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Design of STATCOM for Power System Stability Improvement

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[1]

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Abstract

This paper presents the model of a STATCOM which is controlled externally by a newly designed Power Oscillation Controller(POC) for the improvements of power system stability and damping effect of an on line power system. The proposed POC consists of two controllers(PID POD).PID parameters has been optimized by ZiglerNecles close loop tuning method. Machine excitation has been controller by using excitation controlleras required. Both single phase and three phase faults has been considered in the research. In this paper, A power system network is considered which is simulated in the phasor simulation method the network is simulated in three steps; without STATCOM, With STATCOM but no externally controlled, STATCOM with Power Oscillation Controller(POC). Simulation result shows that without STATCOM, the system parameters becomes unstable during faults. When STATCOM is imposed in the network, then system parameters becomes stable. Again, when STATCOM is controlled externally by POC controllers, then system voltage power becomes stable in faster way then without controller. It has been observed that the STATCOM ratings are only 20 MVA with controllers and 200 MVA without controllers. So, STATCOM with POC controllers are more effective to enhance the voltage stability and increases power transmission capacity of a power system .So STATCOM with POC excitation controllers, the system performance is greatly enhanced.

Index terms— STATCOM, voltage regulator, power system controller, PID, POD, power oscillation controller (POC), MATLAB simulink.

1 Design of STATCOM for Power System Stability Improvement

Sohel Hossain ? , Atiqur Rahman Khan ? & Jannat-E-Noor ?

Abstract-This paper presents the model of a STATCOM which is controlled externally by a newly designed Power Oscillation Controller (POC) for the improvements of power system stability and damping effect of an on line power system. The proposed POC consists of two controllers (PID & POD). PID parameters has been optimized by Zigler Necles close loop tuning method. Machine excitation has been controller by using excitation controller as required. Both single phase and three phase faults has been considered in the research. In this paper, A power system network is considered which is simulated in the phasor simulation method & the network is simulated in three steps; without STATCOM, With STATCOM but no externally controlled, STATCOM with Power Oscillation Controller (POC). Simulation result shows that without STATCOM, the system parameters becomes unstable during faults. When STATCOM is imposed in the network, then system parameters becomes stable. Again, when STATCOM is controlled externally by POC controllers, then system voltage & power becomes stable in faster way then without controller. It has been observed that the STATCOM ratings are only 20 MVA with controllers and 200 MVA without controllers. So, STATCOM with POC controllers are more effective to enhance the voltage stability and increases power transmission capacity of a power system .So STATCOM with POC & excitation controllers, the system performance is greatly enhanced.

2 INTRODUCTION

ower system stability improvements is very important for large scale system. The AC power transmission system has diverse limits, classified as static limits and dynamic limits [1][2].Traditionally, fixed or mechanically switched shunt and series capacitors, reactors and synchronous generators were being used to enhance same types of stability augmentation [3].

For many reasons desired performance was being unable to achieve effectively. A STATCOM is an electrical device for providing fast-acting reactive power compensation on high voltage transmission networks and it can contribute to improve the voltage profiles in the transient state and therefore, it can improve the qualities and performances of the electric services [3]. An STATCOM can be controlled externally by using properly designed different types of controllers which can improve voltage stability of a large scale power system. In previous study Authors has d signed a PID controller which has tuned by Triple Integral Differential (TID) tuning method [4]. However, in this study, With a view to get better performance, A new Power Oscillation Controller (POC) has been designed & proposed for STATCOM to injects Vqref externally for the improvement of power system stability. Therefore, thyristor based STATCOM with POC controllers has been used to improve the performance of power system.

3 II.

4 CONTROL CONCEPT OF STATCOM

A static synchronous compensator (STATCOM), also known as a "static synchronous condenser" ("STATCON"), is a regulating device used on alternating current electricity transmission networks. It is based on a power electronics voltage-source converter and can act as either a source or sink of reactive AC power to an electricity network. If connected to a source of power it can also provide active AC power. It is a member of the FACTS family of devices. Usually a STATCOM is installed to support electricity networks that have a poor power factor and often poor voltage regulation. A STATCOM is a voltage source converter (VSC)-based device, with the voltage source behind a reactor. The voltage source is created from a DC capacitor and therefore a STATCOM has very little active power capability. However, its active power capability can be increased if a suitable energy storage device is connected across the DC capacitor. The reactive power at the terminals of the STATCOM depends on the amplitude of the voltage source **??**5].diagram.

5 III.

6 POWER SYSTEM MODEL

This example described in this section illustrates modeling of a simple transmission system containing 2-hydraulic power plants [Fig. **??**]. STATCOM has been used to improve transient stability and power P Figure **??** : Single line diagram of 2-machine power system A single line diagram represents a simple 500 kV transmission system is shown in Fig. **??** [6].In the proposed plan because resistor is low cost than potential transformer. A 1000 MW hydraulic generation plant (M1) is connected to a load centre through a long 500 kV, total 700km transmission line. A 5000 MW of resistive load is modelled as the load centre. The remote 1000 MVA plant and a local generation of 5000 MVA (plant M2) feed the load. A load flow has been performed on this system with plant M1 generating 950 MW so that plant M2 produces4046 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 centre by a 200MVAR STATCOM [Fig. **??**].The STATCOM does not have any controller unit. Machine & STATCOM parameters has been taken from reference **??**5].The complete simulink model of STATCOM with power system controller is shown in Fig. 4. To maintain system stability after faults, the transmission line is shunt compensated at its centre by a 200MVAR STATCOM with power system controller. The two machines are equipped with a hydraulic turbine and governor (HTG) [Fig. **??**], excitation system. Any disturbances that occur in power systems due to fault, can result in inducing electromechanical oscillations of the electrical generators. Such oscillating swings must be effectively damped to maintain the system stability.

IV.

7 SIMULATION RESULTS

The load flow solution of the above system is calculated and the simulation results are shown below. Two types of faults: A. single line to ground fault & B. Three phase fault have been considered. The process of selecting the controller parameters to meet given performance specifications is called PID tuning. Most PID controllers are adjusted onsite, many different types of tuning rules have been proposed in the literature [4]. Using those tuning rules, delicate & fine tuning of PID controllers can be made onsite. Also automatic tuning methods have been developed and some of the PID controllers may possess on-line automatic tuning capabilities [4]. The PID controller has three term control signal [4], (1) In Laplace Form, (2) Alternator state can be sensed by a feedback.

If any faults occur in network then HTG changes the speed of machine & Machine excitation can be changed by excitation controller.? ? ? ? ? ? ? ? ? + + = S T S K s G C d i p * T 1 1) (? ? ? ? ? ? ? ? ? + + = S P S K s G C

Inside the excitation controller, a MATLAB program has been sets so that machine excitation will change as required to regain system stability.

8 VII.

9 SIMULATION RESULTS WITH POC

The network remains same [Fig. **??**], just simple STATCOM is replaced by power system controlled STATCOM. During fault, machines speed deviation (d?) & Line voltage (Vabc), Line current (Iabc) are always monitored by power system controller & taking input of those oscillation, after processing as shown in Fig. **??**3, it reduces damping of power system oscillation & helps STATCOM to improve stability. Two types of faults has been considered: A. Single line to ground fault and B. Three phase fault.

10 RESULTS & CONCLUSION

11 CONCLUSION

This paper presents the power system stability improvement i.e. voltage level, machine oscillation damping, real power system model of STATCOM without or with proposed Power Oscillation Controller for different types of faulted conditions. POC is also a very efficient controller then others for STATCOM to enhance the power system stability. From above results, this proposed Zigler-Nicles close loop tuning method for selecting PID controller parameters & POD, In combine, Power Oscillation Controller may be highly suitable as a STATCOM controller because of shorter stability time, simple designed, low cost & highly efficient controller. Machines DC Excitation can also be controlled easily by using excitation controller. Rather that, If POC controller is used then only small rating of STATCOM becomes enough for stabilization of robust power system within very shortest possible time for both steady state & dynamic conditions. These proposed Power Oscillation Controller can be applied for any interconnected multimachine power system network for stability improvement.

These controller can be applied to another FACTS devices namely SSSC, UPFC whose controllers may be controlled externally by designing different types of controllers which also may be tuned by using different algorithm i.e. Fazzy logic, ANN, Genetic algorithm, FSO etc. for both transient and steady state stability improvement of a power system. [1] [2] [3]

Figure 1:

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Figure 2: F 2 2014 Figure 2 :Figure 3 :

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Figure 3: Figure 5 :Figure 6 :

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Figure 4: Figure 7 :

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Figure 5: Figure 4 :

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Figure 6: Figure 10 :

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The performance of the proposed Power Oscillation Controller with STATCOM has been summarized in the table-I. In table-I, ? (infinite time) means the system is unstable, STATCOM rating in MVA. The network is simulated in three steps; without STATCOM, With STATCOM only, STATCOM with proposed Power Oscillation Controller (POC) & Excitation controller.

Controller Status	Controller	1-Ø fault (Stability time)		3-Ø fault (Stability time)	
Controller STATCOM	Rating	Volt	P,Q	Volt	P,Q
No STATCOM	0 MVA	?	?	?	?
STATCOM 200 MVA		3s	3s	5s	5s
STATCOM + POC	20 MVA	0..25s	0.25s	0.25s	0.25s

IX.

Figure 7: Table 1 :

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[2]Year 2014 system oscillations damping. The phasor simulation method can be used.
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[Ye et al. ()] 'Current-source converter. Based STATCOM: Modeling and control'. Y Ye , M Kazerani , V H Quintana . *IEEE Transactions on Power Delivery* 2005. 20 (2) p. .

[Hasan Fayazi Boroujeni et al. (2012)] 'Dynamic Stability Improvement by Using STATCOM in a Multi Machine Environment'. Mehran Hasan Fayazi Boroujeni , Mostafa Amani , Abdollahi . *Research Journal of Applied Sciences, Engineering and Technology* 2040-7467. 2012. September 15, 2012. 4 (18) p. .

[MATLAB Math Library User's Guide] *MATLAB Math Library User's Guide*, Math Works. Inc.

[Lehn et al. ()] *Novel reactive power controllers for the STATCOM and SSSC*, P W Lehn , M R El-Moursi , MS , A M Sharaf . 2006. (Electric Power Systems)

[Furini et al. ()] 'Pole placement by coordinated tuning of Power System Stabilizers and FACTS-POD stabilizers'. M A Furini , A L S Pereira , P B Araujo . *Int. J. Elec. Power Energ. Syst* 2011. 33 (3) p. .

[Habibur and Fayzur (2012)] *Power System Stability Improvement By Using SVC With TID Tuned PID Controller*, Dr Habibur , Harun Fayzur . October-2012. India. 1 p. . IJARCET