Ameliorate The Compensation of Reactive Power By Using Static Synchronous Series Compensator

Mr. Bhushan R. Aloni[1], Mr. Kalpesh M. Mahajan[2]
[1]Dept of Electrical Engineering
[2]HOD, Dept of Electrical Engineering
[1, 2] KCES's COEIT, Jalgaon-425001

Abstract- *Power system stability problem is an occurrence manifested as a nonstandard voltage, current that results in disturbances produced which may lead to unwanted or unnecessary effects on the network, such as stability disturbances, voltage fluctuation etc. The FACT's devices SSSC are used to augment the power system stability, which improves active, reactive power & power oscillation damping. The advantage of this approach is that it is more economical to other conventional controllers & characteristic of SSSC is that injects or absorbs the reactance in the system & control the active and reactive power. In thesis work two machine bus systems with & without PI controllers & SSSC converter simulated in MATLAB. From the simulation results, SSSC can improve the stability of the power system.*

Keywords- Static Synchronous Series Compensator, Transient Stability, Two machine power systems, active & reactive power.

I. INTRODUCTION

Now a day's power crisis is the major problem. Sources are minimized, but electricity demands are increasing, which increasing size and complexity of transmission network. Due to this complexity power engineer would face problem like power oscillation, load flow, voltage quality etc. On top of this the need for reliable, stable and quality power is also on the rise due to electric power sensitive industries like information technology, communication, electronics etc. In this scenario, obtaining the power demand is not the only criteria but also it is the responsibility of the power system engineers to provide a stable and quality power to the consumers. These issues highlight the necessity of understanding the power system stability. In the power system, the load demand, generator outputs and various parameters change continuously. The stability of the system depends on the nature of the disturbance as well as the initial operating condition. Power system subjected to a transient disturbance; the disturbance may be small or large. The system must be able to bring back its operation to steady state condition within minimum possible time after having undergone some sort of transience or disturbance in the line. Flexible AC Transmission devices offer effective scheme to solving various power system stability problems like sending end voltage, receiving end voltage active power and reactive power, phase angle and/or impedance at particular points in power systems. It has been shown in recent studies by using FACTS devices power network becomes more flexible, reliable, improve power transfer capability & enhance the security and stability of power system.

There are three major facets of FACTS. They are shunt compensation, series compensation and phase angle regulation. Of these three the series compensation is used in this project, among all series compensators Static Synchronous Series Compensator play an important role in reactive power compensation, voltage supports because of its steady state performance & operating characteristics. The SSSC consist a synchronous voltage source, implemented by a gate turn-off thyristors based inverter is used to controllable series compensation. The SSSC can generate and insert series voltage so as to influence the power flow through the transmission line.

II. BASIC PRINCIPLE OF SSSC

With the high power forced-commutated valves such as the GTO the converter-based FACTS controllers have become true. The advantages of converter-based FACTS controllers are continuous and precise power control, cost reduction of the associated relative components and a reduction in size and weight of the overall system. An SSSC is an example of a FACTS device that has its primary function to change the characteristic impedance of the transmission line and thus change the power flow.

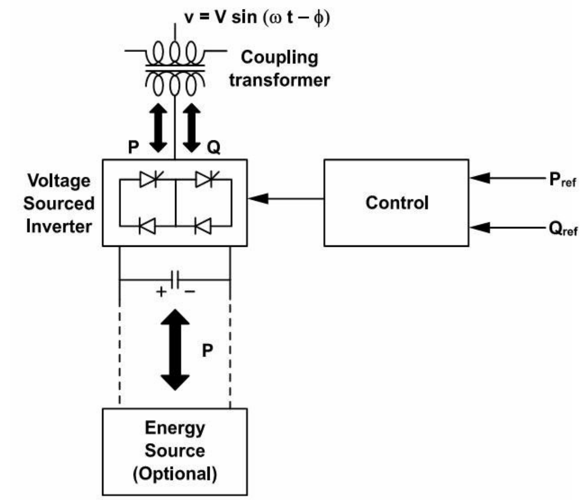

Fig. 1(a) schematic diagram of static synchronous series compensator

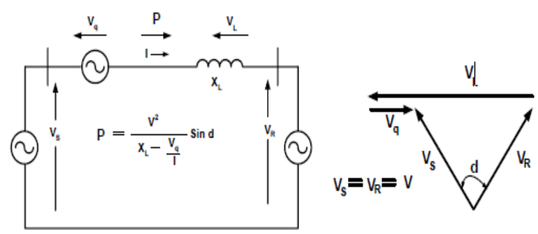

Fig. 1(b) elementary two-machine system with an SSSC and the associated phasor diagram

If the SSSC is equipped with an energy storage system, the SSSC gets an added advantage of real and reactive power compensation in the power system. By controlling the angular position of the injected voltage with respect to the line current, the real power is provided by the SSSC with energy storage element. Fig. 1.(a) Shows a schematic diagram of SSSC with energy storage system for real and reactive power exchange.

III. SYSTEM INVESTIGATED

This project investigates the static synchronous series compensator (SSSC) FACTS series controller performance in terms of power system stability improvements. It consists of a solid state voltage source converter (VSC) which generates a controllable alternating current voltage at fundamental frequency. The SSSC can generates & insert voltage by which the power flow through the transmission line [2,3]. While the primary purpose of a SSSC is to control power flow in steady state, it can also improve transient stability of a power system.

One side of the converter is connected to the AC power lines & other side is connected to energy source through voltage source converter. If dynamic changes occur in the system the control circuit of SSSC & the energy of battery will be converted to the ac form by converter and then injecting this voltage to the circuit the changes will be damped suitably.

IV. TEST SYSTEM DESIGN AND DEVELOPMENT

The test system consists of two power generating station both power station has two salient pole generators G-1 & G-2 of rating 2100 MVA & 1400 MVA respectively. In the simulation one SSSC has been utilized to control the power flow in the 500 KV transmission systems. This system which has been made in ring mode consisting of 4 buses B1, B2, B3, and B4 connected to each other through three phase transmission lines L1, L2-1, L2-2 and L3 with the length of 280, 150, 150 and 50 km respectively. The Three-Phase dynamic load modeled & connected to 500KV transmission line, whose active power P and reactive power Q absorbed by the load vary as function of the system voltage. Fig. 2 shows the single line diagram of the two machine system. Active and reactive powers injected by G-1 and G-2 to the power system are presented in per unit by using base parameters Sb = 100MVA and Vb=500KV, which active and reactive powers of power plants 1 and 2 are (24-j3.8) and (15.6-j0.5) in per unit, respectively. The simulation obtained for the test system without and with PWM Technique SSSC.

V. SIMULATION RESULTS

The two machines are equipped with a hydraulic turbine and governor (HTG), excitation system, four buses has been simulated in MATLAB & result obtained Figure 2 show the configuration of two machine system with and without SSSC. The Bus number B2 selected for testing purpose. The various parameters have been obtained from simulation with & without SSSC, when SSSC is connected to bus B2.

5.1 Bus 2 parameters without SSSC

When simulation runs, due to large load of the test system reactive power of bus-2 got oscillations at first and then will be damped properly & active power got oscillations which keep continuing for 3 seconds. Due to ohmic part of the load the oscillation amplitudes of active power is more than the reactive power and to control the damping the two power generating station governor and other stabilizer are used. After transient mode, the current drawn by is 4.7 pu & voltage magnitude is 1 pu and both much closer to sinusoidal waveform. In figure- on X-axis Time in seconds and on Y-axis Voltage and Current in per unit (pu) is taken.

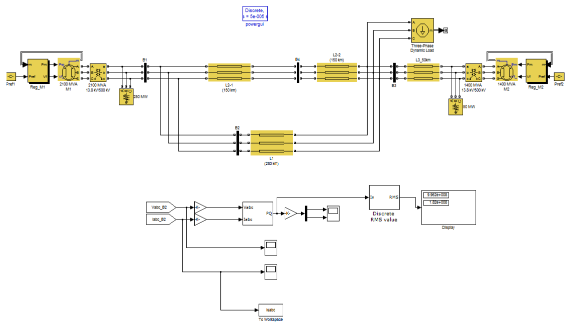

Fig. 2. The configuration of two machine system without SSSC

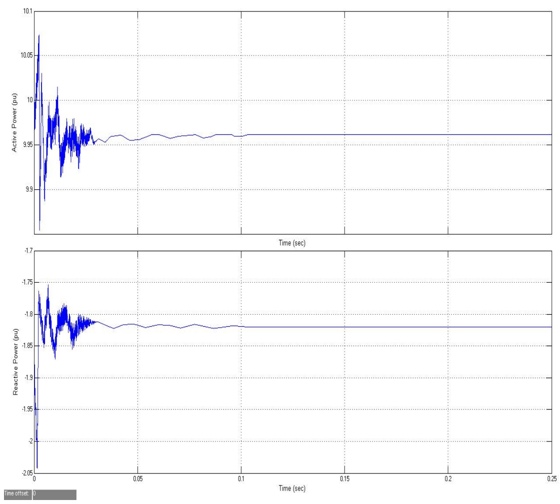

Fig. 3. Active power & Reactive power of Bus-3 without the Installation of SSSC

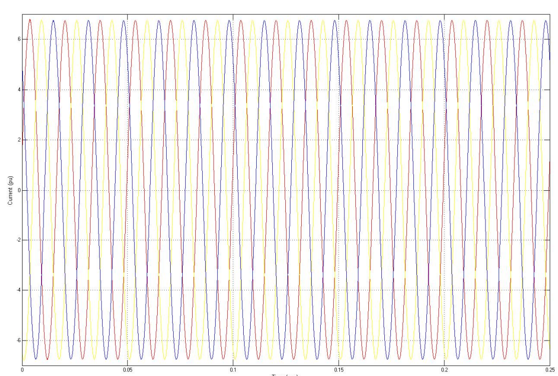

Fig. 4. Current of Bus-3 without the Installation of SSSC

5.2 Bus 2 parameters with SSSC

As shown in Fig. 9, SSSC has been placed between bus-1 and bus-2 and the main objective of this paper is to improve the active and reactive powers and transient oscillation also. When SSSC is configured, the voltage must be kept constant to 1 pu, hence the power flow is done in the presence of SSSC and the simulation results are as follows.

After installation of SSSC the power oscillation damping time will be decreased and system will follow the references value with acceptable error & Current of bus-2 in the presence of SSSC after transient mode will be in the form of sinusoidal form.

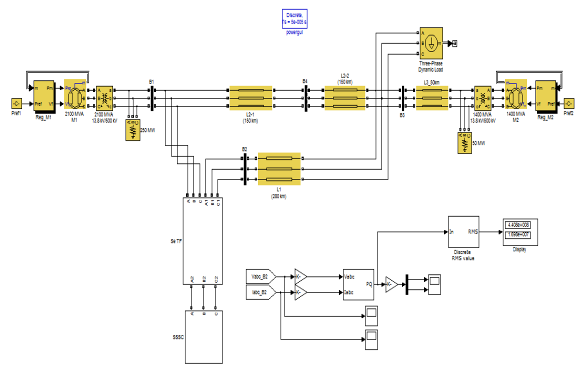

Fig. 6. The configuration of two machine system SSSC

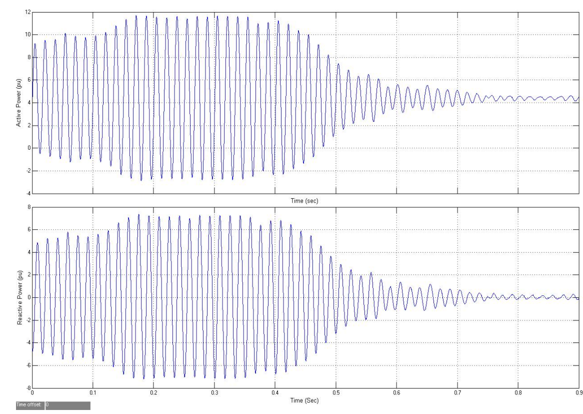

Fig.7. Active power & Reactive power of Bus-3 with the Installation of SSSC

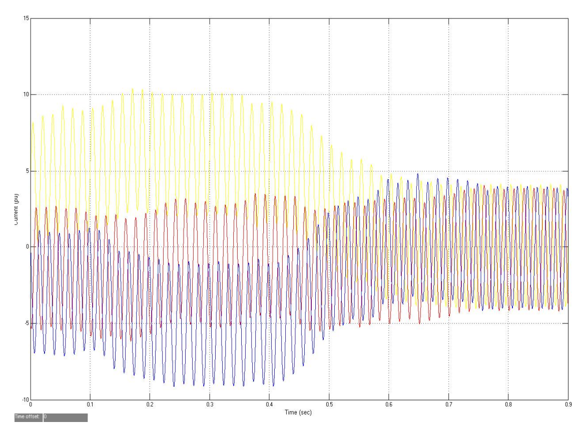

Fig.8. Current of Bus-3 without the Installation of SSSC

Table1. Comparative results obtained from simulation with & without SSSC, when SSSC is connected to Bus B2.

MATLAB SIMULINK	ACTIVE POWER (MW)	REACTIVE POWER (MW)	CURRENT (PU)
WITHOUT SSSC	996.2	440.8	4.47
WITH SSSC	182	16.98	2.8

VI. CONCLUSION

In this research we are analyzed the problem of reactive power compensation in transmission line by using Static Synchronous Series Compensator. The FACTs device is used in series with bus 2 which is SSSC inject a fast active changing voltages in series with the line irrespective of the phase and magnitude of the line current therefore controlling the active and reactive power as well as damping oscillations in the transient mode will achieved.

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