RESEARCH ARTICLE   OPEN ACCESS

Power System Stability Improvement of Long Transmission Line System by Using Static Var Compensator (SVC)

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ABSTRACT
Power system stability is defined as the ability of power system to preserve it's steady stability or recover the initial steady state after any deviation of the system's operation. This paper will discuss how SVC has successfully been applied to control dynamic performance of transmission system and regulate the system voltage effectively. Present time power systems are being operated nearer to their stability limits due to economic and environmental reasons. Maintaining a stable and secure operation of a powersystem is therefore a very important and challenging issue. Shunt FACTS devices play an important role in improving the transient stability, increasing transmission capacity and damping low frequency oscillations. In this paper shunt FACTS device-SVC is used in a two area power system for improving the power system stability. MATLAB software has been used in this study.
Keywords - FACTS, long transmission line, MATLAB, SVC, power system stability, three phase fault.

I. INTRODUCTION

In recent years, greater demands have been placed on the transmission network, and these demands will continue to increase because of the increasing number of non utility generators and heightened competition among utilities themselves. Due to this today's changing electric power systems create a growing need for flexibility, reliability, fast response and accuracy in the fields of electric power generation, transmission, distribution and consumption. Static Var Compensators (SVC) devices are used to improve voltage and reactive power conditions in AC systems. It also increases transmission capacity as result of power oscillation damping. The effectiveness of this controller depends on its optimal location and proper signal selection in the power system network [1]. SVC has the ability of improving stability and damping by dynamically controlling it's reactive power output. The transient stability improvement of the two area system with different loading conditions is investigated in this work. Shunt Flexible AC Transmission System (FACTS) devices, when placed at the mid-point of a long transmission line, play an important role in controlling the reactive power flow to the power network.

II. STATIC VAR COMPENSATOR

By providing dynamic reactive power, svc can be used for the purpose of regulating the system voltage, compensating the voltage at reasonable level, improving the capacity of the transmission line. From the operational point of view, the SVC adjusts its value automatically in response to changes in the operating conditions of the network [2]. By suitable control of its equivalent reactance, it is possible to regulate the voltage magnitude at the SVC point of connection, thus enhancing significantly the performance of the power system. In its simplest form, SVC consists of a TCR in parallel with a bank of capacitors [3],[4],[5]. Fig. 1 shows the schematic diagram of the most basic FC/TCR arrangement of the SVC.
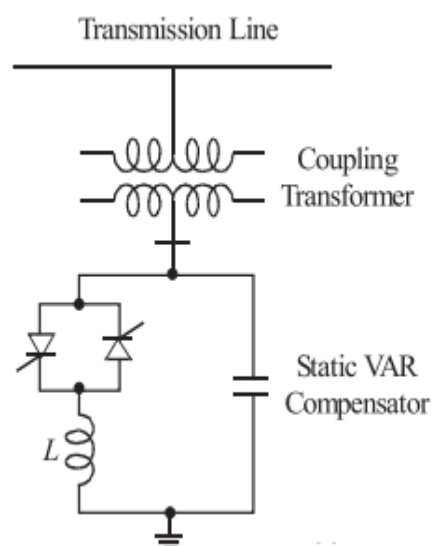

Fig 1. SVC connected to a transmission line.

III. SVC V-I CHARACTERISTICS

The SVC can be operated in two different modes:
• In voltage regulation mode

• In var control mode (the SVC susceptance is kept constant)

When the SVC is operated in voltage regulation mode, it implements the following V-I characteristic [6].
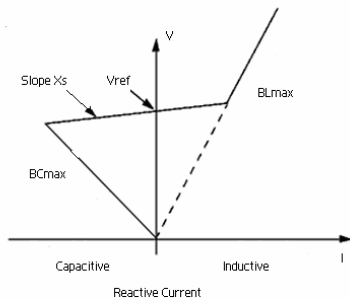

Fig 2. The V-I Characteristics Curve of SVC.

Electrical loads both generate and absorb reactive power. Since the transmitted load varies significantly from one hour to another, the reactive power equilibrium in a grid varies as well. The result can be undesirable voltage amplitude variations, a voltage depression, or even a voltage collapse.

A rapidly operating Static Var Compensator (SVC) can regularly provide the reactive power necessary to control dynamic voltage swings under different system conditions and thereby improve the power system transmission and distribution performance. Installing an SVC at one or more appropriate points in the network will enhance transfer capability through improved voltage stability, while maintaining a smooth voltage profile under different network conditions [7]. In addition, an SVC can diminish active power oscillations through voltage amplitude modulation.

IV. MODELLING OF SVC

To show the stability improvement by SVC in a two area power system, a model of two area system is designed in MATLAB as shown in Figure 3.. In this model a 1000 MW power plant-1 is connected with another 5000 MW power plant-2 through a long 500 kV, 700 km transmission line. Both the plants are supplying the power to loads connected. Here two different loads are connected at bus B1 and B3 of the system [8]. A stop block is used to stop the simulation.
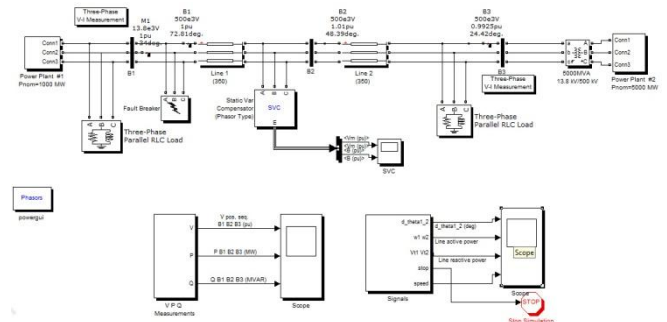

Fig 3. Simulation of Static Var Compensator in Simulink.

V. SIMULATION RESULTS

In this paper SVC regularly provides the necessary reactive power to control voltage swings and thereby improves transmission perfrormance [9]. The resultant simulation curves of the above MATLAB model are :
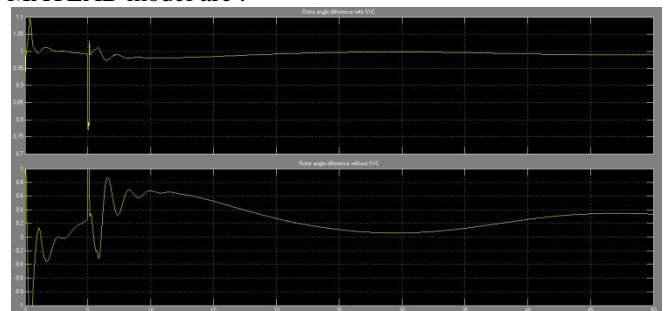

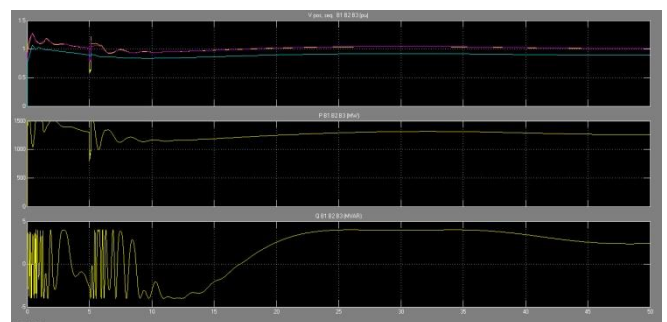Fig 4. Rotor angle difference with SVC and without SVC.

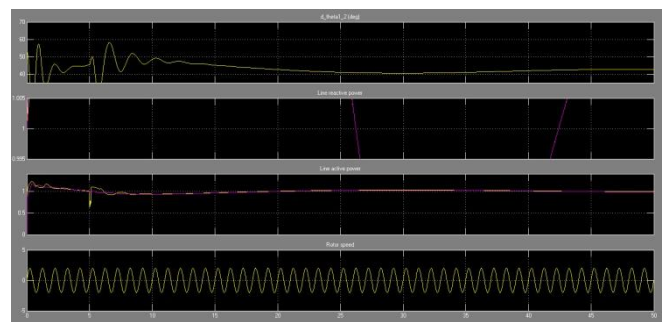Fig 5. Simulation curves of V(pu), P(MW) and Q(MVAr).

Fig 6. Simulation curves of Rotor angle difference, line active power, line reactive power and rotor speed.

VI. CONCLUSION

In this paper, the basic structure of an SVC operating under typical bus voltage control and its model are described. This paper presents the stability improvement of voltage level and real & reactive power in a power system model containing SVC [10]. In this study, the effectiveness of shunt FACTS devices such as SVC has been studied in improving the system stability of a two-area power system with different loads. The simulation results shown here show the effective working of SVC. Hence by properly modelling these controllers, it would be interesting to determine any other possible advantage of these controllers in power system stability studies.

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