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ABSTRACT

Economic, environmental and legislative problems limit the scope of electric utilities in regards to construction of generation facilities and new transmission lines. In this respect, power electronics based FACTS technology was initiated by the EPRI in the late 1980s which aimed to enhance power transmission capabilities of existing transmission corridors. The FACTS Controllers achieve this objective by controlling the power system parameters like series impedance, shunt admittance, current, voltage and phase angles. A variety of FACTS Controllers have been envisaged, designed and installed in transmission utilities worldwide.

The emergence of FACTS Controllers has followed two different technical approaches to develop two different groups of controllers – thyristor based and self-commutated converter based. The former include the Static VAr Compensator (SVC), the thyristor controlled series capacitor (TCSC) and phase shifter. STATCOM, SSSC and UPFC comprise the later.

Among the thyristor based FACTS Controllers, the thyristor controlled series capacitor (TCSC) is one which is predominantly used for power flow control. It is a series FACTS device which can be used for rapid and continuous control of the effective series impedance of a line. Since the active power flow in a line is inversely proportional to its reactance, the TCSC can be used to control the active power flow in the line to any specified value, within operating limits.

For power system planning, design, operation and control, power flow solution of the network installing TCSC is an essential requirement. This necessitates a TCSC power flow model.

The earliest algorithms for power flow were based on the Gauss-Siedel iterative scheme. However, Gauss-Siedel method was found to be system dependent. For large system size, it sometimes failed to converge. Later, the Newton-Raphson algorithm came into being. It possessed quadratic convergence characteristics. Subsequently, the Newton-Raphson algorithm emerged as the de-facto standard for power flow in industry.

In light of this, a Newton-Raphson model of the TCSC has been an essential requirement for power flow solutions of networks installing TCSCs. In this work, two separate Newton power flow models of the TCSC have been developed. The first one is a susceptance model, which

subsequently employs a separate Newton Raphson loop for solving the TCSC firing angle. The second one is a more comprehensive Newton-Raphson model, which treats the firing angle itself as one of the state variables along with the bus voltages and angles.

Both the proposed models demonstrate very good convergence characteristics when tested on a small six bus system and the IEEE 30 bus test system.

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