POWER PROFILES IN TRANSMISSION SYSTEM USING TCSC

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Abstract: During the last few years, power system networks, especially the transmission sections have been operated under highly stressed conditions. Environmental pressures on transmission expansion, increased electricity consumption in heavy load areas new system loading patterns due to the opening up of the electricity market, etc. are the factors responsible for stressed operating conditions of power systems. It seems as though the development brought about by the increased use of electricity is raising new barriers to power system expansion. A number of voltage instability incidents have been experienced across the world. As a consequence, voltage stability has become a major concern in power system planning and operation. FACTS Controllers are used to enhance controllability and increase power transfer capability. Among the FACTS devices, the TCSC controller has given the best results in terms of performance and flexibility.
Keywords: Reactive power control, TCSC, FACTS Controllers, power stability

I. INTRODUCTION

During the last three decades, power system networks, especially the transmission sections have been operated under highly stressed conditions. Environmental pressures on transmission expansion, increased electricity consumption in heavy load areas (where it is not feasible or economical to install new generating plants), new system loading patterns due to the opening up of the electricity market, etc. are the factors responsible for stressed operating conditions of power systems. It seems as though the development brought about by the increased use of electricity is raising new barriers to power system expansion. Under these stressed conditions a power system can exhibit a new type of unstable behavior characterized by slow (or sudden) voltage drops, sometimes escalating to the form of a collapse. Voltage stability has become a major concern for the secure operation of many power systems. If voltage magnitude at load buses is within the acceptable limit then the voltage becomes stable else it is not in stable condition. The voltage stability is classified into four categories: large disturbance voltage stability, small disturbance voltage stability, short-term voltage stability and long-term voltage stability. Voltage instability is basically caused by an unavailability of reactive power support in an area of the network, where the voltage drops uncontrollable. Lack of reactive power may essentially have two origins: firstly, a gradual increase of power demands without the reactive part being met in some buses or secondly, a sudden change in the network topology redirecting the power flows in such a way that the required reactive power cannot be delivered to some buses. A number of factors are affecting the voltage stability of a power system[1]-[6]. They are,

- Reactive power imbalance
- Variation in load (over load)
- Changes in speed of the prime mover
- Switching heavy loads and long transmission lines
- Large changes in power angle
- Fast changes in power transfer
- Loss of synchronism and short circuit

Introducing FACTS devices is the most effective way for utilities to improve the voltage profile and voltage stability margin of the system. A Flexible Alternating Current Transmission System (FACTS) is a system comprised of static equipment used for the AC transmission of electrical energy. It is meant to enhance controllability and increase power transfer capability of the network. It is generally a power electronics based device FACTS devices are defined by the IEEE as "a power electronic based system and other static devices that provide a specific control of one or more AC transmission system parameters to enhance controllability and increase power transfer capability .FACTS could be connected:

- In series with the power system (series compensation)
- In shunt with the power system (shunt compensation)
- Both in series and in shunt with the power system

II. THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC)

For TCSC is one of the most important and best known FACTS devices, which has been in use for many years to increase line power transfer as well as to enhance system stability. The TCSC consists of three main components: capacitor bank C, bypass inductor L and bidirectional thyristors SCR1 and SCR2. The firing angles of the thyristors are controlled to adjust the TCSC reactance in accordance with a system control algorithm, normally in response to some system parameter variations.

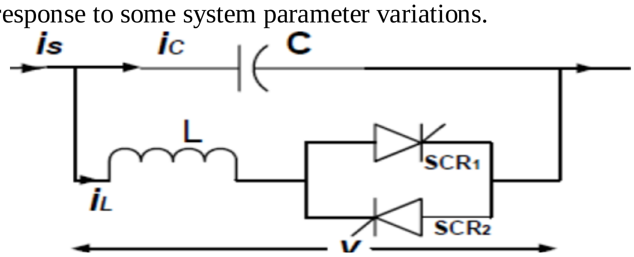

Fig.1 Basic functional diagram of TCSC

III. MODELLING OF TCSC

Series compensation objects to directly control the overall series line impedance of the transmission line. When TCSC operates in the constant impedance mode it uses current and voltage feedback for calculating the parameters like TCSC impedance. The reference impedance indirectly determines the power level, although an automatic power control mode could also be introduced. The TCSC can operate in capacitive or inductive mode. The capacitive mode is achieved with firing angles 69-90deg. The impedance is lowest at 90deg, and therefore power transfer increases as the firing angle is reduced. In capacitive mode the range for impedance values is approximately 115-130 Ohm. Comparing with the stability with an uncompensated line The capacitive mode also employs a phase lead compensator. Each controller further includes an adaptive control loop to improve performance over a wide operating range. The controller gain scheduling compensates for the gain changes in the system, caused by the variations in the impedance. The firing circuit uses three single-phase PLL units for synchronization with the line current. Line current is used for synchronization, rather than line voltage, since the TCSC voltage can vary widely during the operation.

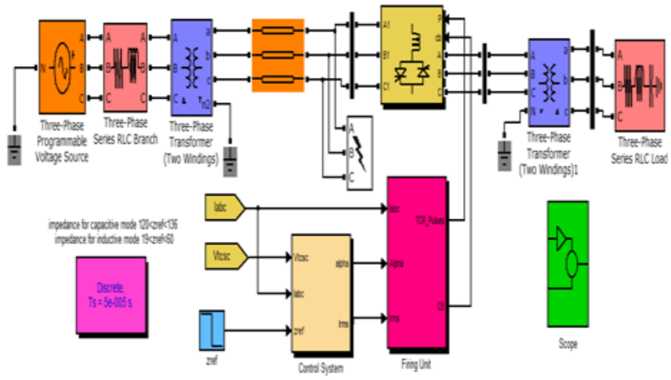

Fig. 2: Power System modeling with TCSC

IV. SIMULATION & RESULTS

As shown in figure 3, the power system is without TCSC, the active and reactive power slightly increase from 0 to 2.6 & 1.8 MW respectively. After t = 0.3 sec the power become reduce due to synchronization of complete system up to t =0.4 sec. from t = 0.4 sec the powers comes in previous state but the there is some instability and fluctuation in the power system. Similarly as shown in figure 4, the power system with TCSC, the active and reactive power slightly increase from 0 to 2.6 & 1.8 MW respectively. After t = 0.2 sec the power become reduce due to synchronization of complete system up to t =0.4 sec. from t = 0.4 sec the powers comes in previous state without any fluctuation and power system is in stable condition.

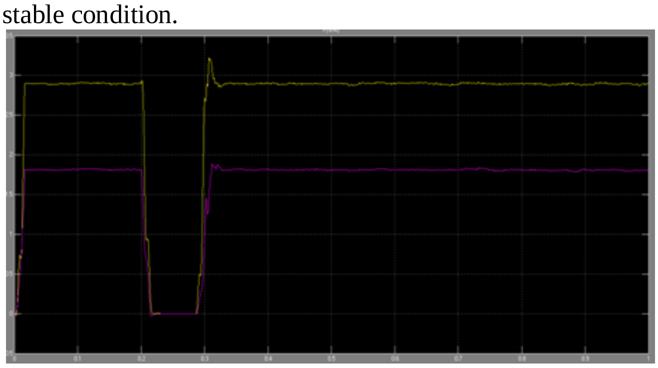

Figure3. Active and reactive power Waveform of power system without TCSC

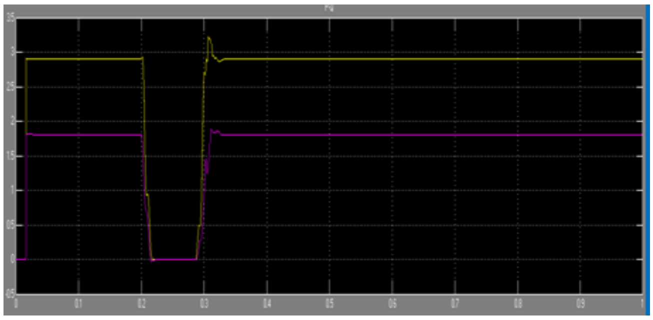

Figure 4: active and reactive power Waveform of Power System with TCSC

V. CONCLUSION

This paper provides a detailed analysis of some of the fundamental aspects of proper TCSC controller design. The proposed method is implemented using MATLAB software. TCSC controller shows the effectiveness of TCSC in controlling active and reactive power through the transmission line. The comparison of simulations of with and without TCSC in power system networks. It shows the TCSC controller enhances power profiles of transmission system that why for large interconnected systems TCSC controller is essential.

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