Review: Enhancement of Power System Stability using Static Var Compensator (Svc)

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***Abstract*—**The use of reactive power is to improve system efficiency. It is acceptable to some level; it may cause some problem in Electrical system if system is purely resistive or capacitive.AC systems supply or consume two kinds of power i.e. real power and reactive power. Real power accomplishes useful work while reactive power supports the voltage that must be controlled for system reliability. Reactive power has a profound effect on the security of power systems because it affects voltages throughout the system. it also used to provide the voltage levels necessary for active power to do useful work. it is also essential to move active power through the transmission and distribution system to the customer. Reactive power (VARS) is required to maintain the voltage to deliver active power (watts) through transmission lines. If there is insufficient reactive power, the voltage sags down and it is not possible to push the power demanded by loads through the lines. There are various techniques for power system stability, this paper covers the point of system stability by using “Shunt compensation technique” to the improvement of power system stability using one of the FACTS device named “Static VAR Compensator (SVC)”.

Keywords-. Reactive Power, VAR, SVC, Stability, Matlab/Simulink

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I. Introduction

Injecting reactive power into the system raises voltages, and absorbing reactive power lowers voltages. Synchronous generators, SVC and various types of other DER (Distributed energy resource) equipment are used to maintain voltages throughout the transmission system. Voltage-support requirements are a function of the locations and magnitudes of generator outputs and customer loads and of the configuration of the DER transmission system. These requirements can differ substantially from location to location and can change rapidly as the location and magnitude of generation and load change. At very low levels of system load, transmission lines act as capacitors and increase voltages. At high levels of load, however, transmission lines absorb reactive power and thereby lower voltages. Most transmission-system equipment (e.g. Capacitors, inductors, and tap-changing transformers) is static but can be switched to respond to changes in voltage-support requirements. First, it must maintain adequate voltages throughout the transmission and distribution system for both current and contingency conditions. Second, it seeks to minimize congestion of real-power flows. Third, it seeks to minimize real-power losses are the three objectives which System operation has when managing The reactive power of the system in tolerable limit.

However, the mechanisms of system operators which use to acquire and deploy reactive-power resources are changing. These mechanisms must be fair and effective to all parties as well. Further, they must be demonstrably fair. Voltages are controlled by providing sufficient reactive power control margin to “modulate” and supply needs through: Shunt capacitor and reactor compensations Dynamic compensation Proper voltage schedule of generation. Voltages are controlled by predicting and correcting reactive power demand from loads. To provide adequate service quality Maintain proper stability of the power system Voltage and reactive power must be properly managed and controlled. Reactive power is present when the voltage and current are not in phase One waveform leads the other Phase angle not equal to 0o Power factor less than unity Measured in volt-ampere reactive (VAR) Produced when the current waveform leads voltage waveform (Leading power factor) Vice versa, consumed when the current waveform lags voltage (lagging power factor).the following figure shows relation among the various power.[7]

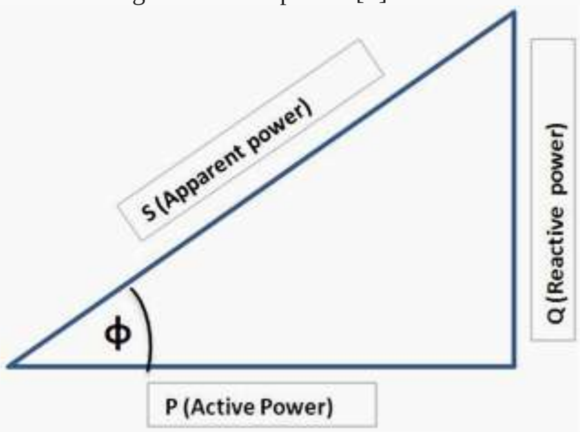

Figure 1: Power Triangle

II. VARIOUS TECHNIQUES FOR IMPROVING POWER SYSTEM STABILITY

1. **Reduction of transmission system reactance**: The series inductive reactance's of transmission networks are primary determinants of stability limits.
   Reduction of transmission network reactance's is achieved by:
   i)Reducing reactance of transmission lines.
   ii)using transformer with lower leakage reactance's
   iii)Series capacitor compensation
2. **Series compensation**:
   i) Series capacitors directly off set the line series reactance
   ii)The maximum power transfer capability of transmission line may be significantly increased by the use of series capacitor banks[5]
3. **Shunt compensation:**
   i) Shunt compensation capable of maintaining voltages at selected point of the transmission system.
   ii)By increasing flow of the synchronizing power Among interconnected generators) it can improve system stability .[6]
   iii) Synchronous generator, **Static VAR Compensator (SVC),** STATCOM are some devices used for these purpose[2]

III. INTRODUCTION TO SVC

An SVC combines conventional capacitors and inductors with fast switching capability. Switching takes place in the sub cycle time frame (i.e., in less than 1/60 of second), providing a continuous range of control. The range can be designed to span from absorbing to generating reactive power. Consequently, the controls can be designed to provide very fast and effective reactive support and voltage control. Because SVCs use capacitors, they suffer from the same degradation in reactive capability as voltage drops. They also do not have the short-term overload capability of generators and synchronous condensers. SVC applications usually require harmonic filters to reduce the amount of harmonics injected into the power system[7].

IV. IMPORTANCE OF SVC

Static Var Compensator is "a shunt-connected static Var generator or absorber whose output is adjusted to exchange capacitive or inductive current so as to maintain or control specific parameters of the electrical power system (typically bus voltage)". SVC is based on thyristors without gate turn-off capability. The operating principal and characteristics of thyristors realize SVC variable reactive impedance. SVC includes two main components and their combination: Thyristor-controlled and Thyristor-switched Reactor (TCR and TSR); and Thyristor-switched capacitor (TSC).

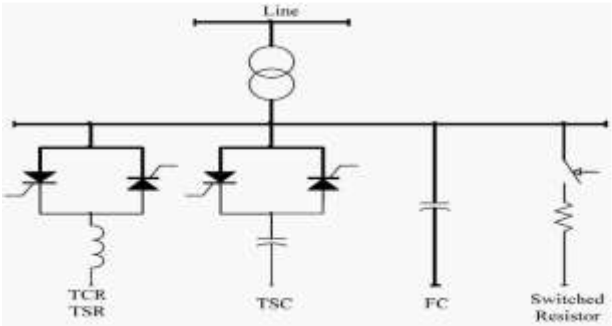

Figure 2 -Static VAR Compensators (SVC)

A **static VAR compensator** is a set of electrical devices for providing fast-acting reactive power compensation on high-voltage electricity transmission networks. SVCs are part of the Flexible AC transmission system device family, regulating voltage, power factor, and harmonics and stabilizing the system. Unlike a synchronous condenser which is a rotating electrical machine, a static VAR compensator has no significant moving parts (other than internal switchgear). Prior to the invention of the SVC, power factor compensation was the preserve of large rotating machines such as synchronous condensers or switched capacitor banks.[1]

The SVC is an automated impedance matching device, designed to bring the system closer to unity power factor. SVCs are used in two main situations:

i) Connected to the power system, to regulate the transmission voltage ("Transmission SVC")

ii) Connected near large industrial loads, to improve power quality ("Industrial SVC")

In transmission applications, the SVC is used to regulate the grid voltage. If the power system's reactive load is capacitive (leading), the SVC will use to controlled reactors to consume VARs from the system, lowering the system voltage. Under inductive (lagging) conditions, the capacitor banks are automatically switched in, thus providing a higher system voltage. By connecting the thyristor-controlled reactor, which is continuously variable, along with a capacitor bank step, the net result is continuously variable leading or lagging power.[8]

In industrial applications, SVCs are typically placed near high and rapidly varying loads, such as arc furnaces, where they can smooth flicker voltage.[1],[2]

V. TECHNICAL TOOLS FOR ANALYSIS

The following methods can be use for performance analysis of SVC for Reactive Power Compensation.

i). MATLAB/SIMULINK:

Simulink is a graphical programming environment for modeling, simulating and analyzing multi-domain dynamic systems. It offers tight integration with the rest of the MATLAB environment and can either drive MATLAB or be scripted from it. Simulink is widely used in automatic control and digital signal processing for multi-domain simulation and Model-Based Design. [5][9]

ii). PSCAD:

PSCAD (Power System Computer Aided Design) is a graphical interface based on motor Electromagnetic Transients including DC (EMTDC). The program allow to users easily creating simulators, carrying out simulation and visualization of the simulation mode "online". This makes it possible to display the instantaneous value measurements , as well as changes in system parameters during the simulation using the sliders and switches multi-position . All these features of the program give you the opportunity to influence the simulation during her lifetime, what more can reflect the real conditions. The program PSCAD has a rich library (Master Library) elements ready to be inserted to the test simulator. In addition to simple passive components.

VI. MATLAB/SIMULINK FOR POWER SYSTEM STABILITY ANALYSIS USING SVC

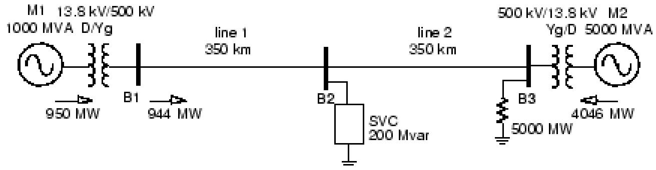

Figure:3 Example of Transmission System

A 1000 MW hydraulic generation plant (M1) is connected to a load center through a long 500 kV, 700 km transmission line. The load center is modeled by a 5000 MW resistive load. The load is fed by the remote 1000 MVA plant and a local generation of 5000 MVA (plant M2).

A load flow has been performed on this system with plant M1 generating 950 MW so that plant M2 produces 4046 MW. The line carries 944 MW which is close to its surge impedance loading (SIL = 977 MW). To maintain system stability after faults, the transmission line is shunt compensated at its center by a 200 Mvar static var compensator (SVC). The SVC does not have a power oscillation damping (POD) unit. The two machines are equipped with a hydraulic turbine and governor (HTG), excitation system, and power system stabilizer (PSS).

This system is available in the power_svc_pss model. Load this model and save it in your working directory as case1 to allow further modifications to the original system. This model is shown in Model of the Transmission System (power_svc_pss)

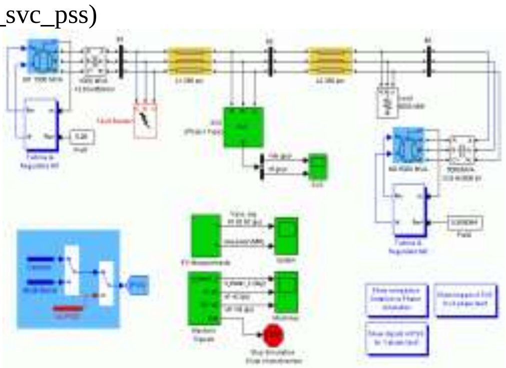

Figure: 4 Model of the Transmission System (power_svc_pss)

VII. CONCLUSION

In this paper we discussed, how to enhance power system stability. As reactive power plays an important role in controlling the voltage of power system. Hence by using shunt compensation with the use of FACTS Device named Static VAR Compensator (SVC) we control adversity in transmission system causes due to voltage fluctuation and make system run smoothly.

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