##### **STABILITY IN POWER SYSTEM BY COMPENSATING REACTIVE POWER WITH SVC AND PSS**

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***ABSTRACT:*** *Flexible AC transmission systems are a new technology which has a principal role of enhancing controllability and power transfer capability in AC system.**Flexible AC Transmission System (FACTS) devices, when placed at the mid-point of along transmission line, play an important role in controlling the reactive power flow to the power network, the system voltage fluctuation and transient stability.*

*This paper deals with the study of Static Var Compensator (SVC) to improve transient stability in along transmission line with pre defined direction of real power flow. It has been observed that the FACTS devices, when placed slightly off centre towards sending-end, give better performance in improving transient stability and the location depends on the amount of load. The functional structure for SVC built with a Thyristor Controlled Reactor (TCR). A MATLAB Software is used to carry out simulations of the system under study and the results expected are in this paper shown to access the performance of SVC on the voltage stability of the system by using with PSS.*

***Keywords:*** *FACTS, PSS, SVC, transient stability*

1. **INTRODUCTION**

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. Flexible Alternating Current Transmission Systems (FACTS) are new devices emanating from recent innovative technologies that are capable of alternating voltage, phase angle and/or impedance at particular points in power systems (Acha et al., 2002; Acha et al., 2000). Their fast response offers a high potential for power system stability enhancement apart from steady-state flow control. Among the FACTS controllers, Static Var Compensator (SVC) provides fast acting dynamic reactive compensation for voltage support during contingency events which would otherwise depress the voltage for a significant length of time (Cai, 2004; Muwaffaq, 2003). SVC also dampens power swings and reduces system losses by optimized reactive power control.

 This paper deals with the location of a FACTS device like Static Var Compensator (SVC) to improve transient stability in along transmission line with pre defined direction of real power flow. It has been observed that the FACTS devices, when placed at centre towards sending-end, give better performance in improving transient stability and the location depends on the amount of load. This paper investigates the effects of Static Var Compensator (SVC) on voltage stability of a power system. The functional structure for SVC built with a Thyristor Controlled Reactor (TCR) and its model are described. The model is based on representing the controller as variable impedance that changes with the firing angle of the TCR.

 MATLAB/SIMULINK has been used in this study to conduct simulations on voltage regulation at the point of connection of SVC to the system. However, the aim of this paper is to enhance voltage stability using Static Var Compensator at the event of occurrence of fault in the system.

1. **NEED FOR REACTIVE POWER COMPENSATION**

A thyristor-controlled generator of reactive power, either [lagging](http://www.answers.com/topic/lagging) or leading, or both. The word var stands for [volt](http://www.answers.com/topic/volt) ampere reactive, or reactive power. The device is also called a static reactive compensator. Reactive power is the product of voltage times current where the voltage and current are 90° out of phase with one another. Thus, reactive power flows one way for one-quarter of a cycle, the other way for the next quarter of a cycle, and so on (in contrast to the real power, or active power, which flows in one direction only).

 This back-and-forth flow results in no net power being delivered by the generator to the load. However, current associated with reactive power does flow through the conductor and creates extra losses. Most loads draw lagging reactive power, which causes electric power system voltage to [sag](http://www.answers.com/topic/sag). On the other hand, under light loads, the [capacitance](http://www.answers.com/topic/capacitance) of high-voltage lines can create excessive leading reactive power, causing the voltage at some locations to rise above the nominal value. Finally, it is [prudent](http://www.answers.com/topic/prudent) to keep reactive power flows to a minimum in order to allow the lines to carry more active power

1. **SYSTEM MODEL**

Studies have been performed on a single machine connected to a constant voltage bus through two transformers Z1 and Z4 and a transmission line divided equally into two sections Z2 and Z3 as shown in Fig. 1. An SVC device is connected at the middle bus. The SVC is a combination of reactors and capacitors. It can be controlled quickly by. thyristor switching.The thyrister acts as a variable susceptance



 Fig.1: Test power system to analyzing SVC for transient stability



 Fig 2: SVC connected to transmission line



 Fig 3: Actual photo of SVC

The SVC is shown in Fig. 2. The main inputs to the SVC controller are the reference voltage (Vref) and the terminal bus voltage (Vt). The SVC has a firing control system and for simplicity,. An auxiliary signal is used as the input to the adaptive fuzzy controller for system oscillations damping. The adaptive fuzzy logic controller consists of a recursive least squares with a variable forgetting factor (RLS) identifier that tracks the plant dynamic behavior by identifying the relation between the generator speed deviation signal and the incremental susceptance(B) and a fuzzy logic controller. The fuzzy logic controller is adapted using the identified model

1. **STATIC VAR COMPENSATOR (SVC) DESCRIPTION**

The SVC uses conventional thyristors toachieve fast control of shunt-connected capacitors andreactors. The configuration of the SVC is shown in Fig. 2,which basically consists of a constant capacitor(C) and athyristor controlled reactor (L).The delay angle control ofthe thyristor banks determines the equivalent shuntadmittance presented to the power system (Zhang,2003a, b), New version of SVC is basically a shunt connected static var generator/load whose output is adjusted to exchange capacitive or inductive current so as to maintain or control specific power system variables; typically, the controlled variable is the SVC bus voltage (Stagg and El- Abiad, 2002; Saadat, 2002) . One of the major reasons for installing a SVC is to improve Dynamic voltage control and thus increase system load ability. An additional stabilizing signal, and supplementary control, superimposed on the voltage control loop of a SVC can provide damping of system oscillation as discussed. In this paper,

 The SVC is basically represented by a variable reactance with maximum inductive and capacitive limits to control the SVC bus voltage ,with an additional control block and signals to damp oscillations, reactive power demand at the bus varies, the susceptance is varied subject to the limits. However, the reactive power is a function of the square of the bus voltage. Hence the reactive power generated decreases as the voltage decreases.

1. **POWER SYSTEM STABILIZER**

A PSS can be viewed as an additional block of a generator excitation controller AVR, electromechanical oscillations. Thus, the PSS uses auxiliary stabilizing signals such as shafts added to improve the overall power system dynamic performance, especially for the control of peed, terminal frequency and/or power to change the input signal to the AVR. This is a very effective method of enhancing small-signal stability performance on a power system network. In large power systems, participation factors corresponding to the speed deviation of generating unit scan be used for initial screening of generators on which toad PSS However, a high participation

factor is a necessary but not sufficient condition For a PSS at the given generator to effectively damp oscillation. Following the initial screening a more rigorous valuation using residues and frequency response should be carried out to determine the most suitable locations for the stabilizers.

 The Block diagram of the power system stabilizer will be as shown in the Fig. 3. The stabilizer is consists mainly four blocks, these are PSS gain (Ks), Wash out circuit, Compensator and limiter. Compensator is nothing but a simple lag/lead controller. in large interconnected power systems, the damping torque of system is reduced and system need to PSS for stability.The basic function of PSS is to add damping torque to the generator rotor oscillations by controlling its excitation using auxiliary stabilizing signal. To provide damping, the stabilizer must produce a component of electrical torque in phase with the rotor speed deviations.

 This type of PSS consists of a washout filter, a dynamic compensator. The output signal is fed as a supplementary input signal to the excitation of generator. The washout filter, which is a high pass filter, is used to reset the steady state offset in the PSS output. The dynamic compensator is made upto two lead-lag stages with time constants T1-T4 and an additional gain KDC.

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 Fig. 4: PSS model used for simulations

**6. ADVANTAGES**

1. Faster response, since the converter can immediately provide capacitive output before the TSCs could be switched in (The TCR can only be observed the reactive power).

2. Reduce harmonic generation and the possible elimination of filters, since the can be design the have very low harmonic generation (TCR is the harmonic source in the SVC)Greater flexibility to optimize for loss evaluation criteria since the convertor power, which makes it possible to switch the capacitors with either a net VAR surplus

3. As the reactive power is compensate, it lead to improve power factor of power system.

4. It helps to increase the power transfer capability of transmission line as the receiving end voltage is obtain in limit and reduce the voltage drop occur in transmission line due to inductive reactance.

**7. MATLAB SIMULATION BLOCK DIAGRAM**



Fig. 5: SIMULINK test power system

**8. EXPECTED RESULT**

Fig.8.1 Generator current oscillation

 Fig.8.2 Susceptance variation of SVC

Fig.8.3 Line 2 current oscillation



Fig.8.4 Magnitude voltage in Bus 1,2,3



Fig.8.5 Real and reactive power flow in the line 1

**9. CONCLUSION**

In this paper, the basic structure of an SVC operatingunder typical bus voltage control and its model aredescribed. The model is based on representing thecontroller as variable impedance that changes with thefiring angle of the Thyristor Controlled Reactor (TCR),which is used to control voltage in the system.Simulations carried out confirmed that Static Var Compensator could provide the fast acting voltage supportnecessary to prevent the possibility of voltage reductionand voltage collapse at the bus to which it is connected.

In this paper, the effectiveness of shunt FACTSdevices such as SVC has been studied in improving thetransient stability of a sample two-area power system withvarious and different studies such as investigation theresponse of SVC to transient phenomena. In above paper the effect of PSS is seen. Itshows that when there is a pre-defined direction of real power flow, the shunt FACTS devices need to be placed slightly centre towards the sending end for maximum benefit from the stability point of view. The optimal location of these devices also depends on the amount of local load and through load and it is seen that as the amount of local load increases the optimal location, from the transient stability point of view,moves towards the sending-end.

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