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Power Quality Enhancement of Power Transmission System Using Static Var Compensator with PID Controller

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ABSTRACT: Power quality has become a serious problem to power system engineers and industrial facilities over the last decade. An introduce of more and more complicated technologies being used in industrial and commercial facilities, a highly reliable source of electricity has become essential for all consumers. The most common power quality problems in power systems are voltage flicker and Voltage sags that can be mitigate with reactive power sources like Static Var Compensators (SVCs) FACT controller. An SVC can reinstate voltage at a particular network node by generating or observing reactive power. This paper presents modeling and simulation of SVC & PID controller in MATLAB/Simulink. In this paper, Two types of power system network having same voltage rating has been considered for simulation & compared the performance of SVC with load end and source end. This work is presented to improve the transmission line voltage stability & power quality and machine oscillation damping stability also, by using SVC without & with PID controller & compared their performance. And Simulation results shows that SVC with PID controller is more effective to enhance the power quality and increase transmission capacity in the power system.

Keywords: Power quality Flexible AC transmission System (FACTS), Static Var Compensator (SVC), PID controller.

I. INTRODUCTION

Power quality is an important issue in power systems. Poor power quality may reduce production capacity of the system, damage sensitive equipments, cause major downtimes and lessen overall revenues and profits [1]. And Voltage sags and voltage flicker are the most common power quality problems. Sags, temporary reductions in voltage will cause loss of motor capacity and can sensitive customer operations, interfere with variable-speed drives, relays and robotics [2]. Flicker can be recognized as rapidly occurring voltage sags, caused by sudden and increasing load current. Voltage flicker is commonly caused by non linear loads such as a welders, motors, and Electric Arc Furnace that require a large amount of real and reactive power. The Static Var Compensator is a tool to improve power quality, have been undergoing development since the 1970's [3]. Therefore a substantial understanding of control scheme and dynamic behavior of SVC have become essential so as to define the utilization of the compensator. This objective could be achieved by computer simulation, which also plays an important role in the design and analysis of SVC's and other devices [4].

II. POWER QUALITY

Any Power problem manifested in voltage, current, or frequency deviations that result in failure or maloperation of customer equipment. Power is mainly categorized as voltage dip, voltage swells, voltage collapse and voltage instability problem [1]. The power supply system can only control the quality of the voltage; it has no control over the currents that particular loads might draw. Therefore, the standards in the power quality area are devoted to maintaining the supply voltage within certain limits. There is always a close relationship between voltage and current in any practical power system. Although the generators may provide a near-perfect sine-wave voltage, the current passing through the impedance of the system can cause a variety of disturbances to the voltage [2, 3].

III. STATIC VAR COMPENSATOR (SVC)

SVC's being dated from early 1970's, have the largest share among FACTS devices. They consist of conventional thyristors which have a faster control over the bus voltage and require more sophisticated controllers compared to the mechanical switched conventional devices [1]. SVC's are shunt connected devices capable of generating or absorbing reactive power. By having a controlled output of capacitive or inductive current, they can maintain voltage stability at the connected bus. Static Var compensators (SVCs) are very flexible and have many roles in power systems. SVCs can be used for power factor correction, flicker reduction, and steady-state voltage control, and also have the benefit of being able to filter out undesirable frequencies from the system [5, 6].

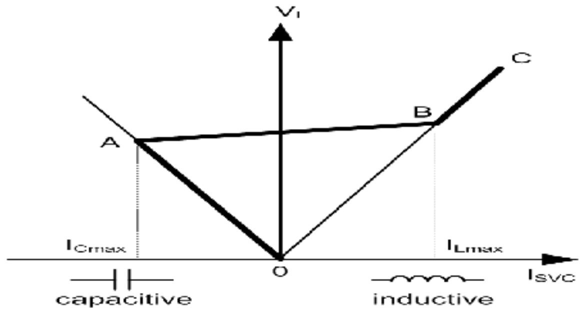

Fig. 1. V-I characteristics of SVC.

The voltage-current (V-I) characteristic of an SVC with the two operating zones is shown in Fig. 1. A slope around the nominal voltage is also indicated on the V-I characteristic, showing a voltage deviation during normal operation, which can be balanced with maximum capacitive or inductive currents. As the bus voltage drops, so does the current injection capability. This linear dependence is a significant drawback in case of grid faults, when large amount of capacitive current is needed to bring back the bus nominal voltage.

IV. CONTROL CONCEPT OF SVC CONTOLLER

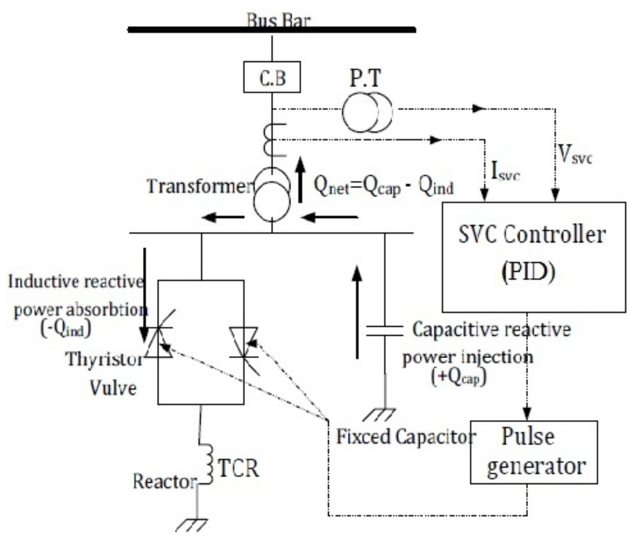

Fig. 2. SVC based control system.

SVC controller always investigate the bus voltage(Vs_{vc}) & current (I_{svc}), after taking investigations, controller compares the actual bus voltage with V_{ref} & taking error voltage, $V_{error} = V_{ref} - V_a - (I_{svc}*X_{sl})$ & integrate it in limit ($-Q_{cap}$ to $+Q_{ind}$), this produces net susceptance which controls the pulse generator & Thus TCR & TSC are controlled & voltage becomes stable towards it's V_{ref} shown in Fig. 2 [7,8].

V. MODEL OF SVC IN POWER SYSTEM

CASE (I). Show the fig. of power system model of single line three bus systems with transmission line.

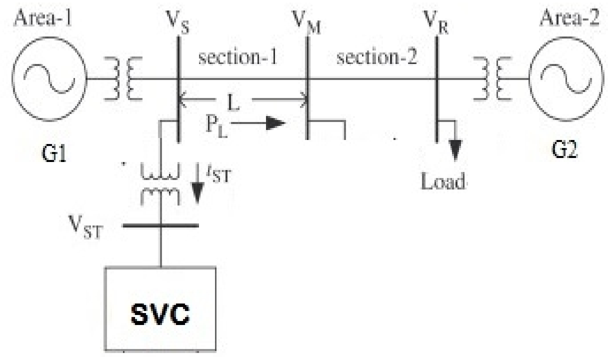

Fig. 3. Single line diagram of SVC model connected to source end in power system.

The SVC generates a balanced 3-phase voltage whose magnitude and phase can be adjusted rapidly by using solid state switches. The SVC is composed of a voltage source inverter with a dc fixed capacitor and coupling transformer, and signal generation control circuit and fundamental frequency voltages, the controller can be represented in power quality studies using the basic model SVC connected to source end in power system shown in Fig. 3. It analogous the case where power is transmitted through an electrical transmission line connecting various generators and loads at its sending and receiving end. It should be noted that accept the SVC control parameters, all the parameter of the transmission system are not known in practice [5].

CASE (II) Show the fig. of power system model of single line three bus systems with transmission line.

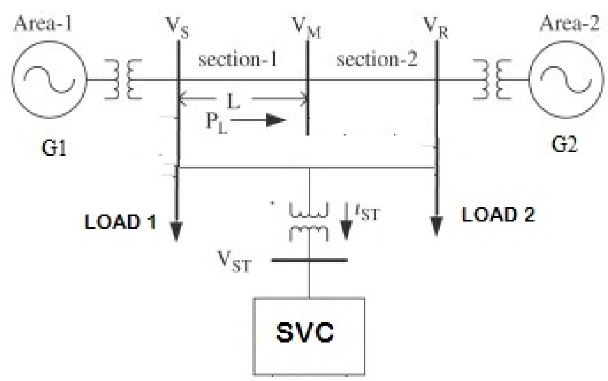

Fig. 4. Single line diagram of SVC model connected to load end in power system.

Fig. 4 shows the single line diagram of SVC model connects to the load end in power system. This mode of operation power is transmitting through generating to distribution station by electrical transmission line. As we know that in such an experiment the SVC control parameters known, And rest of the parameter of the transmission system are not known in practice. The system is employed in the experiment to evaluate the proposed control scheme. The parameters of the example system are given as follows-

Generator: S = 500MVA, V = 11 kV, ω0 = 314.159rad/s, D = 5.0 pu., H = 4.0s, Xd = 1.863 pu, X'd = 0.657pu, X"d = 0.245pu, T'd0 = 6.9s T"d0 = 0.03s , Xq = 0.657pu., Xq"= 0.27pu, T"d0 = 0.06s, Xad **=** 1.712pu, ***kc* =** 1, and Max [Ef(t)] = 6.Opu.

Transformer: **S** = 500 MVA, winding 1(Y) = 22 kV, winding 2(Δ) = 230kV, and X_T **=** 0.127 pu.

Transmission line: Length =300km, XL1 = XL2 = 0.24265pu, *RL1*= RL2 = 0.016pu and f= 50Hz

SVC: 220MVAR, R_s=0.03 pu., L=0.2pu, C_{dc}= 1000pF, snubber circuit: R_b = 5000Ω**,** and *C* = 0.06 μF.

VI. SIMULATION AND RESULTS

In this model case (I), performance of controller is evaluated IEEE standard. The simulations result carried out using MATLAB/ SIMULINK environment for power system SVC connected source end Fig. 3 for evaluating robustness is condition of disturbances.

1. This simulation result shows that line power and bus voltage fluctuation With SVC connected to source end of power system.

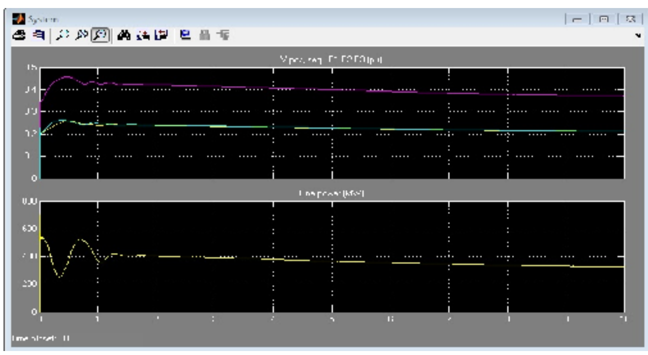

Fig. 5. Shows the waveform of Bus voltage and Line power.

2. This result shows that of rotor deviation, changes in angular velocity and terminal voltages variations With SVC connected to source end of power system.

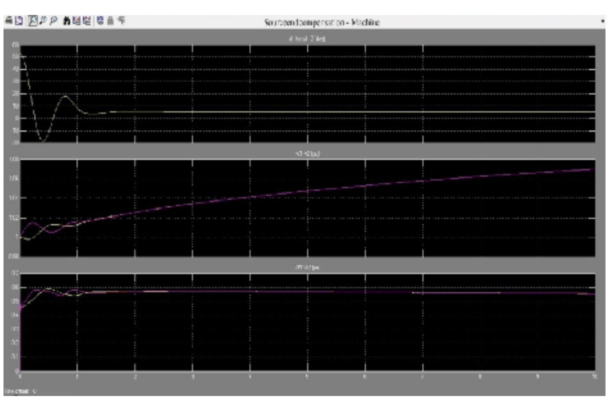

Fig. 6. Shows the waveform of rotor deviation, angular velocity and terminal voltages.

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In this model of case (II), performance of controller is evaluated the simulations result carried out using MATLAB/ SIMULINK environment for power system SVC connected load end Fig. 4 for evaluating robustness is condition of disturbances.

1. This simulation result of line power and bus voltage fluctuation With SVC connected to load end of power system.

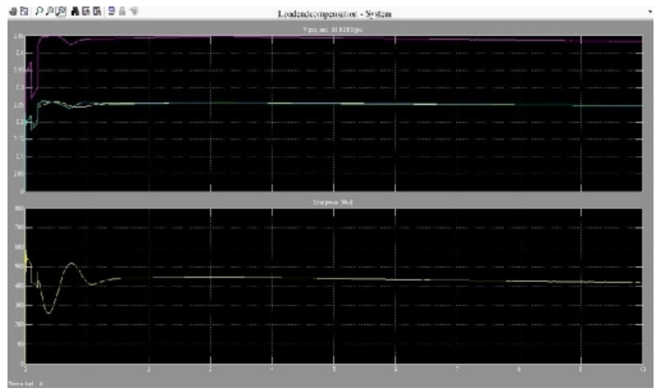

Fig. 7. Shows the waveform of Bus voltage and Line power.

2. This result shows that of rotor deviation, changes in angular velocity and terminal voltages variations With SVC connected to load end of power system.

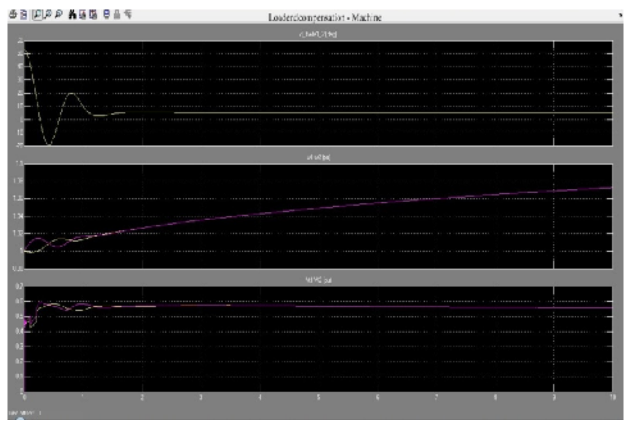

Fig. 8. Shows the waveform of rotor deviation, angular velocity and terminal voltages.

VII. CONCLUSION

This paper has been presenting the power quality issues of power system different location of static Var compensator, and then summarized result the switching strategy of fault based on two generating station. The result shows: SVC considered source end and load end transmission line, and different switch modes result different effect especially when fault. The effects on power compensation line power, bus voltages rotor deviations angular velocity and terminal voltages of power system using SVC installed at source end and load end for the same transmission line of power system were studied and compared based on the simulation. On the basis of simulation result we found that performance of installation of SVC is better control over power quality management at load end side as compared to source end.

REFERENCE

[1]. Electrical Power Systems Quality 2E (Roger Dugan, Mark McGranaghan, Surya Santoso & Wayne Beaty).

[2]. N. G. Hingorani. "Flexible AC Transmission Systems," *IEEE Spectrum*, April 1993.

[3]. IEEE Special stability controls working Group, "Static VAR Compensator Models for Power Flow and Dynamic Performance Simulation," *IEEE Transactions on power systems*, vol. **9**, no.1 February 1994. pp. 229-240.

[4]. A.E. Hammad "Analysis of power system stability enhancement by static var compensator", IEEE PWRS, vol **1**, no. 4, pp. 222-227.

[5]. H. Ebrahimirad, A. Choobdar and GR. Dehnavi.A new control approach for voltage quality improvement in distribution power system by means of an SVC.

[6]. Reactive Power Management and Voltage Control of large Transmission system using SVC (Static VAR Compensator) Computational Science and Engineering Department, Department of Electrical and Computer Engineering, North Carolina A & T State University, Greensboro, USA.

[7]. Voltage Level Improvement of Power System By Using SVC With POD Controller. International Journal of Advanced Technology & Engineering Research (IJATER.ISSN No: 2250-3536 Volume **2**, Issue 4, July 2012.

[8]. Power Quality Improvement For Grid Connected Wind Energy System Using Svc Light. *International Journal of Engineering Research & Technology (IJERT)*. ISSN: 2278-0181.Vol. **1**, Issue 6, August – 2012.