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TRANSIENT STABILITY IMPROVEMENT OF POWER SYSTEM USING STATIC SYNCHRONOUS COMPENSATOR AND STATIC VAR COMPENSATOR

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ABSTRACT: 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 power system is therefore a very important and challenging issue. Transient stability has been given much attention by power system researchers and planners in recent years, and is being regarded as one of the major sources of power system insecurity. Shunt devices play an important role in improving the transient stability, increasing transmission capacity and damping low frequency oscillations. Thus this paper proposed the Transient stability improvement of power system using static synchronous compensator (SSC) and static var compensator (SVC) under fault condition. SSC is a shunt device consisting of a voltage source inverter and a gate pulse generation circuit that connected to the transmission line through a coupling transformer. SVC is thyristor based controller that provides rapid voltage control to improve the transient stability of power system in various abnormal conditions. This paper shows the simulation results of model for different fault conditions with SSC and without SSC and shows how the SVC helps to improve the stability when Power system stabilizer is fail to maintain the stability. Transient stability of an IEEE 9 bus system is modeled in MATLAB SIMULINK Software is studied in this paper.
KEY WORDS: Power systems, static synchronous compensator (SSC), static var compensator (SVC), Transient stability.

I. INTRODUCTION

Stability of power system is the ability of the system to return under normal working conditions after being stressed by different transients [1]. Otherwise, “stability” can be described as the natural tendency of thesystem to develop equal or greater forces than the disturbing forces, in order to continue working in a steady state. The system remains in synchronism if forces attempting to keep machines in synchronism are sufficient to defeat disturbing forces. Conversely, instability means conditions that lead generators to lose synchronism and power system failure. The transient stability studies involve the determination of whether or not synchronism is maintained after the machine has been subjected to several disturbances [2]. These disturbances might be sudden application of a large load, loss of generation, loss of large load, short circuits or phase loses in transmission.Generally, generation, transmission, and distribution are the three steps in a power system. Supply continuous power is the main aim to design power system by maintaining voltage stability in presence of lightning, short circuit between transmission lines phase wires, and ground faults [3]. One or many generators may be severely disturbed due to these above-listed faults, by causing a gap between demand and generation. The importance of power system stability is increasingly becoming one of the most limiting factors for system performance. Recent major black-outs across the globe caused by system instability, even in very sophisticated and secure systems, illustrate the problems facing secure operation of power systems. With increase automation and use of electronic equipment, the quality of power has gained utmost importance, shifting focus on the concepts of voltage stability, frequency stability, inter-area oscillations etc. By the stability of a power system, we mean the ability of a system to remain in operating equilibrium, or synchronism, while disturbances occur on the system Transient stability of power systems becomes a major factor in planning and day-to-day operations and there is a need for fast on-line solution of transient stability to predict any possible loss of synchronism and to take the necessary measures to restore stability [4]. Recently various controller devices are designed to damp these oscillations and to improve the system stability, which are found in modern power systems, but Static Series Synchronous compensator (SSSC) still remains an attractive solution.

II. LITERATURE SURVEY

Synchronization issues rising day by day in the installation of bigger systems as the escalation of power demand. Therefore, for upcoming development, demand forecasting has become, gradually, complex due to the increase in the use of electricity demand which results in overloading of the power lines. Due to overloading, the voltage at each bus gets reduce and the efficiency of the generator to supply active and reactive power decreases under an abnormal operation of a power system representing a contingency situation [5]. By increasing the power generation and by constructing a new transmission line are may be useful to resolve the glitches of overhead transmission lines and increasing load demand to bring back the power system in safe operation. The major concern in system operation is the stability of the power system [6].

The analysis of transient stability is very important to design an electric power system. Transient stability is the capability of the power system to sustain large disturbances such as transmission line short circuit, losses of the generator, and load to persist in normal operating condition [7]. The disturbances result in a large deviation of the generator rotor angle, effect on power flow, bus voltage, and other system variables causes the partial loss or loss of transmission network.

Power system stability is calculated during initial phases when generating and transmission units are still in development. Research is needed to determine the relay protection system, circuit breakers, optimal fault clearing time, voltage levels and transmission capacity between systems [8] If power system loses stability, the machines will no longer work at synchronous speed. That will lead to drastic fluctuations of voltage levels, currents and power. That condition can cause damages to the loads that are supplied with energy from the unstable system. Transient stability studying requires a lot more attention because its impact on the system is greater than other conditions. Studies in this area should be carried out to ensure that the system supports the transitional provisions that come as a result of a great transient. Short circuits are a kind of these transients. During

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the occurrence of a fault, the stability of the power system depends not only by the system itself, but also depends on the type and location of the fault, the clearing time, etc.

System response during transient conditions includes changes in rotor angle and it is influenced by the non- linear relationship between power and the rotor angle. Following the sudden transients in the power system, differences of rotor angles, rotor speeds and the power transmitted through transmission lines, change rapidly according to the type of fault [9]. For large transients, the change in rotor angle can be large enough to get the machine out of synchronism. Transient stability is a phenomenon that occurs within a second for generators placed near the fault location. The goal of transient stability studies is to assure if rotor angle remains in stable conditions after the fault clear [10]. Fault clearing includes, switching off transmission lines, which weakness the system. Changes in transmission system, lead to changes in rotor angle. Lose of synchronism becomes obvious within a second from the fault occurring. Faults in overloaded transmission lines cause more instability than faults in slightly loaded lines. Also, three phase faults cause greater transients than one phase or two phase faults.

III. PROPOSED SYSTEM

The Generic Power System Stabilizer (PSS) block can be used to add damping to the rotor oscillations of the synchronous machine by controlling its excitation. The input to the power system stabilizer is the synchronous machine speed deviation with respect to nominal (d_w in p_u) or the acceleration power (P_a=P_m-P_e in p_u). The output of PSS is the stabilization voltage in p_u which is connected as input to the excitation system. The disturbances occurring in a power system induce electromechanical oscillations of the electrical generators. These oscillations, also called power swings, must be effectively damped to maintain the system stability. The output signal of the PSS is used as an additional input (vstab) to the Excitation System block. The PSS input signal can be either the machine speed deviation, d_w, or its acceleration power, $P_a = P_m - P_{eo}$ (difference between the mechanical power and the electrical power). The Generic Power System Stabilizer is modeled by the following nonlinear system:

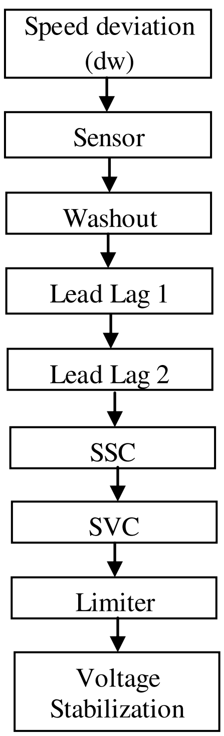

Fig 1: PROPOSED POWER SYSTEM FRAMEWORK

SSC is a static synchronous compensator, it is a shunt controller used to inject the current and control the voltage. It is connected to the transmission line through a coupling transformer. The shunt controller is use only to consume or to supply the reactive power. SSC consists of a voltage source inverter, which is used to convert dc voltage at its input terminal into three phase ac voltage. SSC can be applied with two basic control which includes (a) control of dc voltage across dc capacitor and (b) regulation of the ac voltage of power system at the bus bar, where SSC is installed. The basic principle of SSC involves the generation of controllable alternating current voltage source behind a transformer leakage reactance with a voltage source converter connected to a DC storage capacitor. The difference in voltage across the reactance produces active and reactive power exchanges between the SSC and the power system.

SSC in this paper consists of a gate pulse generator circuit which is use to generate the gate pulses for the firing of the IGBT/Diode of the voltage source inverter. VSI is used to produce the output voltage. To the gate pulse generator input is given as a three phase current which is then converted to d-q frame of reference by parks transformation then its value is compared with the reference voltage by the PI controller and again it is converted to three phase ia, ib and ic current which is feed to three separated PI controllers. Here it is compared with the triangular wave and if the given condition is satisfied then pulses are generated which are the input to the VSI. Voltage Source Inverter has filters and IGBT/Diode which is use to generate the output voltage.

Static Var Compensator is thyristor based controller that provides rapid voltage control. The situation has occurred increase transient, oscillatory and voltage instability, which are now these problem can be rectified by using Static Var Compensator. Voltage instability is the cause of voltage collapse. The only way to save the system of voltage collapse through control reactive power. Various FACTS device are connected in the transmission line to inject and absorb the reactive power. When it will absorb the reactive power TCR are connected in the transmission line. When it will inject the reactive power TSC are connected in the transmission line.

IV. RESULTS

The Matlab software is used to analysis of transient stability of the multi-machine, IEEE (Kundur's Two-Area System) two area 11 Bus -bus power system network with SVC and SSC which are connected at bus 7 as shown in figure 2 & 3. The system contains eleven buses and two areas, connected by a weak tie between bus 7 and 9. Totally two loads are applied to the system at bus 7 and 9. Two shunt capacitors are also connected to bus 7 and 9 as shown in the figure 8&9. The system comprises two similar areas connected by a weak tie. Each area consists of two generators, each having a rating of 900 MVA and 20 kV. All four machines are equipped with a steam turbine and governor (STG), excitation system and power system stabilizer (PSS).The left half of the system is identified as area 1 and the right half is identified as area 2. The saturation of the synchronous machines are not identical. Both SVC and SSC used for this model have same rating of +/- 200 MVA and the reference voltage is set to 1 pu for both SVC and SSC

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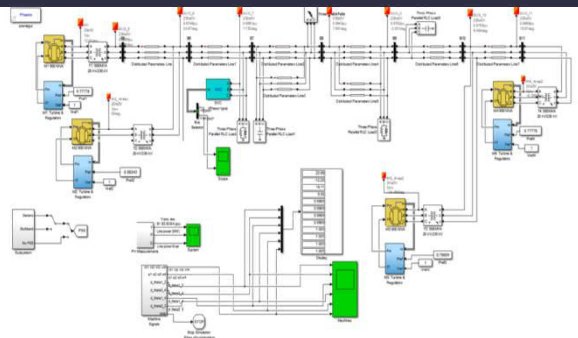


Fig. 2: SIMULINK MODEL OF 3 MACHINE 9 BUS SYSTEM WITH SVC

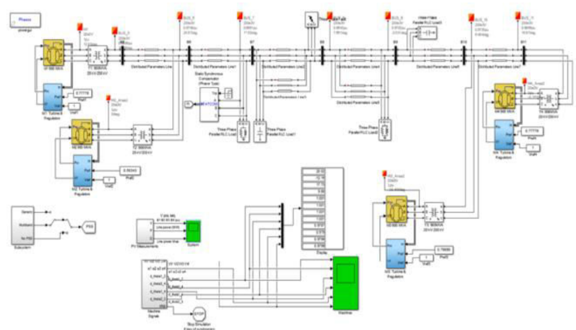
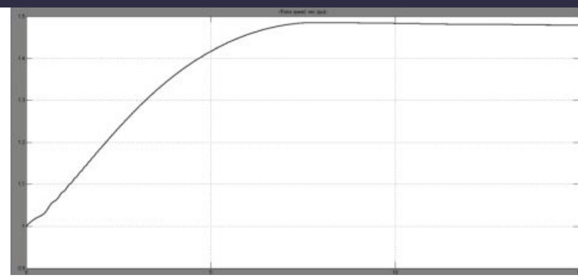


Fig. 3: SIMULINK MODEL OF 3 MACHINE 9 BUS SYSTEM WITH SSC

The comparison is made between the above facts devices with and without PSS for stability enhancement of IEEE 11 bus system. From fig 4 (a) the result shows that the rotor speed is fluctuate during the fault condition and fig 4 (b) shows that SSC has improve the rotor speed to the value of almost 1 pu without any fluctuation even during the fault condition.

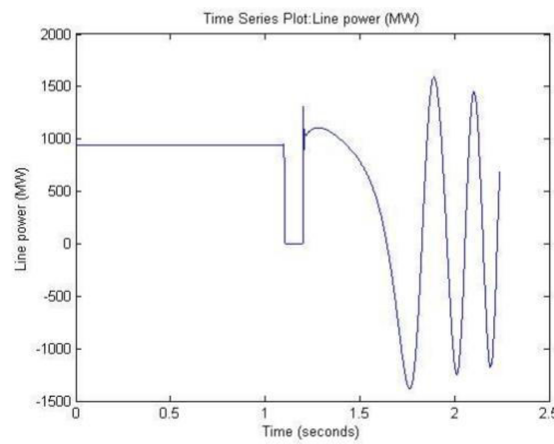
(a) Without SSC



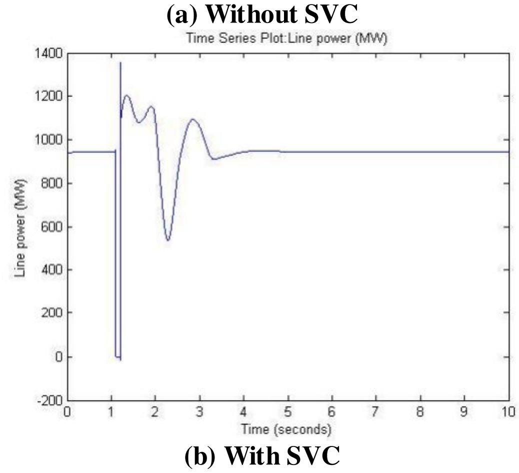
(b) With SSC

Fig. 4: ROTOR SPEED

Figure 5 proves the performance of different conditions of transient stability by using SVC and PSS and without SVC and PSS. That is the amount of randomness in the waveforms as shown in figure 5 (a) and (b).



(a) Without SVC



(b) With SVC

Fig 5: LINE POWER

V. CONCLUSION

In this project the transient stability of a two machine system was obtained by using the

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SSC and SVC with power system stabilizer. The stabilizer improved the damping of ossicilations created in the machine by the threephase fault and the reactive power improvement was done by SVC by injecting reactive power in the system or receiving the line power by the controller. Hence by improving of the transient stability was done by using Mat Lab simulink software. The presence of SSC has reduced the fault magnitude as a result of which the main system losses have also been reduced. In this paper simulation of SSC has verified that it can be applied to the power transmission line to compensate the reactive power and also to improve the voltage profile. It is use for the improvement of transient voltage behaviour of the power system.

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