International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 11 | Nov 2018 www.irjet.net p-ISSN: 2395-0072

Analysis of Power System Stability Using Various FACTS Controllers

K. Madumathi[1], C.Yasodha[2], S.Vadivel[3], T. Somasundaram[4]

[1,2,3]Assistant Professor/EEE, Mahendra Institute of Technology, Mallasamudram, Tamilnadu, India
[4]Associate Professor/EEE, Mahendra Institute of Technology, Mallasamudram, Tamilnadu, India

***

Abstract - *Now a days the power system are often subjected to various disturbances such as generator malfunctioning, outage of a transmission line, various types of faults like symmetrical or short circuit faults, asymmetrical faults like line to ground fault, line to line fault, double line to ground fault, various losses in transmission line, thermal issues etc. the protection of power system under these circumstances is a tedious and complicated process. This paper deals the stability of power system by introducing different types of flexible AC transmission system (FACTS) controllers onto the various parts of the power system. The analysis is carried out using MATLAB/Simulink software.*

Key Words: **FACTS, TCSC, SVC, STATCOM, UPFC, SSSC**

1. INTRODUCTION

In the evolving utility environment, financial and market forces are and will continue to demand a more optimal and profitable operation of the power system with respect to generation, transmission and distribution. To achieve both operational reliability and financial profitability, it has become clear that more efficient utilization and control of the existing transmission system infrastructure is required. A technically attractive solution to solve above problem is to use some efficient controls with the help of FACTS (Flexible AC Transmission Systems) devices. FACTS technologies allow for improved transmission system operation with minimal infrastructure investment, environmental impact, and implementation time compared to the construction of new transmission lines [4].

Power system stability is defined as the property of a power system that aids it to remain in a state of operating equilibrium under normal operating conditions as well as in disturbed conditions and to regain an acceptable state of equilibrium after being subjected to a disturbance which may be small or big. If the disturbance is small it is small signal stability and if the disturbance is large it is referred as large signal stability. The major classification of stability is rotor angle stability and voltage stability based on rotor angle and voltage deviations [2].

Mahajan et al [2018] describes the improvement in stability of power system with the help of facts controllers. The controllers chosen for the study were SVC and TCSC. Based on the result it has been observed that introduction of TCSC in place of SVC has better performance.

2. FACTS CONTROLLERS

The swift development of power electronic technologies provides exciting opportunities to develop new power system equipment for better utilization of enhancing the security, capacity and flexibility of power transmission systems. FACTS solutions empower the power grid owners to increase the existing transmission network capacity keeping in mind of maintaining or improving the operating margins necessary for the stability of grid. Supply of reliable, high quality electrical energy at a reasonable energy at a reasonable cost is at the heart of the nation's economy.

- Static Var Compensator (SVC)
- Static Synchronous Compensator (STATCOM)
- Static Synchronous Series Controller (SSSC)
- Unified Power Flow Controller (UPFC)
- Thyristor Controlled Series Compensator (TCSC)

Static Var Compensator (SVC), the first generation of FACTS, which was brought to market nearly twenty years ago. The SVC consists of a fast thyristor switch controlling a shunt capacitor bank, which help provide voltage support for heavy loads near the end of a line. It also contributes to system stability but do not control power flow directly.

Static Synchronous Compensator (STATCOM) also named Advanced Static Var Generator (ASVG), the second generation of FACTS, is a new reactive power compensator that overcomes the technical limitations and high cost of the SVC. The development of STATCOM is based on the use of Gate Turnoff (GTO) thyristors which is basically a voltage source inverter that converts the dc voltage at its input terminals into a three phase set of output voltages. The STATCOM that can either generate or absorb reactive power, is superior to SVC in providing the voltage support. It also can respond quickly to damp any big disturbances on the power system.

Static Synchronous Series Compensator (SSSC) which is similar with STATCOM except its output transformer connected in series with the line, is in the design stage and expected to be selected for utility demonstration quit soon.

Unified Power Flow Controller (UPFC), the third generation of FACTS and the most versatile FACTS device consists of one STATCOM and one SSSC connected by a common dc link that includes a storage capacitor. UPFC will be the first FACTS device having the unique ability to simultaneously control all three parameters of power flow voltage, line impedance and phase angle. This combination of functions gives the UPFC a unique capability to control simultaneously both real and line reactive power flows on a transmission corridor.

Thyristor Controlled Series Capacitor (TCSC) is a capacitive reactance compensator which consists of a series capacitor bank shunted by a thyristor controlled reactor in order to provide a smoothly variable series capacitive reactance. TCSC's are an excellent tool to introduce if increased damping is required when interconnecting large electrical systems. They can overcome the problem of sub-synchronous resonance, a phenomenon that involves an interaction between large thermal generating units and series compensated transmission systems.

3. SIMULATION AND RESULTS

The VI characteristic and the output voltage of SVC are shown in Figure 3.1 & 3.2

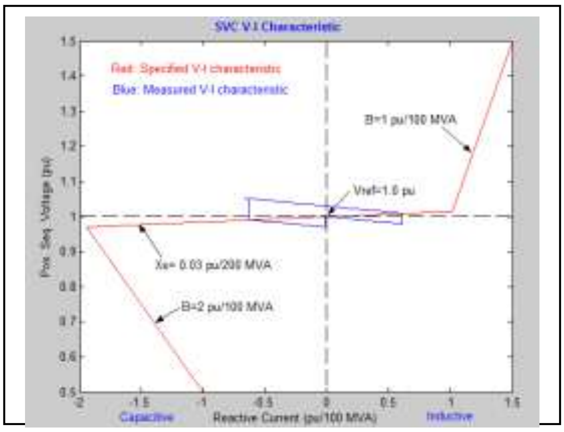

Fig 3.1 VI characteristic of SVC

Fig 3.3 & 3.4 represent the reference voltage and reactive power & output voltage and reactive power of STATCOM respectively.

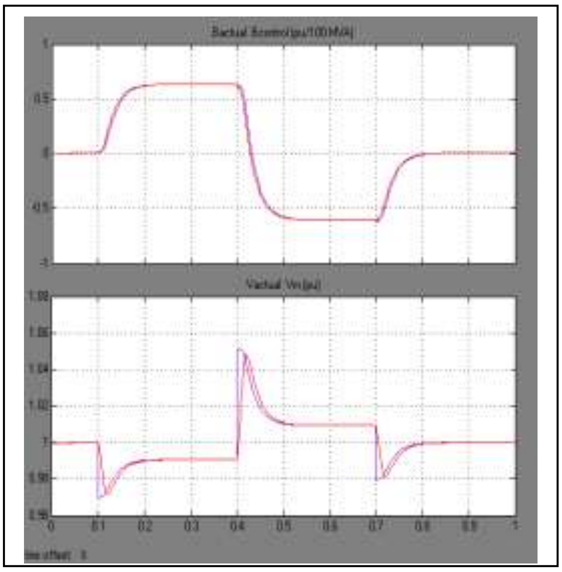

Fig 3.2 Output waveform of SVC

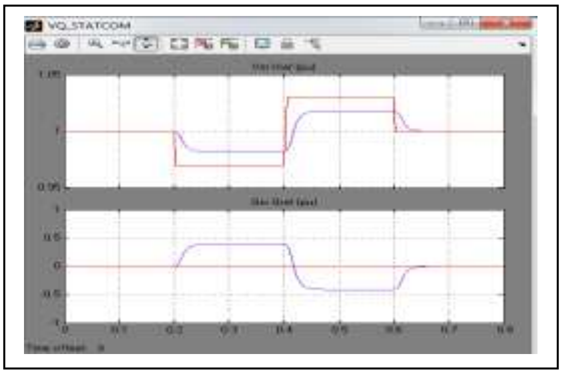

Fig 3.3 Reference voltage and reactive power of statcom

Fig 3.5 shows the output voltage magnitude and phase angle of TCSC. Fig 3.6 shows the SSSC operation with and without power oscillation damping.

Fig 3.7 shows the output voltage and power of SSSC. Fig 3.8 shows the real power and reactive power of UPFC and Fig 3.9 shows the voltage magnitude and phase angle of UPFC.

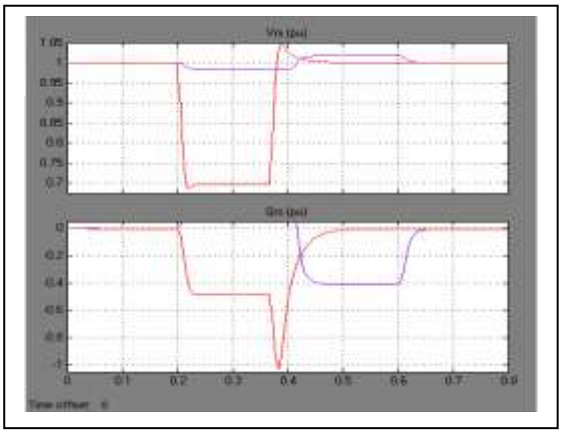

Fig 3.4 Output voltage and reactive power of statcom

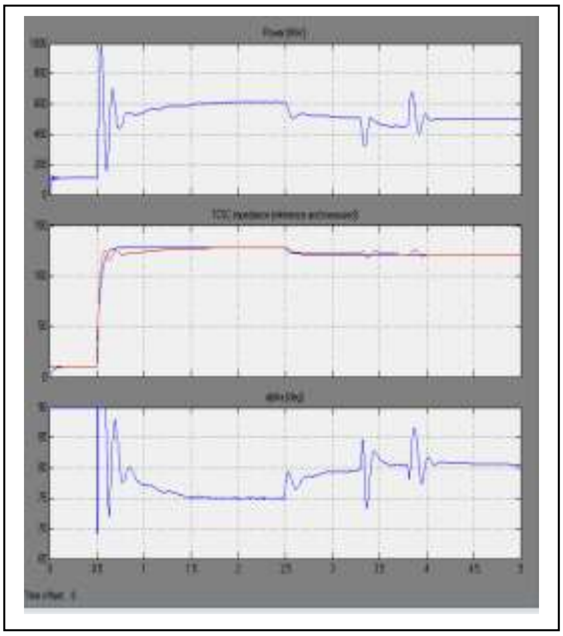

Fig 3.5 Output voltage and angle of TCSC

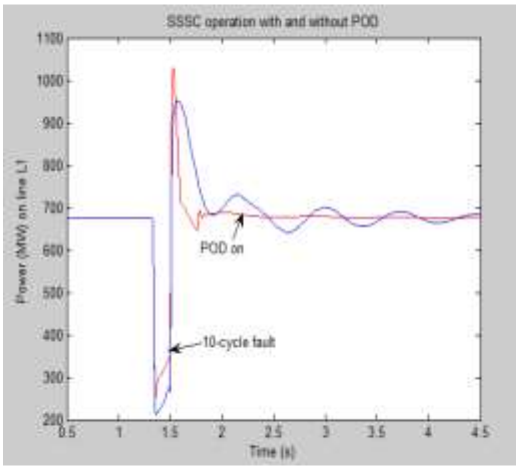

Fig 3.6 SSSC operation with and without POD

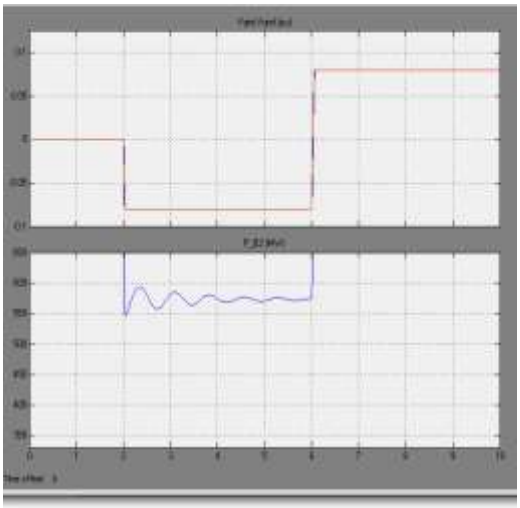

Fig 3.7 Output voltage and Power of SSSC

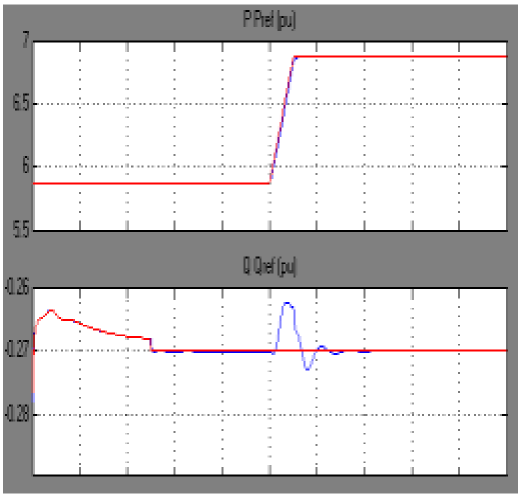

Fig 3.8 Real power and Reactive power of UPFC

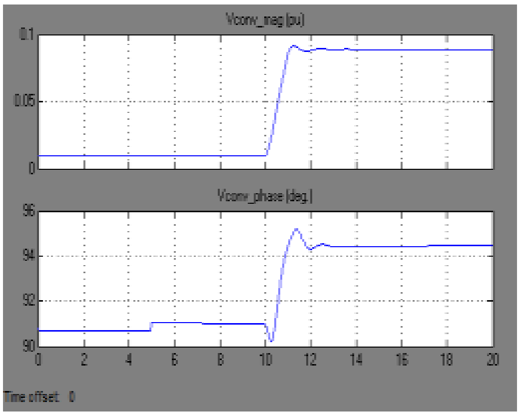

Fig 3.9 Voltage magnitude and phase angle of UPFC

CONCLUSION

The series capacitor controls capacitor, switched shunt capacitor and reactor controls voltage, phase shifting transformer controls voltage, these features are incorporated in different types of facts controllers. The main benefit that FACTS controller solutions provide is the cycling/repeatability and smooth control that accompanies the power electronic based switching. Fault current is limited, transient and dynamic stability has been improved.

ACKNOWLEDGEMENT

We would like to thank The Management, The Principal and Department of Electrical and Electronics Engineering of Mahendra Institute of Technology, Mallasamudram to carry out this research.

REFERENCES

[1]. P. Kundur, J. Paserba, V. Ajjarapu, G. Andersson, A. Bose, C. Canizares, N. Hatziargyriou, D. Hill, A. Stankovic, C. Taylor, T.V. Cutsem, and V. Vittal, "Definition and classification of power system stability: IEEE/CIGRE joint task force on stability terms and definitions," IEEE Trans. Power Syst., vol. 19, no. 3, pp. 1387–1401, Aug. 2004.

[2]. P. Kundur, Power System Stability and Control. New York, NY, USA: McGraw-Hill, 1994.

[3]. V. Mahajan, "Power System Stability Improvement with Flexible A .C. Transmission System (FACTs) Controller," Power System Technology an IEEE Power India Conference, POWERCON 2008.

[4]. C.Ravichandran, T A Raghavendiran (2013), "Flexible AC Transmission Systems".

[5]. M. Muruganandam M. Kirubavathi, G. Dineshkumar, "Fault Current and Overvoltage Limitation in a Distribution Network with Distributed Generation

units Through Superconducting Fault Current Limiter", International Journal of Engineering Research & Technology, vol.3 , issue.11, pp. no. 1442-1445, Nov. 2014

[6]. S.Sindhuja, K.Madumathi, M.Muruganandam, S.Saravanan, "Improving the stability of a two bus system using shunt active filter", IJIRSET, Vol.4, Special Issue 6, May 2015.

[7]. S.Lal, K.Madumathi, M.Muruganandam, S.Saravanan, "Battery Energy Storage Station (BESS) Based Smoothing Control of Photovoltaic (PV) and Wind Power Generation Fluctuations", IJIRSET, Vol.4, Special Issue 6, May 2015.

BIOGRAPHIES

Madumathi is working as Assistant Professor in EEE department in Mahendra Institute of Technology. She is having more than 10 years of teaching experience. Her areas of interest include control system, power system analysis and renewable energy.

Yasodha is working as Assistant Professor in EEE department in Mahendra Institute of Technology. She is having more than 8 years of teaching experience. Her areas of interest include Electrical Machines & Power system Transient.

Vadivel is working as Assistant Professor in EEE department in Mahendra Institute of Technology. He is having more than 5 years of teaching experience. His areas of interest include Electrical drives and control and power electronics.

Prof.T.Somasundaram is working as Head of the EEE department in Mahendra Institute of Technology. He is having more than 18 years of teaching experience. His areas of interest include Solid state drives and power electronics.