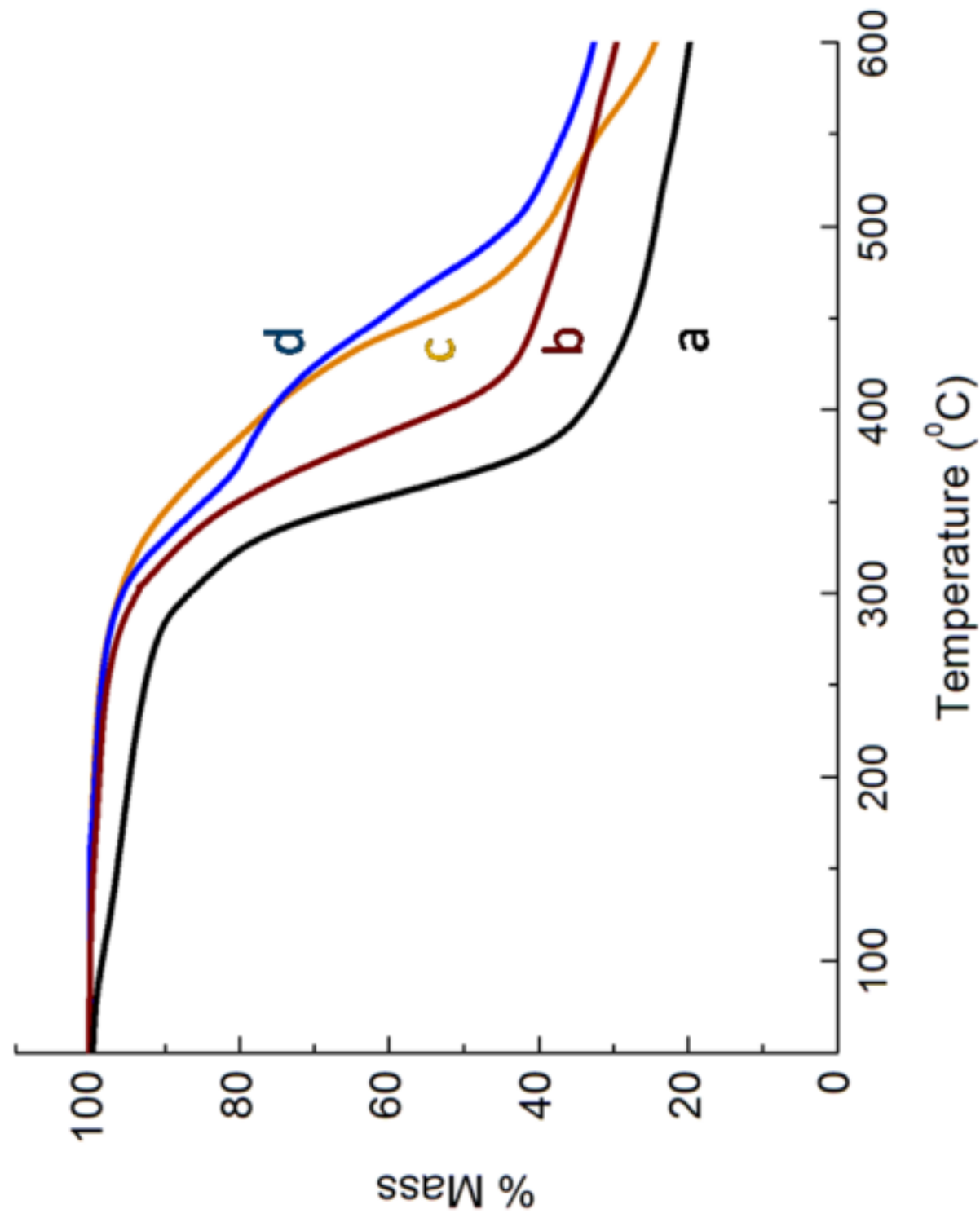
Figure6

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Figure 8

Figure9

# VANET (Vehicular Ad-Hoc Networks): Avoidance of Risk Factor in Secure Communication

Manoj Diwakar, Dhirender Kumar, Nitin Thapliyal

Abstract: Recent advances in development of Wireless Communication in Vehicular Ad-hoc Network (VANET) has provided emerging platform for industrialists and researchers. Vehicular ad-hoc networks are multi-hop networks with no fixed infrastructure. It comprises of moving vehicles communicating with each other. One of the main challenges in VANET is to route the data efficiently from source to destination. Also because of wireless medium it is vulnerable to several attacks. Since attacks mislead the network operations, security is mandatory for successful deployment of such technology. This paper has two parts: first part, introduce an approach to provide secured message transaction in VANET and second part covers the risk management at the time of message transaction in VANET.

Keywords: **VANET, Public-Key, Digital Signature**

I. INTRODUCTION

The vehicular ad-hoc networks [VANET] is very popular among the networks due to their interesting and promising functionalities like vehicular safety, traffic congestion avoidance, and location based services as shown in figure 1. The main object of the architecture for VANET is Safety driving, Traffic congestion avoidance and Location based services, the vehicle generates a warning message and distributed in to all vehicles in a certain geographical region, potentially using wireless multi-hop communication. The delay control for VANET and data aggregate is an efficient technique for minimizing the redundant data and improve communication efficiency by using adaptive forwarding delay control scheme known as the catch-up scheme [2]. The safe driving and infotainment services on the move can be develop by the usage of hash chaining concept of cryptography [4]. Security and Reliability like road travel collision, traffic congestion, and fuel consumption are overcome by destination making systems which are created by physics, vehicle dynamic and historical data collected from GPS system [5]. Cooperative approach to get self-management to enhanced the privacy and integrity, detecting the nodes and distributing the network operation [6]. For the development of security and privacy the public key infrastructure protocol are used which defines the security requirements and detailed definitions the security requirements and detailed definition of the scheme for the security and privacy by using shared asymmetric keys [7]. In order to decrease the delay in geodynamic group based authentication the symmetric key based cryptography is introduced as group communication by creating groups and maintaining then geodynamic ally by group leader [8].
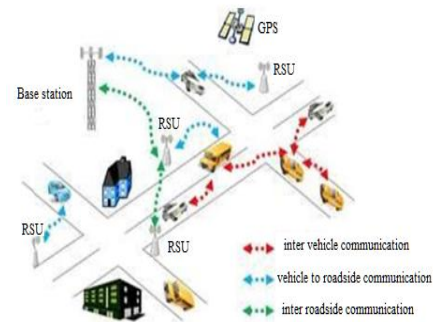
Fig 1: Vehicular Ad-Hoc Network (VANET)

Effective vehicular communication can be done by message authentication scheme which enhance cooperation, privacy, and vehicular communication, a separate edited message authentication scheme is introduce [10]. In the safety driving application, vehicles broadcast safety messages every 300ms [14].The authors propose a promising protocol which let vehicles have to verify message cooperatively by verification of digital signature. However, in order to guarantee efficient cooperation, vehicles have to verify at least twenty –five messages within 300ms which is still a heavy computation burden for the on-board unit (OBU) installed on a vehicle.

II. PUBLIC-KEY CRYPTOGRAPHY APPROACH

Authentication; - Authentication Protocols are used to convince parties of each other's identity and to exchange session keys. They may be one-way or mutual. Central to the problem of authenticated key exchange are two issues: confidentiality and timeliness. To prevent masquerade and to prevent compromise of session keys, essential identification and session key information must be communicated in encrypted form. This requires the prior existence of secret or public keys that can be used for this purpose. The second issue, timeliness, is important because of the threat of message replays.

Digital Signature Standard

A digital signature may be formed by encrypting the entire message with the sender's private key, or by encrypting a hash code of the message with the sender's private key. Confidentiality can be provided by further encrypting the entire message plus signature using either public or private key schemes. It is important to perform the signature function first and then an outer confidentiality function, since in case of dispute, some third party must view the message and its signature. But these approaches are dependent on the security of the sender's private-key.

Will have problems if it is lost or stolen and signatures forged. Need time-stamps and timely key revocation.

Digital Signature Schemes

- public key signature schemes
- the private-key signs (creates) signatures, and the public-key verifies signatures
- only the owner (of the private-key) can create the digital signature, hence it can be used to verify who created a message
- anyone knowing the public key can verify the signature (provided they are confident of the identity of the owner of the public key - the key distribution problem)
- usually don't sign the whole message (doubling the size of information exchanged), but just a **hash** of the message
- digital signatures can provide non-repudiation of message origin, since an asymmetric algorithm is used in their creation, provided suitable timestamps and redundancies are incorporated in the signature
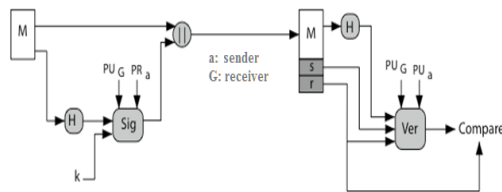

Fig 2: Dss Approach

To create a signature, a user calculates two quantities, r and s, that are functions of the public key components (p, q, g), the user's private key (PR) and public key (PU), the hash code of the message H, and an additional integer k that should be generated randomly or pseudo-randomly and be unique for each signing as shown in figure 2. The signature (r, s) is then sent with the message to the recipient. Note that computing r only involves calculation mod p and does not depend on message hence can be done in advance. Similarly with randomly choosing k's and computing their inverses, a digital signature can be created. At the receiving end, verification is performed using the formulas shown. The receiver generates a quantity v that is a function of the public key components, the sender's public key, and the hash of the incoming message. If this quantity matches the r component of the signature, then the signature is validated. Note that the difficulty of computing discrete logs is why it is infeasible for an opponent to recover k from r, or x from s. Note also that nearly all the calculations are mod q, and hence are much faster save for the last step. The structure of this function is such that the receiver can recover using the incoming message and signature, the public key of the user, and the global public key.

III. PROPOSED ARCHITECTURE

A. PROPOSED FRAMEWORK

The proposed framework uses the algorithm for secure communication of messages, the algorithm are hash and Digital Signature as shown in figure 3. The hash key technique is used because the framework does not need a specific range. Why because the key length is fixed and larger which is defined in the RSU. The nodes are ordinary vehicles on the road that can communicate with each other and RSU's though radio. In a highway scenario RSU are normally away from each other.
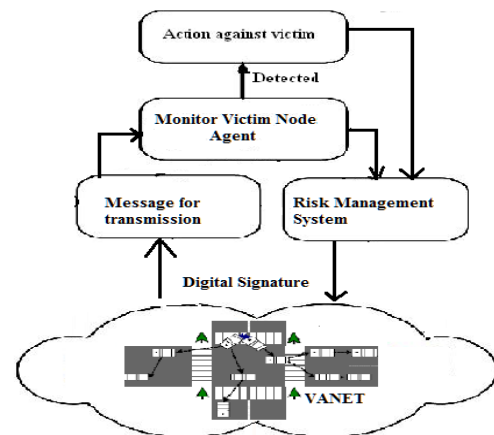

Fig 3: Proposed Framework

A message can be transmitted over VANET but user must ensure that message is authenticate. For authentication, Digital signature concept can be included. For that user's public key and private key should be used and a time-stamp value should be generated for a particular session. As session is finished, user's public key and private key should be destroyed. And acknowledgement should be send to sender as message failed. For a successful transmission, first a message should be appended with digital signature and also encrypted in the same framework. After that it should be verified by session value for secure transmission.

B. RISK MANAGEMENT MODEL

Figure 4 shows the model of risk management. The risk-based approach to security control selection and specification considers effectiveness, efficiency, and constraints due to applicable Executive Orders, directives, policies, regulations, standards, or guidelines [1].

- Implement the security controls
- Describe how the controls are employed within the information system and its environment of operation.
- Assess the security controls using appropriate assessment procedures to determine the extent to which the controls are implemented correctly, operating as intended, and producing the desired outcome with respect to meeting the security requirements for the system.
- Authorize information system operation based on a determination of the risk to organizational operations and assets, individuals, other organizations.

• Monitor the security controls in the information system on an ongoing basis including assessing control effectiveness, documenting changes to the system or its environment of operation, and reporting the security state of the system to designated organizational officials.
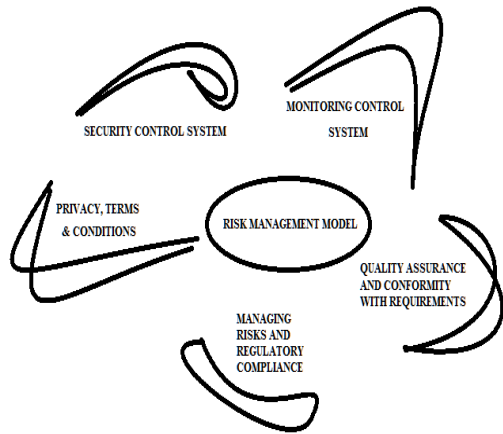

Fig 4: Risk Management Model

IV. SECURITY CONTROL SYSTEM

The following steps are used for security controls:

• Common control-related considerations
• Technology-related considerations
• Public access-related considerations
• operational/environmental-related considerations

Security controls designated by the organization as common controls are, in most cases, managed by an organizational entity other than the information system owner. Organizational decisions on which security controls are viewed as common controls may greatly affect the responsibilities of individual information system owners with regard to the implementation of controls in a particular baseline. Security controls that refer to specific technologies (e.g., wireless, cryptography, public key infrastructure) are applicable only if those technologies are employed or are required to be employed within the information system [15] [16]. Security controls that can be supported by automated mechanisms do not require the development of such mechanisms if the mechanisms do not already exist or are not readily available in commercial or government off-the-shelf products. Security controls that are based on specific assumptions about the operational environment are applicable only if the information system is employed in the assumed environment. For example, certain physical security controls may not be applicable to space-based information systems, and temperature and humidity controls may not be applicable to remote sensors that exist outside of the indoor facilities that contain information systems. When public access to organizational information systems is allowed, security controls are applied with discretion since some security controls from the specified control baselines (e.g., identification and authentication, personnel security controls) may not be applicable to public access.

V. MONITORING CONTROL SYSTEM

In particular, the organization revisits on a regular basis, the risk management activities described in the Risk Management Framework. In addition to the ongoing activities associated with the implementation of the Risk Management Framework, there are certain events which can trigger the immediate need to assess the security state of the information system and if required, modify or update the current security controls.

• Reconfirm the security category and impact level of the information system.
• Assess the current security state of the information system and the risk to organizational operations and assets, individuals, other organizations, and the Nation.
• Plan for and initiate any necessary corrective actions.
• Consider reauthorizing the information system.

The security plan for the information system is updated to reflect any initial changes to the original plan. A plan of action and milestones is developed for any noted weaknesses or deficiencies that are not immediately corrected and for the implementation of any security control upgrades or additional controls. The authorizing official may choose to conduct a limited reauthorization focusing *only* on the affected components of the information system and the associated security controls and/or control enhancements which have been changed during the update. Authorizing officials have sufficient information available from security control assessments to initiate, with an appropriate degree of confidence, necessary corrective actions.

VI. PRIVACY, TERMS & CONDITIONS

The increasing availability of bandwidth allows new combinations and opens new IT perspectives. Our team of world renowned lawyers specialized in Data Protection, Privacy, information technology law and outsourcing agreements develops pragmatic contractual templates that protect the business relationship. Additionally, we help government agencies and companies in data protection notifications for local data protection authorities regarding the collection and use of personal identifiable information. We have extensive experience in dealing with such issues:

• Sensitivity of entrusted information.
• Localization of information and applicable law
• User access rights to information
• Cross border and third party data transfers
• Externalization of privacy
• Workable contractual rules with privacy implications

VII. MANAGING RISKS AND REGULATORY COMPLIANCE

Risk management framework is one of security assessment tool to reduction of threats and vulnerabilities and mitigates security risks. The risk management industry spans all other industries. A quick internet search shows

risk management associated with insurance, banking, financial services, IT, mining, environmental management, human resources, medicine, travel, forestry, asset management, energy, construction, sports, pharmaceuticals; basically risk management spans all of society. Despite this wide-spread referencing, the most common association is between risk and insurance and/or financial services. Issues like:

- Risks are effectively identified and evaluated.
- Risk management processes are both effective and efficient.
- Key risks are appropriately reviewed and reliably reported to those who need to know
- While increasing attention is being paid to improving effectiveness, many companies are looking both to improve efficiencies and reduce the costs of effective governance, risk, and compliance activities.

VIII. QUALITY ASSURANCE AND CONFORMITY WITH REQUIREMENTS

By providing approach Quality management systems, quality assurance and verification of conformity we tackle these challenges:

- Determining the needs and expectations of customers and interested parties.
- Establishing the quality policy and quality objectives of the organization.
- Determining the processes and responsibilities necessary to attain the quality objectives.
- Determining and providing the resources
- Establishing methods to measure the effectiveness and efficiency of each process.
- Applying these measures to determine the effectiveness and efficiency of each process.
- Determining means of preventing nonconformities and eliminating their causes.
- Establishing and applying a process for continual improvement of the quality management system

IX. CONCLUSION

This paper has addressed, cooperative message authentication, where the participating keys are given priority. In this method, the message is allowed to authenticate by using Risk management system. RSA and digital signature algorithm is used for message authentication. Risk Management system also create a trust between node to node by using reauthorizing the information system, public access-related considerations, system component allocation-related considerations and Defined Security Control Parameters. Secure message transaction and Risk management system provide safety and security in VANET.

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Waste Energy Management and Recovery: A Novel Solution to Energy Conservation and Sustainable Development

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Abstract

In this paper, we present two major energy recovery systems viz. Exhaust Air Recovery and Waste Heat Recovery. By practically deploying these systems, we show how these systems help in conversion of waste energy into useful energy. These systems, even if implemented at small scale will not only save a lot of energy but also reduce carbon dioxide emission and hence preserve the environment.

Keywords: Exhaust air recovery, waste heat recovery, energy conservation

1. Introduction

Energy is one of the major inputs for economic development of any country. Of all, the energy sector assumes a critical importance in view of the ever increasing energy needs requiring huge investments to meet them. Some of the strategies that can be used to meet future challenges to energy security include: building stockpiles, diversification of energy supply sources, increased capacity of fuel switching, development of renewable energy resources and sustainable development.

However, of all these options, the simplest and the most attainable is reducing demand through persistent energy conservation efforts and recycling the waste energy, that is, converting one form of energy into other useful form. In this paper, we discuss two energy conversion processes which are very easy to implement in any house, industry, hospital or restaurant.

- Use of exhaust air to generate electricity (**exhaust air recovery**)
- Use of low grade heat for warming water/ producing steam (**waste heat recovery**)

2. Exhaust Air Recovery

We know that wind is not a common phenomenon everywhere. For a successful running of a windmill, a steady wind speed of about 20 km per hour is needed. But we can use exhaust air from one or more ventilation systems of a bounded area such as a mine, a tunnel or some other area requiring ventilation. Their system utilizes existing wind-powered electric generating equipment in front of the exhaust fan of the ventilation systems. Even air from low volume air conditioning exhausts can be utilized for generating electricity.

We use an existing wind powered generator and a means of mounting the generator in proximity to the exhaust outlet. The shroud directs the air conditioner fan exhaust flow to a wind turbine, having two or more blades positioned in the air flow, so when the air flow passes over the blades, the shaft of the turbine is spun and electricity is generated thereby. The shroud also serves to protect anyone around or near the turbine from injury by the blades spinning in the exhaust fan airflow.

2.1 Deployment and Results

For deployment of the design, we install a fan made of cast steel in front of exhaust plant as shown in Figure 1. The fan is connected to a dynamo of 230V, 6kVA rating through a small pulley on the same shaft. The output of dynamo is connected to load as required. Area of the window used for expelling exhaust air is 1.61 x 1.99 m^2. By controlling the rate of flow of exhaust air, we record the data shown in Table I.

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Figure 1. Fan installed in front of the exhaust window. A dynamo can also be seen.

TABLE I

VOLTAGE PRODUCED DURING THE DEPLOYMENT OF EXHAUST AIR RECOVERY SYSTEM

Sr. No.	Velocity of exhaust air (m/s)	Fan rpm	Actual rpm of small pulley	Volts produced	Load that can be connected
1.	6.64	175	1220	190	CFL 2 Nos. (20 W each)
2.	6.97	200	1390	230	100W + CFL 2 Nos. (20 W Each)

2.2 Benefits

The benefit of this exhaust air recovery in the form of electricity lies in industries and hotels where exhaust air from fans and chiller plants can be used to generate electricity. It will reduce the load on power plants and hence help in the reduction of carbon dioxide emission thus improving the environment. It will also reduce the wastage of energy in the form of transmission losses which account for nearly 27 percent of the total electricity generated. As an example, say a thermal power plant generates 10 MW of electricity in a day. 10% of the electricity is lost in the power station itself leaving only 9 MW for transmission. Owing to transmission losses (about 10%), only 8.1 MW reaches the substations/feeders. The distribution losses reduce it further to about 7.3 MW. Here, we see that a net of 27% electricity generated goes as waste. But in case of electricity generated by the exhaust air recovery, the losses will be considerably reduced because the point of generation is nearly the same as point of consumption (Figure 2).
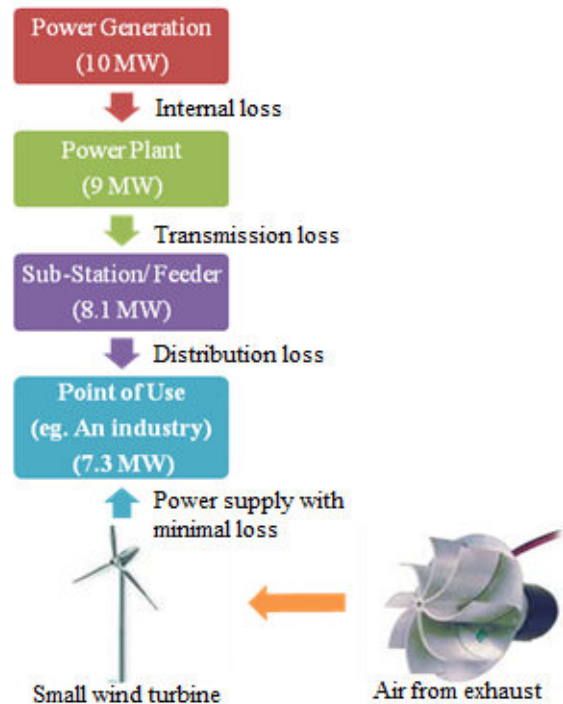
Figure 2. A schematic showing benefits of using power from exhaust air recovery

3. Waste Heat Recovery

Waste heat is heat, which is generated in a process by way of fuel combustion or chemical reaction, and then dumped into the environment even though it could still be reused for some useful and economic purpose. The essential quality of heat is not the amount but rather its value. The strategy to recover this heat depends in part on the temperature of the waste heat gases and the economics involved.

Large quantity of hot flue gases is generated from boilers, kilns, ovens, furnaces and air conditioning systems. If some of this waste heat could be recovered, a consumable amount of primary fuel could be saved. The energy lost in the waste gases cannot be fully recovered. However, much of the heat could be recovered and loss minimized. There can be three types of heat recovery: High temperature heat recovery, Medium temperature heat recovery and Low temperature heat recovery

In this paper, we discuss the recovery of heat from air conditioning systems and chiller plants which come under the category of medium and low temperature heat recovery depending upon the size of the plant in consideration.

3.1 Waste Heat Boilers

Waste heat boiler is an ordinary water tube boiler in which the hot exhaust gases from air conditioning/ chiller plants pass over a number of parallel tubes containing water. The water is warmed/ vaporized in tubes depending upon the temperature and heat capacity of the exhaust gases.

Because the exhaust gases are usually in the medium/ low temperature range and in order to conserve space, a more compact boiler can be produced if the water tubes are finned in order to increase the effective heat transfer area on the gas side.

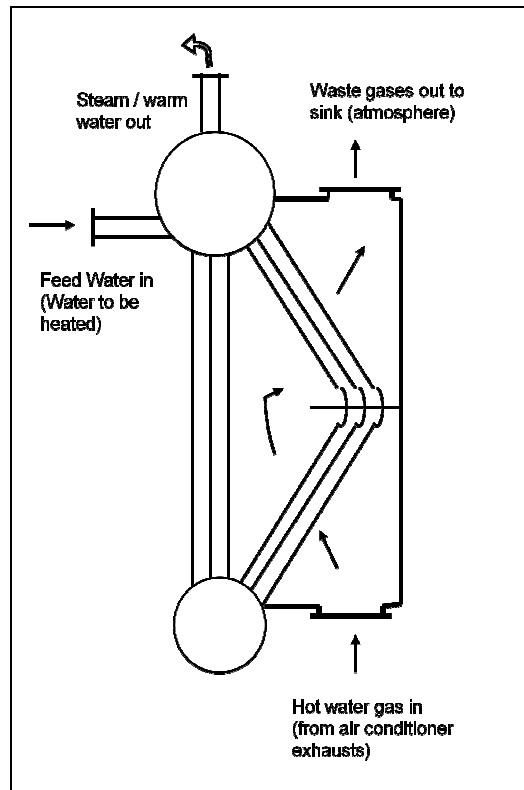The possible design for the boiler is shown in Figure 3.

Figure 3. Proposed design for the waste heat boiler

3.2 Results

In general, 1 ton of refrigeration is removing 3.88 kJ of heat in 1 second that is equivalent to 3.88 kW of power. Thus if 1 ton air conditioner runs for an hour, it consumes 3.88 kWh of energy and it is equivalent to 1.4×10^{7} Joules of energy. Practically, considering efficiency to be only 20-25%, this is a huge amount of energy which can be used for boiling water and other heating purposes. If not harnessed, this heat energy goes waste as loss to the ambient i.e. air.

3.3 Benefits

The major benefit with these types of boilers could be in houses, hospitals, hotels and industries where big air conditioning systems are installed and they reject a large amount of waste heat to the sink (atmosphere) continuously. These are the places where warm water/steam is also required round the clock for many of the operations. This system, if installed with each air conditioning system could help save a lot of energy in terms of power used and indirectly reduce the pressure on power plants. This will improve the quality of environment as the amount of carbon dioxide released into the atmosphere will decrease greatly. Apart from these benefits, some of the indirect benefits of waste heat recovery include:

Reduction in pollution: A number of toxic combustible wastes such as carbon monoxide gas, sour gas, carbon black off gases, oil sludge, acrylonitrlie and other plastic chemicals etc releasing to atmosphere if when burnt in the incinerators serves dual purpose i.e. recovers heat and reduces the environmental pollution levels.

Reduction in equipment sizes: Waste heat recovery reduces the fuel consumption, which leads to reduction in the flue gases produced. This results in reduction in equipment sizes of all flue gas handling equipments such as fans, stacks, ducts etc.

Reduction in auxiliary energy consumption: Reduction in equipment sizes gives additional benefits in the form of reduction in auxiliary energy consumption like electricity for fans, pumps etc.

4. Conclusion

In this paper, we have presented the techniques employed to recover waste energy and convert it into useful form. It is not that these technologies are not in use at present. We all are aware of the wind mills and heat pumps or compressors. But the main emphasis should be on using these technologies in a more beneficial way so that we

get commercial benefits as well as preserve our environment. One of the key problems being faced in installing these systems is of high initial cost and unavailability of equipments. The problems can be addressed by popularizing these concepts. This will surely help in initial cost reduction.

Another important issue which needs to be addressed is of environment. The global warming is increasing day by day due to increase in emission of carbon dioxide into the atmosphere. By following energy recycling and recovery, we can greatly reduce the carbon dioxide emission and add to the quality of environment. In this paper, we have emphasized that be it on small scale, waste energy recycling is a must if we have sustainable development in the future.

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