International Journal of Electrical, Electronics and Computer Engineering **2**(2): 18-22(2013)

ISSN No. (Online): 2277-2626

Enhancement of Voltage Profile by using Fixed Capacitor- Thyristor Controlled Reactor (FC-TCR)

Ghanshyam Vishwakarma and Nitin Saxena
Department of Electrical Engineering,
Jabalpur Engineering College Jabalpur, (MP)

(Received 17 June, 2013, Accepted 05July, 2013)

ABSTRACT: This paper addresses improving the voltage stability limit of power flow between two different regions in an electric power system using the Fixed capacitor Thyristor controlled reactor (FC-TCR) or Static Var Compensator (SVC). Modelling and simulation of Static Var Compensator (SVC) for power system stability enhancement and improvement of power transfer capability have been presented in this paper. First, power flow results are obtained and then power (real and reactive power) profiles have been studied for an uncompensated system and then compared with the results obtained after compensating the system using the above-mentioned SVC device. The simulation results demonstrate the performance of the system in improving the power profile and thereby voltage stability of the same. All simulations have been carried out in MATLAB/SIMULINK environment. A methodology for determining the power flow margin is simply briefed.

Keywords: *SVC, Voltage Stability, voltage sag, power quality, Matlab/Simulink, FC_TCR.*

I. INTRODUCTION

Increased use of transmission facilities owing to higher industrial demand and deregulation of the power supply industry has provided the necessity for exploring new ways of maximizing the power transfers of existing transmission facilities, while maintaining acceptable levels of system reliability and stability [1]. In such an environment, application of the Flexible AC Transmission System (known as FACTS) in power systems has become an issue of great concern. The FACTS facilitates power flow control, increased power transfer capability, and enhances the security and stability of power systems without expanding transmission and generation utilities.

Excellent applications of FACTS controllers, such as the unified power flow controller (UPFC), and the Static Synchronous Compensator (STATCOM), have yielded successful results [2]. It has been shown in recent case studies that FACTS can provide a more flexible stability margin to power systems and also improve power transfer limit in either shunt or series compensation [3, 4].

This paper focuses on studying the effect of SVCs on the voltage stability limit of interface flow. Interface flow limit is defined as the maximum power transfer that can be allowed through interface lines connecting two regions of a power system in terms of the steady-state voltage stability.

A power flow model of a SVC is proposed to make a practical study of the influence of SVCs on the interface flow limit. The SVC, a gate turn-off (GTO) thyristor based shunt voltage source inverter (VSI), injects the shunt-compensating voltage almost in quadrature with the line current, controlling the line impedance and active power flow. The SVC power flow model is obtained by adding such control characteristics to the VSI injection model. This model of SVC compensated system is described in the next points with the simulation model and its results were described.

II. THEORETICAL DESCRIPTION

Static VAR compensated FACTS device are the most important device and have been used for a number of years to improve voltage and power flow through the transmission line by resolving dynamic voltage problems. SVC is shunt connected static generator/absorber. Utilities of SVC controller in transmission line are many:

a) Provides high performance in steady-state and transient voltage stability control.
b) Dampen power swing.
c) Reduce system loss.
d) Control real and reactive power flow.

Simple FC-TCR type SVC configuration is shown in figure 1. In FC-TCR, a capacitor is placed in parallel with a thyristor controlled reactor. Is, Ir and Ic are system current, reactor current and capacitor current respectively which flows through the FC-TCR circuit. Fixed capacitor- Thyristor controlled reactor (FC-TCR) can provide continuous lagging and leading VARS to the system [5]. Circulating current through the reactor (Ir) is controlled by controlling the firing angle of back-back thyristor valves connected in series with the reactor. Leading var to the system is supplied by the capacitor. For supplying lagging vars to the system, TCR is generally rated larger than the capacitor.

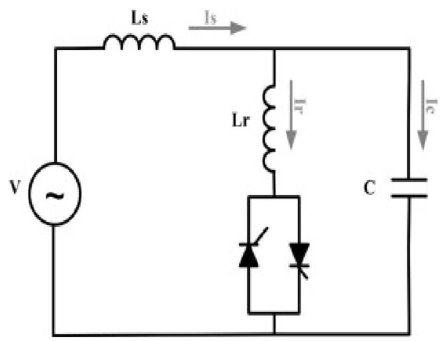


Fig. 1. SVC system.

III. MODELLING OF THE DEVICES

The modelling of SVC compensated system is described as given below. The system is modelled by using MATLAB/SIMULINK. And their results are obtained by simulation of the system.

A. Uncompensated system

Fig. 2 shows the basic transmission (11kV, 50Hz) model of an uncompensated system. This model consists of different buses at which the simulation results were obtained by scopes. 11kv voltage is supplied from the AC voltage source to the system. Source resistance and inductances are 0.01Ω and 0.01H and load is kept constant at 30KW and 10KVAR for the above transmission line model. Simulation is done using MATLAB/SIMULINK.

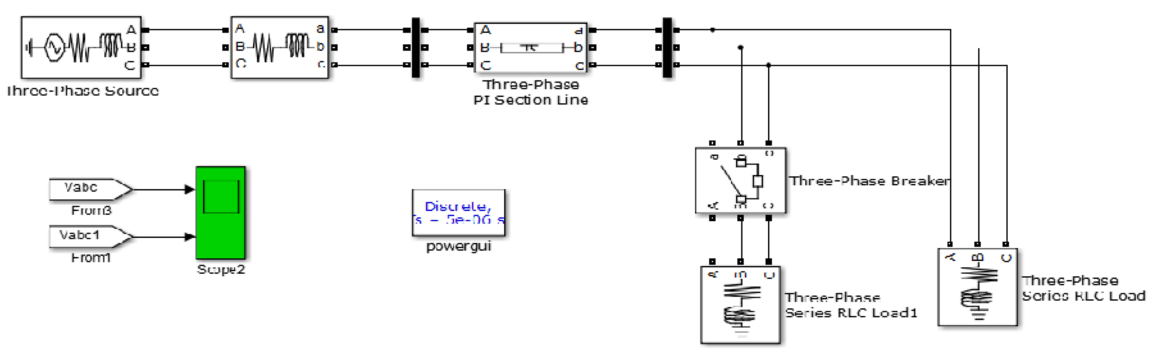


Fig. 2. Uncompensated system.

B. SVC Compensated model

The compensated system model is shown in the given figure 3 below which consists of a voltage source three phase transmission line a SVC subsystem. This model is simulated by using MATLAB. And we got the simulation results as shown below in Fig. 3.

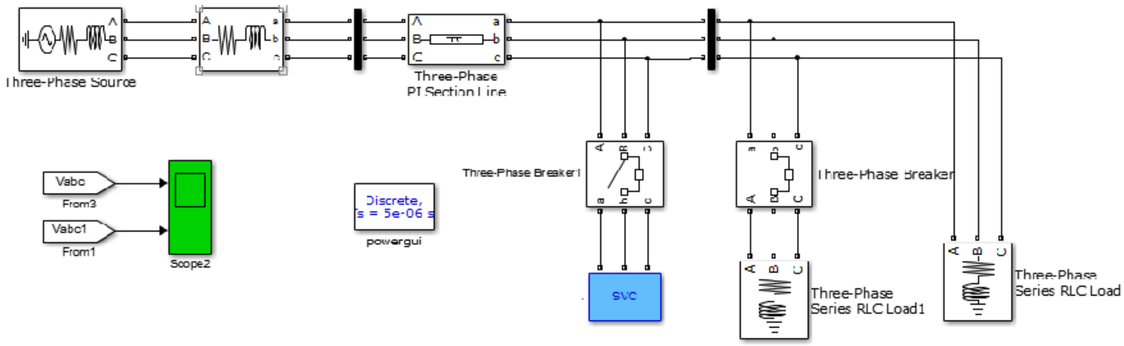
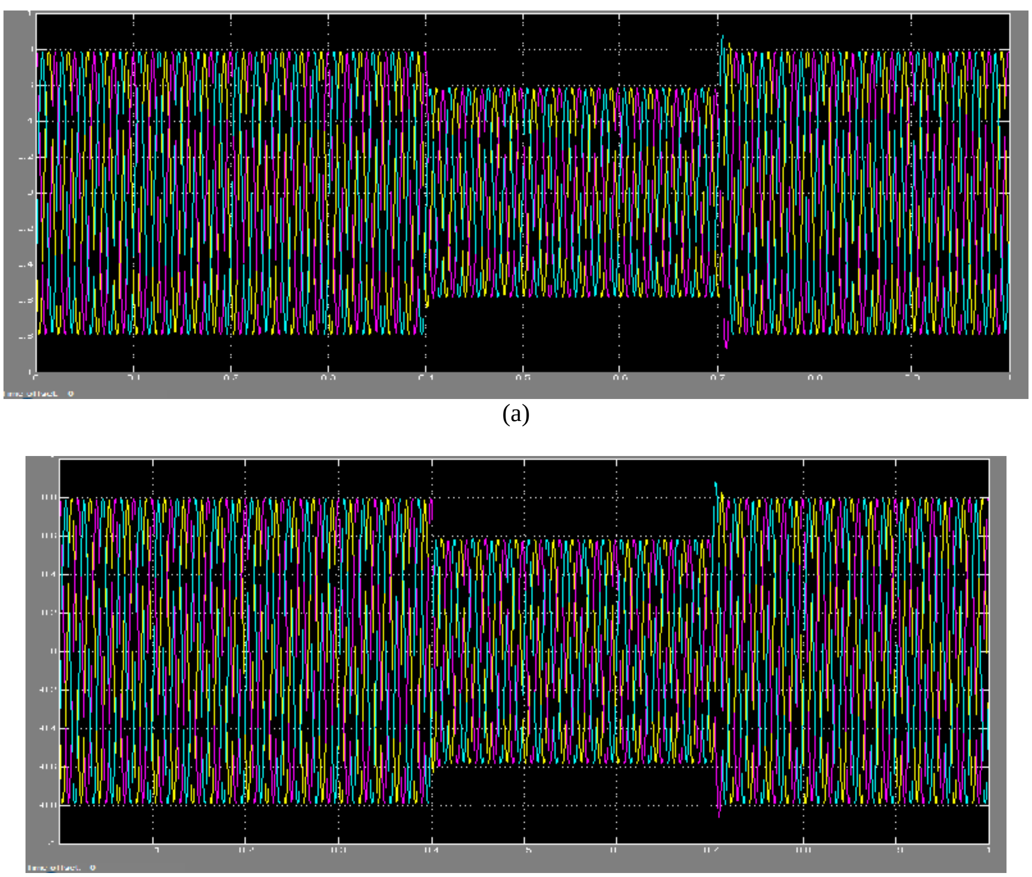


Fig. 3. SVC Compensated system for voltage sag.

IV. RESULTS AND DISCUSSION

Simulation result of uncompensated system is as shown below in which voltage sag will occur for the time in between 0.4 to 0.7 seconds and the whole voltage magnitude will also be less than that of 1 p.u. value for both the buses i.e. for bus1 and for bus2. We have to compensate the above system by using SVC system so that we can get the actual voltage profile. After we get the updated voltage profile we change the values of simulation result will represent that the voltage profile is compensated and the magnitude of the voltage profile is also maintained at the actual voltage. So the above results will show that this device can improve and maintain the voltage profile constant so that the system may not collapse for the small duration at which the fault will occur.

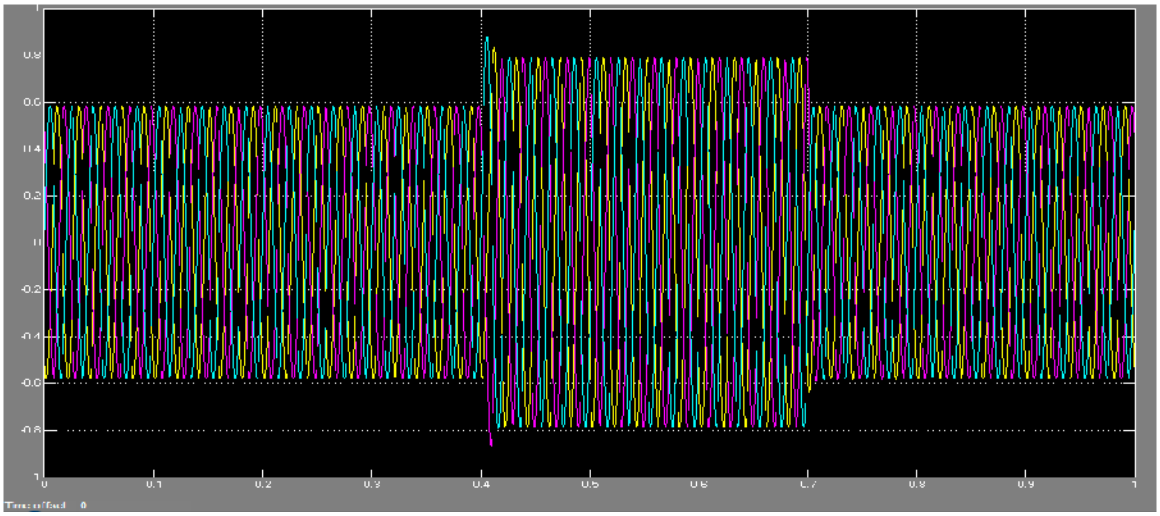


(a)

(b)

Fig. 4 (a) Voltage sag at BUS 1 (b) Voltage sag at BUS 2.

The above two figures shows that the voltage sag will occur in the system due to the transition time given in the system. Due to this transition time the system may get collapse, so we have to remove the transients in the system. An SVC system is connected in parallel to the system. SVC will compensate the transients or sag of the system. Same as sag, swell will also make problems to the power quality of the system. So swell must also have to be removed for better power quality. The swell and its related simulation result will be shown in the given figure below 4(a) and 4(b) respectively.



(a)

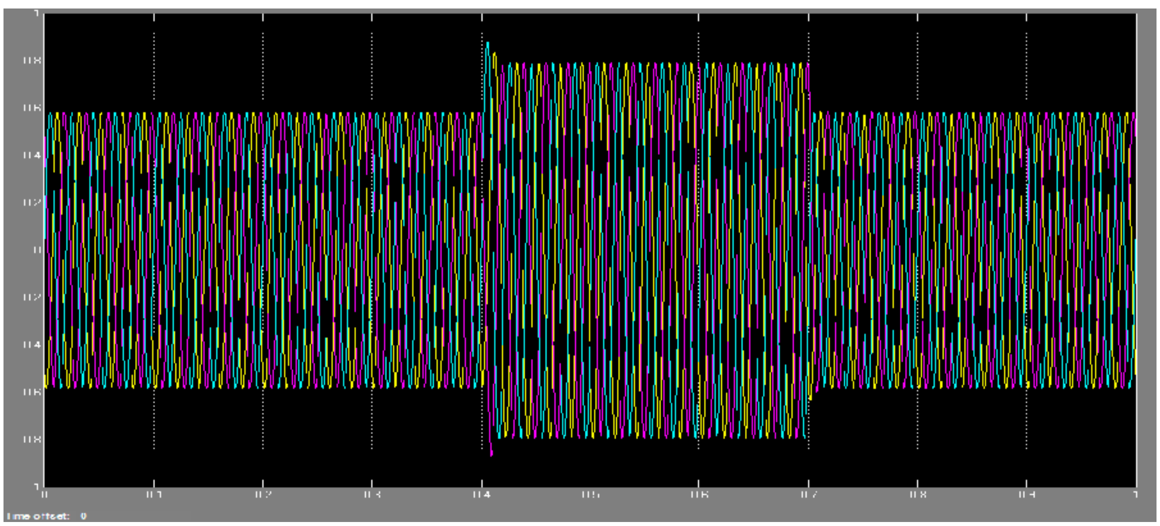


Fig. 5. Simulation result of an Uncompensated system.
(a) voltage swell at BUS 1 (b) voltage swell at BUS 2.

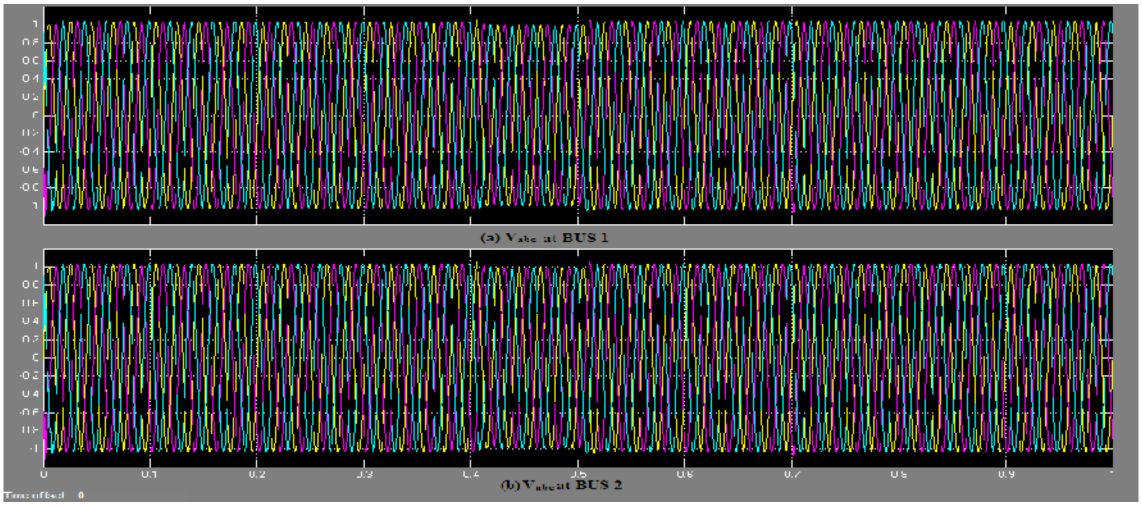


Fig. 6. Simulation result of SVC Compensated system.

V. CONCLUSION

From the above simulation we conclude that SVC is able to compensate the voltage sag as well as voltage swell. It also increases the power transmission capability.

The simulation results indicated a considerable increase in power flow limit by SVC compensation. Further study on impacts of various FACTS controllers such as UPFC, STATCOM, etc. should be carried out to seek for the most effective way of increasing the power flow limit.

REFERENCES

[1]. CIGRE, "*FACTS Overview*", *IEEE Power Engineering Society*, 95 TP 108, April 1995.

[2]. N.G Hingorani & Laszlo Gyugyi, "*Understanding FACTS: concepts and technology of flexible AC transmission System*", IEEE Press, New York (2000*).*

[3]. K.R. Padiyar, "FACTS controllers in power transmission and distribution,"New Age Int. Publisher, 2007.

[4]. Abhijit Chakrabarti & Sunita Halder, "*Power System Analysis Operation and Contro*l". Prentice Hall of India Pvt. Limited, New Delhi, 2006.

[5]. Anulekha Saha, Priyanath Das and Ajoy Kumar chakraborty, "Performance Analysis and Comparison of Various FACTS Devices in Power System*", International Journal of Computer Applications,* Vol. **46,** No.15, May 2012.

[6]. M. P. Donsion, J. A. Guemes, J. M. Rodriguez, "Power Quality Benefits of Utilizing FACTS Devices in Electrical power System", *IEEE* 2007, 26-29.