ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology (IARJSET)

National Conference on Renewable Energy and Environment (NCREE-2015)

IMS Engineering College, Ghaziabad

Vol. 2, Special Issue 1, May 2015

STABILITY ENHANCEMENT OF SINGLE MACHINE INFINITE BUS SYSTEM USING SOLAR PV CELL

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ABSTRACT: The aim of this work is to study the dynamic performance and stability enhancement of Single Machine Infinite Bus System (SMIB) using solar pv cell. HPFC is an advanced FACTS controller which can be installed in a transmission line between the two electrical areas. The main advantage using HPFC is that it can be used to replace or supplement existing equipments. In the present thesis the Phillips-Heffron Model of SMIB Systems are presented. A proposed model of HPFC is presented and incorporated with SMIB models for analysis of the enhancement of stability. All these models are simulated using MATLAB/SIMULINK. Simulation results show that the designed controller has an excellent capability in damping power system oscillations if HPFC parameters are selected carefully. The results when compared to that of existing FACTS controllers show that HPFC gives better performance. The significance of the results are better stability and constant power supply.

Keywords: Model of SMIB Systems, FACTS controllers, Model of HPFC, MATLAB/SIMULINK. Simulation

POWER SYSTEM STABILITY

1.1 INTRODUCTION

Power system stability has been recognized as an important problem for secure system operation since the 1920s. Many major blackouts are caused by power system instability. As power systems have evolved through continuing growth in interconnections, use of new technologies and controls, and the increased operation in highly stressed conditions, different forms of system instability have emerged. A clear understanding of different types of instability and how they are interrelated is essential for the satisfactory design and operation of power systems.

1.2 DEFINITION OF POWER SYSTEM STABILITY

Power system stability is the ability of an electric power system, for a given initial operating condition, to regain a state of operating equilibrium after being subjected to a physical disturbance as in Fig.1.1 with most system variables bounded so that practically the entire system remains intact.

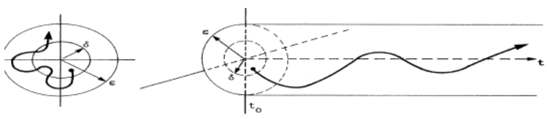
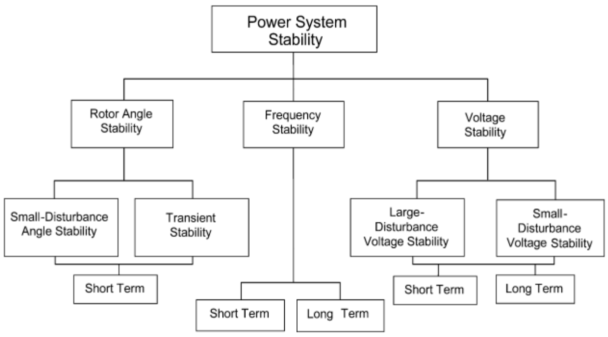


Fig.1.1 Illustration of the Definition of Stability



1.3 HYBRID POWER FLOW CONTROLLER

A block diagrammatic view of the envisioned typical HPFC application is shown in Fig.1.3. The HPFC is installed on a transmission line that connects two electrical areas. In general, its point of installation will be "within" the transmission line, i.e. at some distance from strong voltage busses.

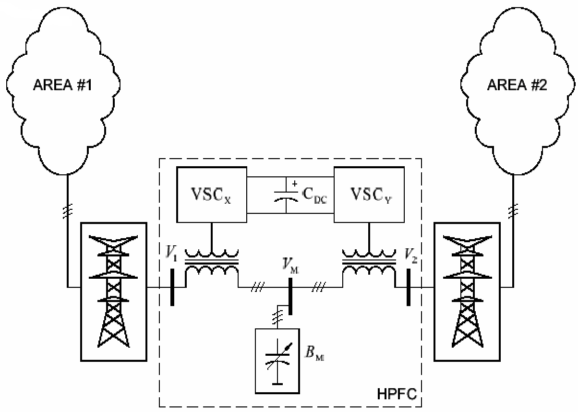


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Fig.1.3 Hybrid Power Flow Controller- Typical Application

Central to the HPFC's topology is the shunt connected source of reactive power denoted as B_M in Fig. 1.8 a switched capacitor bank, or a static VAr compensator. Next, there are two voltage–sourced converters (VSC_X and VSC_Y) connected in series with the associated line segments using coupling transformers. The converters share a common DC circuit, coupling each other's DC terminals. The DC circuit permits exchange of active power between the converters. By controlling the magnitudes and angles of voltages supplied by the converters, the flow of active power through the line and the amounts of reactive power supplied to each line segment can be simultaneously and independently controlled. The control of the shunt connected reactive element is coordinated with the control of converters to supply the bulk of the total required reactive power.

A basic comparison of this topology with that of the UPFC highlights the important features of this new circuit. In short, UPFC's shunt converter is substituted by a (presumably existing) switched capacitor, while its series converter is split into two "half-sized" ones, installed on each side of the shunt device. Such topological arrangement results in operating characteristics similar to those of the UPFC, while achieving considerable savings in the total required converter MVA ratings. The hybrid configuration for the control of power flow is introduced here [27]. This concept has been extended with the help of two VSCs.

1.9 HEFFRON- PHILIPSMODEL OF SMIB POWER SYSTEM

The SMIB system considered is a synchronous generator with type 1 excitation system connected to an infinite bus through a transmission line. The non linear generator equations are linearized around a nominal operating point to obtain a simplified linear model of SMIB system as shown in Fig. 1.4. The block diagram model shown in Fig.1.4 is known as Heffron-Philips model. By introducing a number of new constant a very compact notation is achieved. The model shall enable the user to directly implement a usable representation of an SMIB system, including the mechanical dynamics, field winding and excitation system. This implementation can be used directly for stability studies. The constants K_1 to K_6 is incorporated in Phillips-Heffron model, which govern the system configuration and operation are as follows.-

$K_1=\{E_bE_{qo}\text{Cos }\delta o/(X_e+X_q)\}+\{E_bI_{q0}\sin\delta_0(X_q-X_d')/(X_e+X_d')$ (1.12)

$K_2=\{i_{qo}(X_e+X_q)/(X_e+X_d')\}$

$K_3=(X_e+X_d')/(X_e+X_d)$ (1.14)

$K_4=E_b\sin\delta_0(X_d-X_d')/(X_e+X_d')$ (1.15)

$K_5=\{(-X_qV_{do}E_b\cos\delta_0)/((X_e+X_q)V_{to})\}-\{X_{d'}V_{do}E_b\sin\delta_0/((X_e+X_d')V_{to})\}$ (1.16)

$K_6=X_eV_{qo}/[((X_e+X_d')V_{to})]$ (1.17)

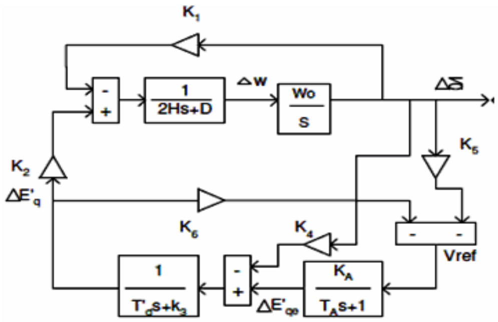

Fig 1.4Heffron -Phillips Model of SMIB

The linearized constant, K_1,K_2 are from the electric torque equation, K_3,K_4 are from field voltage equation and K_5,K_6 are from terminal voltage equation. H is inertia constant, D is the mechanical damping coefficient and T'_{do} is the transient time constant. K_A and T_A are the exciter amplifier constant and time constant where,

E_b=Infinite bus voltage

E_{q0} = Initial quadrature axis component

δ_0 = Initial power angle

i_{q0} = Initial armature current quadrature axis components

X_d, X_q= Direct and quadrature axis reactance

X_e = Exciting reactance

V_d,V_q = Stator terminal voltage, direct and quadrature axis components

This simplified model can be described by state space representation as follows:

$X[t] = AX[t] + BU[t]$ (1.18)

$Y[t] = CX[t] + DU[t]$ (1.19)

$$A=\begin{bmatrix} 0 & \omega_R & 0 & 0 & 0 & 0 \\ \frac{-K_1}{2H} & \frac{-D}{2H} & \frac{-K_2}{2H} & 0 & 0 & 0 \\ \frac{-K_4}{\tau'_{do}} & 0 & \frac{-1}{K_3\tau'_{do}} & \frac{1}{\tau'_{do}} & 0 & 0 \\ 0 & 0 & 0 & \frac{-K_E}{T_E} & \frac{1}{T_E} & 0 \\ \frac{-K_AK_5}{T_A} & 0 & \frac{-K_AK_6}{T_A} & 0 & \frac{-1}{T_A} & \frac{-K_A}{T_A} \\ 0 & 0 & 0 & \frac{-K_EK_F}{T_ET_F} & \frac{K_F}{T_ET_F} & \frac{-1}{T_F} \end{bmatrix} \quad (1.13)$$

where X[t], Y[t] and U[t] are the state vector, output and input signal vector respectively. The [A], [B] and [C] are all real constant matrices of appropriate dimension.

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2.3 INFERENCES DRAWN OUT OF LITERATURE REVIEW

i) The investigator found that the power system is a highly non-linear system. Transient stability is affected with small signal and large signal disturbance. Small signal disturbance means change in loads, while large signal due to short circuit and loss of generation.

ii) After searching and reviewing a number of papers, text books and journals the investigator concluded that much work has been done in the field of stability enhancement of Single Machine Infinite Bus (SMIB) System implemented with different FACTS devices.

- Different modeling techniques.
- Heffron- Phillips model.
- Cost effectiveness of different FACT devices.

iii) In Hybrid Power Flow Controller (HPFC) two topologies have been defined. The first one consists of a shunt connected source of reactive power, and two series connected voltage–sourced converters – one on each side of the shunt device. The second topology is a dual of the first; it is based on two shunt connected current–sourced converters around a series connected reactive element.

iv) A dynamic control scheme of HPFC is presented in which the validity of the mathematical model and feasibility of active and reactive power flow in the controller has been evaluated.

v) Simulation of HPFC has not been done by incorporating in SMIB.

vi) In order to damp Low Frequency Oscillations (LFO), adaptive neuro-fuzzy controller for UPFC is designed and simulated. Simulation is performed for various types of loads and for different disturbances. Simulation results show good performance of neuro-fuzzy controller in damping LFO.

vii) The Adaptive Neuro Fuzzy UPFC controller adjusts control signals by appropriate processing of the input signals, and provides an efficient damping. The results of the simulation show that the UPFC with Adaptive Neuro Fuzzy controller is more effective in damping LFO compared to UPFC with PI controller.

viii) Model Predictive Control based FACTS controller for real time emergency control of WAM based power system has been incorporated.

ix) Detailed investigation have been carried out considering two controllers like Power System Stabilizer (PSS) and Power Oscillation Damping (POD) controller under variation of mechanical disturbances which provides robust performance for SMIB power system.

x) PSASP (Power System Analysis Software Package) is a package of programs widely used in China for power system analysis and simulation. It provides rich functions for user development, including user defined models and user routine interface.

xi) The STATCOM based on voltage source converter (VSC) is used for voltage regulation in transmission and distribution systems.

xii) An investigation on transient stability of power systems equipped with a Static Synchronous Series Compensator (SSSC) as a FACTS device has been carried out

xiii) The use of FACTS devices improves voltage and transient stability and power oscillation damping.

xiv) A modified Heffron-Phillip's (K constant) model has been derived for the design of power system stabilizers. Knowledge of external system parameters, such as equivalent infinite bus voltage and external impedances or their equivalent estimated values is required for designing a conventional power system stabilizer.

xv) The extended Phillips-Heffron model of a single-machine infinite-bus power system installed with a FACTS-based stabilizer, the conventional frequency-domain phase compensation method is applied to design the FACTS-based stabilizer.

2.4 SCOPE OF THE WORK

i) Phillips-Heffron modeling for Single Machine Infinite Bus (SMIB) System can be simulated using MATLAB/SIMULINK.

ii) Simulation of Hybrid Power Flow Controller incorporated in SMIB.

iii) In Hybrid Power Flow Controller (HPFC) two topologies have been defined. The first one consists of a shunt connected source of reactive power, and two series connected voltage–sourced converters – one on each side of the shunt device. The second topology is a dual of the first; it is based on two shunt connected current–sourced converters around a series connected reactive element.

iv) A dynamic control scheme of HPFC is presented in which the validity of the mathematical model and feasibility of active and reactive power flow in the controller has been evaluated.

2.5 PROBLEM FORMULATION

The aim of this work is to study the dynamic performance and stability enhancement of Single Machine Infinite Bus System (SMIB) equipped with Hybrid Power Flow Controller (HPFC).

Thishas been executed by simulating the following:

i) Heffron- Philips model of SMIB.
ii)Hybrid power flow controller (HPFC).
iii)Incorporating HPFC into SMIB model.

Linear analysis techniques have been used to study the dynamic behavior of SMIB system with a hybrid power flow controller. MATLAB/ SIMULINK has immersed very popular tool and are very widely used for modeling and simulation of systems. This software environment has been used for simulating the present problem.

In this chapter some of the relevant papers regarding facts controllers specially hybrid power controller have been discussed. Inferences drawn out after conducting the literature review has been presented and from which the scope of the work and problem statement has been realized. The software implementation of SMIB

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system equipped with HPFC has been discussed and the simulation results have been chalked out in the subsequent chapters.
The transfer function model of any series controller can be depicted as shown in Fig.3.1. The advantage of using transfer function model is that the change in rotor speed can be directly converted into compensation required by the controller.

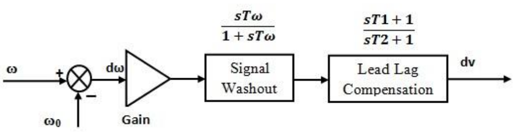

Fig.3.1 Transfer Function Model Series FACTS Controller

The signal washout block serves as a high pass filter with the time constant Tw high enough to allow signals associated with oscillations in speed deviation to pass unchanged. Without it steady changes in speed would modify the terminal voltage. It allows the controller to respond only to changes in speed. The phase compensation block with time constants T1 and T2 provide the appropriate phase lead/lag characteristics' to compensate for the phase lag between the input and the output signals. The gain determines the amount of damping introduced by the device.
When a shunt FACTS device is installed the system, the Philips Heffron linear model of a single machine infinite bus (SMIB) power system is modified to include the influence of the FACTS device on the system performance.
By linearizing the equations at an operating condition of the power system, the Philips Heffron model of the power – system with a shunt FACTS controller can be modified as shown in Fig.1.2.

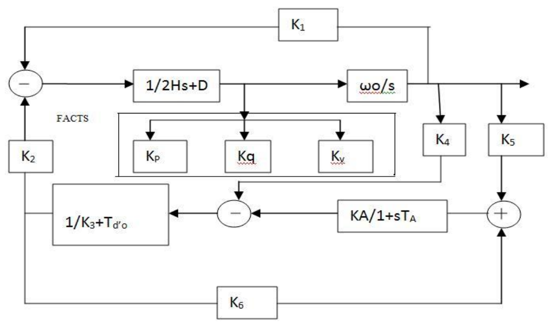

Fig.3.2. The Philips Heffron Model of SMIB with Shunt FACTS controller

The HPFC model is obtained by devising a combination of both the transfer function models of shunt and series controllers. The Philips Heffron model of a SMIB system has been simulated using MATLAB/SIMULINK with and without the proposed HPFC model and stability investigation have been carried out.

3.3 SIMULATION RESULT OF SMIB WITHOUT HPFC

The Philips- Heffron model of an SMIB system without any FACTS controller or HPFC as per FIG.1.11 has been simulated using MATLAB/SIMULINK. The MATLAB/SIMULINK model of SMIB system without HPFC is as shown in Fig.3.3.

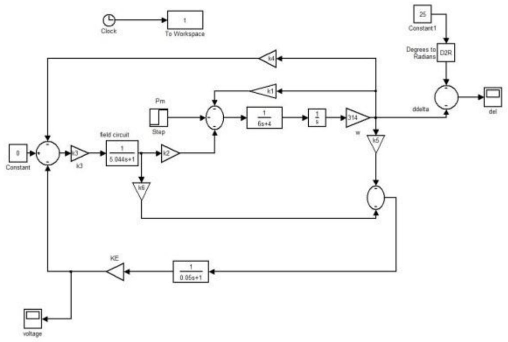

Fig. 3.3 Simulation Model for SMIB without Hybrid Power Flow Controller

The model in Fig.3.3 has been analyzed for stability studies by subjecting to small disturbance by varying the mechanical power ΔPm and exciter gain K_E.

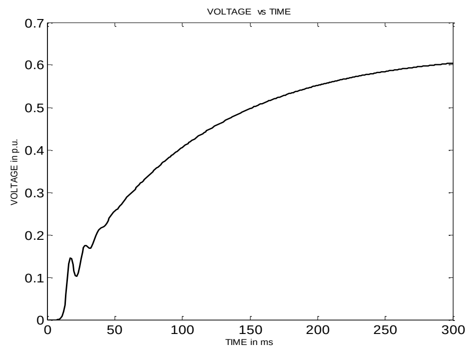

Fig. 3.4 Variation of Terminal Voltage for K_E=1 with ΔPm= 0.01 p.u.

Fig.3.4 shows variation of terminal voltage when subjected to small disturbance of mechanical power(ΔPm) = 0.01 p.u. with Exciter gain (K_E) =1 and Hybrid Power Flow Controller (HPFC) is not functioning and system become unstable. The system behavior in respect to system voltage is again obtained by increasing the value of ΔPm = 10 and K_E = 100 and found to be stable as shown in Fig. 3.5.

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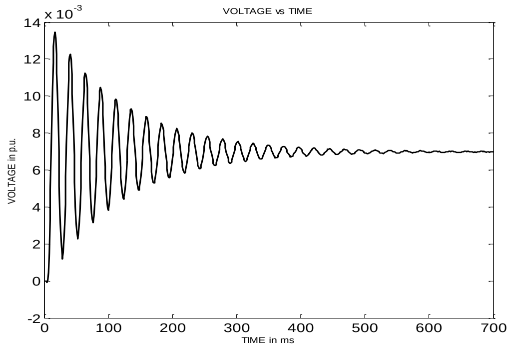


Fig. 3.5 Variation of Terminal Voltage for K_E=100 with ΔPm= 10

Similarly the variation of rotor angle with time has been plotted after subjecting the system with similar disturbances. Fig. 3.6 shows the variation rotor angle K_E = 1 and ΔPm = 0.01 p.u. and the figure depicts that the system becomes unstable. Fig. 3.7 shows the variation of rotor angle with K_E = 100 and ΔPm = 10 and the system is stable.

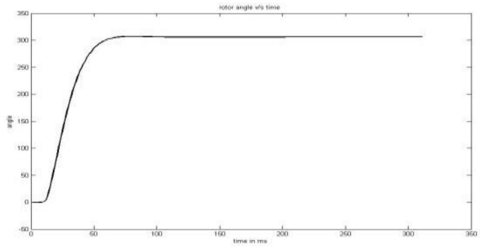


Fig. 3.6 Variation of Rotor Angle for K_E=1 and with ΔPm=0.01 p.u

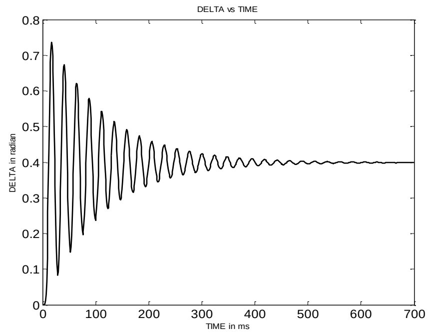


Fig. 3.7 Variation of Rotor Angle for K_E=100 with ΔPm=10

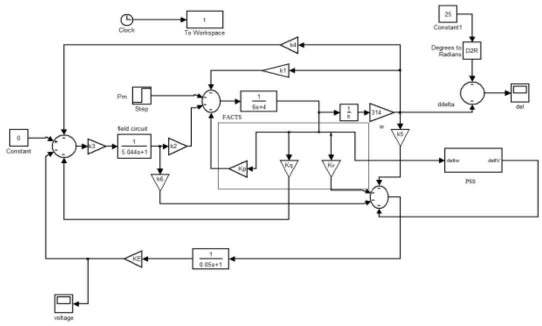
Analysis was done for various values of K_E varying from 0.01 to 100 and ΔPm varying from 0.01 to 100 and tabulated in Table 3.1. Table 3.1 shows that without HPFC the system goes to instability for all values of ΔPm. The exciter gain has to be increased to very high value and thus damping has been improved to maintain the system stable.

Table 3.1 Peak overshoot and settling time of system voltage and Rotor angle with variation in mechanical power and Exciter gain without incorporating HPFC

Mechanical Power ΔP_m in p.u.	Exciter Gain K_E	System Voltage		Rotor Angle	
		peak over shoot in p.u.	settling time in ms	peak overshoot in p.u.	settling time in ms
0.01	0.01	unstable	unstable	unstable	unstable
0.1	0.01	unstable	unstable	unstable	unstable
1	0.01	unstable	unstable	unstable	unstable
10	0.01	unstable	unstable	unstable	unstable
100	0.01	unstable	unstable	unstable	unstable
0.01	0.1	unstable	unstable	unstable	unstable
0.1	0.1	unstable	unstable	unstable	unstable
1	0.1	unstable	unstable	unstable	unstable
10	0.1	unstable	unstable	unstable	unstable
100	0.1	unstable	unstable	unstable	unstable
0.01	1	unstable	unstable	unstable	unstable
0. 1	1	unstable	unstable	unstable	unstable
1	1	unstable	unstable	unstable	unstable
10	1	unstable	unstable	unstable	unstable
100	1	unstable	unstable	unstable	unstable
0.01	10	unstable	unstable	unstable	unstable
0.1	10	unstable	unstable	unstable	unstable
1	10	unstable	unstable	unstable	unstable
10	10	unstable	unstable	unstable	unstable
100	10	unstable	unstable	unstable	unstable
0.01	100	unstable	unstable	unstable	unstable
0.1	100	unstable	unstable	unstable	unstable
1	100	unstable	unstable	unstable	unstable
10	100	Stable for higher value	Settled fast	Stable for higher value	Settled fast
100	100	Stable for higher value	Settled fast	Stable for higher value	Settled fast

3.4 SIMULATION RESULT OF SMIB WITH HPFC

The Philips- Heffron model of an SMIB system with FACTS controller or HPFC as per FIG.1.11 has been simulated using MATLAB/SIMULINK. The MATLAB/SIMULINK model of SMIB system with HPFC is as shown in Fig.3.8.



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International Advanced Research Journal in Science, Engineering and Technology (IARJSET)
National Conference on Renewable Energy and Environment (NCREE-2015)
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Fig. 3.8 Simulation Model for SMIB with Hybrid Power Flow Controller

The model in Fig.3.8 has been analyzed for stability studies by subjecting to small disturbance by varying the mechanical power ΔPm and exciter gain K_E.

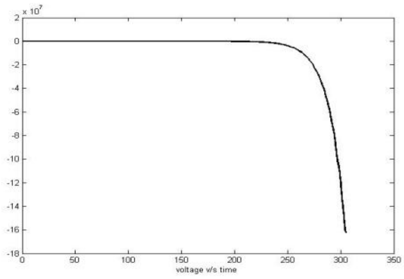

Fig. 3.9 Variation of Terminal Voltage for K_E=1 with ΔPm= 100 K_{HPFC} = 1

Fig.3.9 shows variation of terminal voltage when subjected to small disturbance of mechanical power(ΔPm) = 0.01 p.u. with Exciter gain (K_E) =1 and Hybrid Power Flow Controller (HPFC) is functioning and system become unstable. The system behavior in respect to system voltage is again obtained by increasing the value of ΔPm = 100 and K_E = 1 and found to be stable as shown in Fig. 3.10

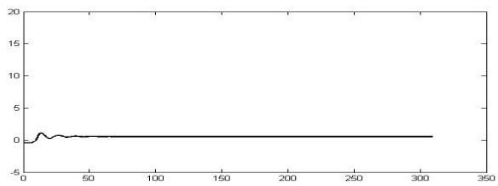

Fig. 3.10 Variation of Terminal Voltage for K_E=1 with ΔPm= 100 K_{HPFC} = 10

Similarly the variation of rotor angle with time has been plotted after subjecting the system with similar disturbances. Fig. 3.11 shows the variation rotor angle K_E = 1 and ΔPm = 100 and the figure depicts that the system becomes unstable. Fig. 3.12 shows the variation of rotor angle with K_E = 1 and ΔPm = 100 and the system is stable.

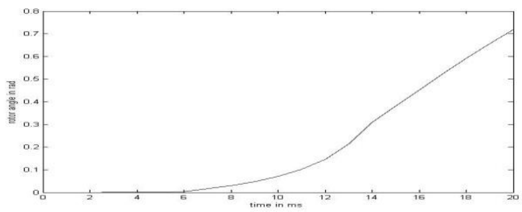

Fig. 3.11 Variation of Rotor Angle for K_E=1 with ΔPm=100 K_{HPFC} = 1

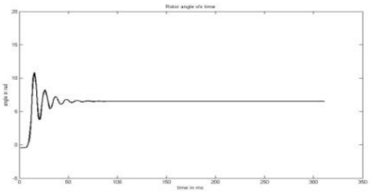

Fig. 3.12 Variation of Rotor Angle for K_E=1 and KHPFC =10 with ΔPm= 100

Analysis was done for various values of K_E varying from 0.01 to 100 and ΔPm varying from 0.01 to 100 and tabulated in Table 3.2. Table 3.2 shows that with HPFC the system goes to instability for all values of ΔPm. The exciter gain has to be same and increasing the value of HPFC gain thus damping has been improved to maintain the system stable.

Table 3.2 Peak overshoot and settling time of system voltage and Rotor angle with variation in mechanical power and Exciter gain incorporating HPFC

Mechanical Power ΔP_m in p.u.	**Exciter Gain K_E**	**System Voltage**		**Rotor Angle**	
		peak overshoot in p.u.	**settling time in ms**	**peak overshoot in p.u.**	**settling time in ms**
0.01	0.01	unstable	unstable	unstable	unstable
0.1	0.01	unstable	unstable	unstable	unstable
1	0.01	unstable	unstable	unstable	unstable
10	0.01	unstable	unstable	unstable	unstable
100	0.01	unstable	unstable	unstable	unstable
0.01	0.1	unstable	unstable	unstable	unstable
0.1	0.1	unstable	unstable	unstable	unstable
1	0.1	unstable	unstable	unstable	unstable
10	0.1	unstable	unstable	unstable	unstable
100	0.1	unstable	unstable	unstable	unstable
0.01	1	stable	stable	stable	stable
0.1	1	stable	stable	stable	stable
1	1	stable	stable	stable	stable
10	1	stable	stable	stable	stable
100	1	stable	stable	stable	stable
0.01	10	stable	stable	stable	stable
0.1	10	stable	stable	stable	stable
1	10	stable	stable	stable	stable
10	10	stable	stable	stable	stable
100	10	stable	stable	stable	stable
0.01	100	stable	stable	stable	stable
0.1	100	stable	stable	stable	stable
1	100	stable	stable	stable	stable
10	100	stable	stable	stable	stable
100	100	stable	stable	stable	stable

3.5 TRANSIENT STABILITY ANALYSIS

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When a three phase short circuit fault occurs on power system, the machine accelerates and the looses its synchronism. If the fault is cleared at a particular time, the system retain its stability. The particular instant at which the fault may be cleared so that the system stability is maintained is known as the critical clearin time and the corresponding angle is called critical clearing angle. One of the most important tasks in transient stability assessment is the determination of the critical clearing time(CCT). HPFC installed on the system improves the critical clearing time(CCT) more effectively.

A fault has been incorporated in the system and the rotor angle variation are observed for different values of fault clearing time(FCT).

The values of the peak overshoot and the settling time of rotor angle for different values of fault clearing time is given in Table. 3.3.This is the case when HPFC is not incorporated in the system. Similar analysis has been done with HPFC incorporated in the system and values of peak overshoot is given in Table.3.4.

From Table 3.3. the critical clearing time (CCT) is 0.2848 seconds and the corresponding critical clearin angle is 15.8 degrees. From Table 3.4 critical clearing time (CCT) is observed to be 0.2938 seconds and critical clearin angle is 27 degrees. When HPFC is incorporated in the system , the critical clearing time (CCT) improves and then enhance the transient stability of the power system. Variation of rotor angle with time for fault clearing time(FCT) is equal to 0.2938seconds. When HPFC is incorporated in the system is shown in Fig. 3.10 Variation of rotor angle with time for the fault clearing time(FCT) equal to 0.3036 seconds is shown in Fig. 3.11.

Table 3.3 Summary of the observations in tabular form with variation in time without Kp, Kv, Kq

Fault clearing time in second	**Rotor Angle**	
	peak overshoot in degree	**settling time in sec**
0.0031	65	6
0.0151	60	6
0.0304	48	6
0.0474	36	5
0.0692	24	5
0.0999	15	5
0.1436	8.5	5
0.2052	6	5
0.2752	11	5
0.2848	15.8	5
0.3075	unstable	unstable
0.3721	unstable	unstable
0.4603	8.2	5

From above table critical clearing time is **0.2848** sec and corresponding angle is **15.8** degree. Before this value response of angle v/s time is stable and settled fast.

Table 3.4 Summary of the observations in tabular form with variation in time with K_P,K_V,Kq

Fault clearing time in second	**Rotor Angle**	
	peak overshoot in degree	**settling time in sec**
0.0031	68	8
0.0153	62	8
0.0305	50	6
0.0475	37	6
0.0695	25	6
0.1003	15	6
0.1442	8.5	6
0.2061	6.3	6
0.2762	11.7	6
0.2938	27	5
0.2958	unstable	unstable
0.3036	unstable	unstable
0.4605	9.2	5

From above table critical clearing time is **0.2938** sec and corresponding angle is **27** degree. Before this value response of angle v/s time is stable and settled fast.

CONCLUSION AND FUTURE SCOPE

CONCLUSION

A single machine infinite bus system has been considered for stability analysis simulation.HPFC is used for damping of power system oscillation in a single system. The performance of the proposed hybrid power flow controller is verified under different disturbances. Simulation results validate the robustness of the proposed control scheme. Moreover, this approach is also simple and easy to be realized in power systems. From above table critical clearing time is **0.2848** sec and corresponding angle is **15.8** radian without Kp, Kv, Kq. Before this value response of angle v/s time is stable and settled fast.From above table critical clearing time is **0.2938** sec and corresponding angle is **27** radian with Kp, Kv, Kq. Before this value response of angle v/s time is stable and settled fast.

Behavior of the SMIB system power system checked with HPFC connected and without HPFC, when system subjected to different kinds of small disturbances and results are presented in table 3.1 to validate the implementation of the HPFC model.

In the first case of the SMIB system was subjected to small disturbances by varying the mechanical input 0.01 p.u. In this case system bus voltage stability studies, it is observed from the plot peak overshoot reduces from 2.9 p.u. to 1.45 p.u., and settling time reduces from 250 ms sec to 160 ms.It is understood that bus voltage shows greater stability while increasing the HPFC gain from 1 to 20 with exciter gain of 100. Similarly behavior of rotor angle has been seen with same disturbances. It is observed from the graph, peak

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology (IARJSET)
National Conference on Renewable Energy and Environment (NCREE-2015)
IMS Engineering College, Ghaziabad
Vol. 2, Special Issue 1, May 2015

overshoot reduces from 7.8p.u. to 6.52 p.u. and settling time reduces from 190ms to 130ms sec.

From the above results it is concluded that the action of HPFC definitely improves the system stability and damps the power system oscillations if HPFC parameters are selected carefully. Hence the stability of the system has been enhanced with the effective control of hybrid power flow controller.

This study shows the role of receding horizon principle based hybrid power flow controller in improving the transient stability of a very complex hybrid system with high nonlinearities and constraints. As the complete detailed dynamic machine model is considered, variation in all parameters can be observed and stability can be enhanced. Thus increasing demand and restriction on having additional new infrastructure, forces the existing power system network to work at its maximum possible limits.

This study presents a useful insight for power utility engineers to evaluate the application of HPFC and its impact on power system. HPFC is an advanced configuration that controls the operation of active and reactive power flow. HPFC will significantly extend the active power and reactive power flow capability and offer a great potential in solving many of the problems faced by the electric utility in a competitive environment. The simulation results prove the capability and performance of HPFC in dynamic control of power flow if A dynamic control strategy is developed in the boundaries of controllable range of HPFC to enhance the dynamic voltage stability.

4.2 FUTURE SCOPE OF THE THESIS

This model can also be used for Power System Analysis Software Package (PSASP). It can also be used with Power System Stabilizer (PSS). It can be used as MATLAB/SIMULINK hard-ware model. Further it can be extended with ANFIS. This can be further extended for GA and PSO to improve power system stability.

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