Global Journals LaTeX JournalKaleidoscope™

Artificial Intelligence formulated this projection for compatibility purposes from the original article published at Global Journals. However, this technology is currently in beta. *Therefore, kindly ignore odd layouts, missed formulae, text, tables, or figures.*

Improvement of Power System Stability by using SVC with Cascade PID Controller

Pranoy Kumar Singha Roy[1], G.K.M. Hasanuzzaman[2] and Md. Moniruzzaman[3]

[1]

Received: 11 December 2012 Accepted: 1 January 2013 Published: 15 January 2013

Abstract

In power system, one most crucial problem is maintaining system stability. The main reasons for occurring stability problem in the system is due to the fault occurs in the system. In this paper the effect of SVC on voltage stability is investigates using cascade Proportional Integral Differential controller.SVC is a shunt type FACTS device which is used in power system primarily for the purpose of voltage and reactive power control. The cascade PID controller parameters has been selected by using Tyreus-Luyben settings method for primary loop controller and modified Ziegler-Nichols method for secondary loop controller. Cascade control is mainly used to achieve fast rejection of disturbance before it propagates to the other parts of the plant.PID controller in cascade architecture is the best choice compared to conventional single loop control system for controlling nonlinear processs. The primary controller is used to calculate the setpoint for the secondrary controller. The effect of fault on line with SVC and SVC with supplementary controller is also investigates. 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 SVC , With SVC but no externally controlled, SVC with cascade PID. The result of the Simulation shows that SVC with cascade PID controllers are more effective to enhance the voltage stability and increases power transmission capacity of a power system .The power system oscillations is also reduced with controllers in compared to that of without controllers. So with cascade PID controllers the system performance is greatly enhanced.

Index terms— svc, voltage regulator, cascade propotional integral differential controller, matlab simulink.

1 Introduction

he challenge facing power system engineers today is to use the existing transmission facilities to greater effect **??**1] . Power system should retain its synchronism during and after all these kind of disturbances. Therefore the transient stability is an important security in power system design. So FACTS has come to help the power system engineer **??**2][3] . The SVC is one of the important FACTS devices whose effectiveness for voltage control is well known. The AC power transmission system has diverse limits, classified as static limits and dynamic limits [4][5] .Traditionally, fixed or mechanically switched shunt and series capacitors, reactors and synchronous generators were being used to enhance same types of stability augmentation **??**6] . For Authors ? ? ?: Department of EEE, Rajshahi University of Engineering & Technology Rajshahi-6204, Bangladesh. e-mails: pronoy331@yahoo.com, g.kibria82@yahoo.com, mdmonir.eee08@gmail.com many reasons desired perfor-mance was being unable to achieve effectively. A static VAR compensator (SVC) 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 **??**6] . An SVC can be controlled externally by using properly designed different types of controllers which can improve voltage stability of a large scale power system [7] . However, in this study, With a view to get better performance, A new PID has been designed & proposed for SVC to injects V qref externally for the improvement of power system stability. The dynamic nature of the SVC lies in the use of thyristor devices (e.g. GTO, IGCT) ??6] . Therefore, thyristor based SVC with PID controllers has been used to improve the performance of 2-machine power system.

2 II.

3 Control Concept of SVC

An SVC is a controlled shunt susceptance(B) which inject reactive power (Q net) into thereby increasing the bus voltage back to its net desired voltage level. If bus voltage increases, the SVC will inject less (or TCR will absorb more) reactive power, and the result will be to achieve the desired bus voltage[Fig. 1]. Here, +Q cap is a fixed capacitance value, therefore the magnitude of reactive power injected into the system, Q net , is controlled by the magnitude of -Q ind reactive power absorbed by the TCR. The basis of the thyristor controlled reactor (TCR) which conduct on alternate half-cycles of the supply frequency. If the thyristors are gated into conduction precisely at the peaks of the supply voltage, full conduction results in the reactor, and the current is the same as though the thyristor controller were short circuited. SVC based control system is shown in Fig. 1 ??6] . for secondary loop controller. Cascade control is mainly used to achieve fast rejection of disturbance before it propagates to the other parts of the plant.PID controller in cascade architecture is the best choice compared to conventional single loop control system for controlling nonlinear processs.

4 III. SVC V-I characteristics

In voltage regulation mode (the voltage is regulated within limits as explained below). b). In VAR control mode (the SVC susceptance is kept constant). From V-I curve of SVC, From Fig. 2 [3], V=V ref +X s .I,: In regulation range(-Bc max <B<Bc max) V=I/Bc max , , : SVC is fully Capacitive(B=Bc max) V=1/Bl max , : SVC is fully inductive(B=Bl max)

5 Power System Model

This example described in this section illustrates modelling of a simple transmission system containing 2-hydraulic power plants[Fig. ??]. SVC has been used to improve transient stability and power system oscillations damping. The phasor simulation method can be used. A single line diagram represents a simple 500 kV transmission system is shown in Fig. ??[9]. Another machine is swing generator.PID is used in the model to add damping to the rotor oscillations of the synchronous machine by controlling its excitation current [5] . 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 and reduce the risk of stepping out of synchronism.

V.

6 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.

Consider a 1-phase fault occurred at 0.1s & circuit breaker is opened at 0.2s (4-cycle fault), Without SVC, the system voltage, power & machines oscillates goes on unstable[Fig. (5,7,9)]. But if SVC(without controller) is applied then voltage becomes stable within 3s [Fig. ??], power becomes within 3s[Fig. ??] & machines oscillation becomes stable within 4.5s [Fig. 10]. All results has been summarized in table-III

7 Designe of Cascade Propotional Integral Differtional Controller (PID)

The Tyreus-Luyben procedure is quite similar to the Ziegler-Nichols method but the final controller settings are different. Tyreus-Luyben PID Controller, the values of delay time, rise time, and settling time are better in comparison with Modified Ziegler-Nichols method. Also this method only proposes settings for PI and PID controllers. These settings that are based on ultimate gain and period are given in table 1. For some control loops the measure of oscillation, provide by ¼ decay ratio and the corresponding large overshoots for set point changes are undesirable therefore more conservative methods are often preferable such as modified Z-N settings In this method, the parameter is selected as T i =?,T d =0. Using the proportional controller Action dt t de T K dt t e T K e(t) K t u d p i p p) ( ) ( ) (? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? ? S S d i p T T 1 1 K E(s) U(s) K p =0.2K cr , T i =0.5P cr , T d =0.33P cr

Notice that the PID controller tuned by proposed Ziegler-Nichols tuning methods rules as follows,

8 Simulation Results

The network remains same [

9 Results & Discussions

The performance of the proposed PID Controller with SVC has been summarized in the table -III. In table-III, ? (infinite time) means the system is unstable, SVC rating in MVA. The network is simulated in three steps; without SVC, With SVC, SVC with proposed CASCADE PID Controller.

10 Conclusion

The obtained results of the conducted investigations along with the associated simulation demonstrated clearly that the proposed (desinged) cascade PID controller enhanced significantly the effectiveness of the integrated SVC in the examined power controller because of shorter stability time, simple designed system. In cascade PID Controller may be highly suitable as a SVC, low cost & highly efficient controller. The proposed cascade PID for SVC is proved to be very effective of robust power system within very shortest possible time for both steady state & dynamic conditions. These proposed cascade PID Controller can be applied for any interconnected multi-machine power system network for stability improvement.

These controller can be applied to another FACTS devices namely SSSC, STATCOM, 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.

11 References Références Referencias

1

Figure 1: Figure 1 :

2 Bus Bar

Figure 2: Figure 2 :

34

Figure 3: Figure 3 :YearFigure 4 :

567891011

Figure 4: Figure 5 :Figure 6 :Figure 7 :Figure 8 :Figure 9 :Figure 10 :Figure 11 :

13

Figure 5: Figure 13 :

14

Figure 6: Fig. 14]

15

Figure 7: Figure 15 :

4

Figure 8: Fig. 4]

Figure 9:

16

Figure 10: Figure 16 :

20

Figure 11: Figure 20 :

Figure 12: s

1

Controller	Kp	Ti	Td
PI	Kcr/3.2	2.2Pcr	
PID	Kcr/3.2	2.2Pcr	Pcr/6.3

Figure 13: Table 1 :

2

Controller	Kp	Ti	Td
PI	0.2Kcr	Pcr/2	
PID	0.2Kcr	Pcr/2	Pcr/3
PID controller is tuned by the proposed both Tyreus-Luyben tuning and modified Ziegler-Nichols methods. The PID controller has three term control signal			

Figure 14: Table 2 :

3

Figure 15: Table 3 :

112 [1] [2]

[1] © 2013 Global Journals Inc. (US)

[2] © 2013 Global Journals Inc. (US) a) Designed of PID Controller

[Athay et al. (2001)] 'A Robust Control for Shunt and Series Reactive Compensators to Damp Electro Strategy mechanical Oscillations'. T Athay , R Podmore , S Virmani . *IEEE Transactions on Power Delivery* Oct. 2001. 16 (4) p. .

[Bus power, P in MW for L-L fault] *Bus power, P in MW for L-L fault*, 21. (with cascade PID)

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

[Garg] *Modeling and Simulation of Static VAR Compensator for Improvement of Voltage Stability in Power System*, Amit Garg . 2.

[Habibur and Fayzur (2012)] 'Power System Stability Improvement By Using SVC With PID Controller'. Dr Habibur , Harun Fayzur . *IJETAE* 2250-2459. July 2012. 2 (7) .

[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

[Yousef (2004)] 'Transient stability Enhancement of multi machine using Global deviation PSS'. Ali M Yousef . *Journal of Engineering sciences* April 2004. 32 (2) p. . Faculty of Engineering, Assiut University