A Review of Power System Stability and Power Oscillation Control Techniques

Akash Suman Shrivastava[1], Sudeep Shrivastava[2]

[1]M.Tech Scholar, Dept. of Electrical Engineering, Vishwavidyalaya Engineering College, Lakhanpur, Chhattisgarh, India

[2] Assistant Professor, Dept. of Electrical Engineering, Vishwavidyalaya Engineering College, Lakhanpur, Chhattisgarh, India

---

Abstract - *In these days contemporary world demand of power is to be exaggerated day by day so extremely economical technique is to be needed for power system or grid. Power system or grid is extremely complicated and interconnected thus there's an excellent demand to enhance power utilization whereas still maintaining dependableness and security. This paper presents a study of assorted researches that were start in previous few decades for power oscillation management or control or control or control. This paper tells us a very important review of power grid stability and power oscillation management or control or control or control techniques. The paper demonstrates summary of assorted approaches and strategies applied to realize it. The paper provides useful data and resources for the longer term studies for analyzers those fascinated by the matter or to try and do further research during this technical space.*

Key Words: **PSS, FACTS, STATCOM, SSSC, VAR, PI Controller.**

1. INTRODUCTION

In today's high complicated and interconnected power systems, there's an excellent ought to improve power utilization whereas still maintaining dependableness and security. Reducing the effective electrical phenomenon or reactance of lines by series compensation may be a direct approach to extend transmission capability. However, power transfer capability of long cable is proscribed by stability thought [13].

Oscillation of generator angle or line angle are typically related to the transmission system disturbances and may occur because of step changes in load, unexpected change or amendment of generator output, transmission line switching and short circuit [18].

Different modes of rotor oscillation are native or local mode, intra-area mode and inter-area mode. The frequency of oscillations of rotor swings varies from 0.2 to 4 Hertz [2]. The lower finish of frequency spectrum corresponds to inter-area modes, during which an outsized range of generators participated and their damping is tough. This low frequency is very important to damp as quickly as attainable as a result of they because mechanical wear in power plants and cause power quality drawback. If the mechanical device oscillations don't seem to be properly controlled within the electrical power system operation, it should result in a partial or total system outage [18].

Power grid or system instability or fluctuation issues that may result in partial or full blackout will be generally classified into 3 main classes, particularly voltage, phase angle and frequency connected issues [3].

In early age this signal instability drawback was resolved by amortisseurs enforced in generator rotors, later with the appliance of quick excitation system this was resolved by development & utilization of power system Stabilizer (PSS) and but in trendy power grid because of the affiliation of power grids in immense space, for inter space oscillation damping because of the power of dominant line impedance, power flow and bus voltage, versatile AC transmission Systems (FACTS) devices implementation offers another answer [19].

2. REVIEW OF PREVIOUS WORK

Oscillation of generator angle or line angle area unit typically related to the transmission disturbances and may occur because of step changes in load, fulminant amendment of generator output, cable switching and short circuit. Totally different modes of rotor oscillation are native mode, intra-area mode and inter-area mode. Instability issues in power systems that may cause partial or full blackout will be broadly speaking classified into 3 main classes, particularly voltage, phase angle and frequency connected issues. antecedently these instability downside were resolved by amortisseurs enforced in generator rotors, later with the applying of quick excitation system by utilization of power grid Stabilizer (PSS) and currently with the affiliation of facility in massive space, inter-area oscillation arises which might be resolved utterly by versatile AC transmission devices. [2, 3, 18, 19].

Flexible AC transmission Systems (FACTS) area unit recognized as a transmission transfer capability improvement resolution, minimizing the gap between system (transient, voltage and little signal) stability and thermal limits. STATCOM will management or control or control voltage magnitude and to a-tiny low extent, the phase angle in an exceedingly very short time and thus has the power to boost the system damping further as voltage profile of the system. Power electronic shift capabilities in terms of management or control or control and high speed

prove FACTS devices additional helpful in power flow improvement, management or control or control of voltage magnitude and transient stability throughout faults leading to improvement in installation stability. [4, 6, 13].

The various sorts of instability problems concerned in installation it additionally mentioned the very fact devices, their operating, Structure and placement in installation. Finally a comparison pill is bestowed for comparison of the performance of reality devices for various system conditions. The comparison results shows that the UPFC shows the most effective performance followed by the STATCOM whereas SSSC comes at the third position and therefore the devices TCSC and volt-ampere gets the last position within the table this can be attributable to lower controllability of the thyristors. Finally it will be aforementioned that the paper provides a non-mathematical clarification and a good comparison of various reality devices. [6, 21].

The SSSC controller consists of a solid-state VSC with many GTO thyristor switches, or the other semiconductor switches with intrinsic turn-off capability valves, a dc capacitance, associate degree injecting electrical device, and a controller. SSSC converters are connected serial with the road through two banks of three single phase two winding transformers. With the potential to vary its electrical phenomenon characteristics from electrical phenomenon to inductive, the SSSC is incredibly effective in dominant power flow in power systems. Associate auxiliary stabilizing signal will be superimposed on the ability flow operation of the SSSC thus on improve the ability system oscillation and stability. The management or control or control electronic equipment comprises phase locked loop (PLL), PI controller, Firing generator, measure circuit [4, 6, 8, 14, 15, and 16]

By exploitation phase management or control or control technique of SSSC the part and modulation index of generator will be controlled to induce desired worth of voltage that is to be injected consistent with the need of the sign to induce electrical phenomenon or inductive compensation thus on increase or decrease the ability transmission consistent with power demand. SSSC works in 3 modes of operation constant voltage injection, constant electrical phenomenon or capacitive management or control or control or control and constant power management or control or control or control mode. The maximum and most Volt-Ampere rating of SSSC is that the product of most voltage injected and therefore the maximum line current. In SSSC line current is taken as relevance synchronize the entire circuit with it. a complete phase shift that is add of phase angle of line current, angle of PI controller and ± 90° is offer to the SSSC injected voltage. [1, 6, 14, 20].

Simulation model of single machine & amp; multi-machine power grid or system, carries with it completely different power grid or system instrumentation generators, transformers, Hydraulic rotary engine Governor System, and Excitation system. Result of 3-phase fault on the voltage, active and reactive power of the conductor and also the management or control or control of those effects by the SSSC-based damping controller is analyzed. [6, 9, 16].

Studied the non-linear dynamic model of the facility system, and supply the liberalized equations in line with this non-linear model to urge the characteristics equation and Manfred Eigen value of the facility system. Variation of various parameters of installation with the variation in SSSC elements injected voltage, dc voltage & modulation index are given therefore on notice the Manfred Eigen values and also the transfer perform of the facility oscillation damping controller. Style of damping controller depend on varied factors its location, management or control or control signal, management or control or control law, coordination among controller. [2, 4, 11, 15].

The structure of damping controller carries with it gain block, low pass filter, washout block and lead-lag compensator block. These blocks are wont to separate out high and low frequency signal to urge correct signal of oscillation. The perform of various blocks and their limiting price of T1, T2, Tw & K constants of those blocks are fixed. Part or phase compensation block give the acceptable part between input & output signals. The management or control or control signal for this controller are often power, rotor speed & angle. This input are often management or control or control at a price by superimposing construction voltage of acceptable magnitude & angle through SSSC. [10, 16, 19].

The studies, tells the techniques of twelve-pulse and PWM controlled SSSC, are conducted still because the show the management or control or control circuits given. The SSSC operating operation conditions and different factors like constraints are compared to the operational conditions of different FACTS devices, showing that the SSSC offers many deserves over different systems. The dc voltage pre-set price in PWM-based controllers has got to be taken fastidiously. Because the modulation magnitude relation lies between zero and one, the dc voltage mustn't be under the utmost of the requested SSSC output part voltage so as to get correct management or control or control. On the opposite hand, if the dc aspect voltage is simply too high, the rating of each devices the GTO valves and dc electrical device has got to be accrued, which suggests higher initial value. Part or phase management or control or control permits the dc voltage to vary in line with the facility system conditions, that is clearly merit able, however it needs an additional sophisticated controller circuit with expensive series transformers. This shows that the employment of SSSC has higher dynamic response. [4, 21, 22].

3. PROBLEM IDENTIFICATION

In today's high advanced and interconnected power systems, there's an excellent ought to improve power utilization whereas still maintaining responsibility and security.

Reducing the effective electrical phenomenon of lines by series compensation could be a direct approach to extend

transmission capability. However, power transfer capability of long conductor is restricted by stability thought.

Following are the problems of style of damping controller.

- Location of the controller – the situation of controller in any intra-area or inter-area mode is extremely vital. Absolute placement of controller is also ineffective. Criteria of location rely on participation issue or eigenvalue sensitivity.

- Choice of management or control signal – The management or control signal ought to be used from native measurement rather than telemetering. It ought to contain the modal element that's to be damped not the noise which will be amplified. The management or control law principally associated with the selection of signal.

- Control law or formula – principally linear management or control theory is employed but some tries are created to use non-linear techniques (fuzzy logic or neural network primarily based controller).

- Robustness of controller underneath varied system conditions – its best condition that matters in sensible cases. A point of adaptation would be needed during a controller that should operate underneath varied conditions.

Co-ordination among controllers – one controller at a given location isn't capable damp all the essential modes. Multiple controllers at totally different locations ought to be used. Therein case, the isolated standardization of individual controller isn't possible or feasible.

4. CONCLUSION

In this paper, an outline and vital problems with completely different analysis studies for Power oscillations management or control is given. Approaches supported completely different strategies are planned and use to resolve the steadiness of grid downside. The effectiveness of the developed strategies was tested on completely different systems conjointly the results were also compared with alternative strategies. It had been ascertained that by exploitation the SSSC with damping controller to regulate power oscillation, the standard of result's are often improved. The provided info within the paper are often useful researchers will result in further studies within the field. This poses to power oscillations of two machine infinite bus system are of high amplitude as compared to SMIB and From the various machine systems, it's analyzed that the facility oscillation of single machine infinite bus system are often controlled during a short time and additional near its traditional price as compared to the two machine infinite bus system. The additional scope of work will management or control the facility oscillation of quite one bus at the same time by victimization quite one damping controller.

REFERENCES

[1]. N. G. Hingorani, L. Gyugyi, "Understanding FACTS: concepts and technology of flexible AC transmission systems", New York: IEEE Press, 2000.

[2]. K.R.Padiyar, "FACTS Controllers in Power Transmission and Distribution".

[3]. H. Saadat, "Power Stability Analysis", TMH Publication Edition, 2002, pp. 460-526.

[4]. A. Kazemi et al.,"Optimal Selection of SSSC-Based Damping Controller Parameters for Improving Power System Dynamic Stability Using Genetic Algorithm", Iranian Journal of Science & Technology, Transaction B, Engineering, Vol. 29, No.B1, Feb. 2005 pp 1-5.

[5]. B. Geethalakshmi, T. Hajmunnisa and P. Dananjayan,"A Fuzzy Logic Controller for Enhancing the Transient Stability of 48-Pulse Inverter Based SSSC", VOL. 10, NO. 2, 2008, pp. 53-58

[6]. H. Taheri , S. Shahabi, Sh. Taheri , A. Gholami "Application of Synchronous Static Series

Compensator (SSSC) on Enhancement of Voltage Stability and Power Oscillation Damping", 978-1-4244-3861 2009 IEEE, pp. 533-539.

[7]. Abdul Haleem, Ravireddy Malgireddy "Power Flow Control with Static Synchronous Series

Compensator (SSSC)", Proc. of the International Conference on Science and Engineering (ICSE 2011) ISBN: 978-981-08-7931-0 pp. 1-5.

[8]. L. Gyugyi, C.D.Schauder, & K.K. Sen," Static synchronous series compensator: A solid-state

Approach to the series compensation of transmission lines".1997 Power Delivery, IEEE Transactions on 12(1), pp.406-417.

[9]. M. Faridi et al.,"Power System Stability Enhancement Using Static Synchronous Series Compensator (SSSC)", 978-1-61284-840-2011 IEEE, pp.387-391.

[10]. L.J.Cai, I.Erlich, "Simultaneous Coordinated Tunning of PSS and FACTS Controller for Damping Power System Oscillations in Multi-Machine Systems", 0-7803-7967 2003 IEEE, pp. 1-6.

[11]. Li Juan, et al. "A Non-linear Control Approach to Increase Power Oscillation Damping", 2008 International Conference on Computer and Electrical Engineering.pp.734-738.

[12]. Majid Poshtan, Parviz Rastgoufard, "A Nonlinear Control Method for SSSC to Improve Power System Stability", 0-7803-9772-X/06/$20.00 ©2006 IEEE.

[13]. V.K.Chandrakar, A.G. Kothari, "MFFN based Static Synchronous Series Compensator (SSSC) for Transient Stability improvement", world Academy of Science Engineering and Technology 05 2009, pp.1066-1070.

[14]. K.K.Sen, "SSSC-static synchronous series compensator: theory, modeling and publications." IEEE Trans. Power Delivery. Vol. 13, No.1, January 1998, PP. 241-246.

[15]. H.F.Wang, "Static synchronous series compensator to damp power system oscillations", Electric Power System Research 54 (2000) pp.113-119.

[16]. Sidartha Panda, "Modelling, simulation and optimal tuning of SSSC-based controller in a multi machine power system", World journal of Modelling and simulation vol. 6(2010) no. 2, pp. 110-12.

[17]. A.Ghosh, G.Ledwich, "Modelling and Control of thyristor-controlled series compensator", IEE Proc.- Trans. Dist. vol-142, No. 3, 1995 pp 297-307.

[18]. D.Murali, M. Rajaram,"Transient Energy Analysis for STATCOM and SSSC Applications",

International journal of Electrical and Power Engineering 3(4): 2009, pp. 191-197.

[19]. Chi Su, Zhe Chen, "Damping Inter-Area Oscillations Using Static Synchronous Compensator (SSSC)", UPEC-46th International Universities Power Engineering Conference, September 2011.

[20]. K.M.Sze. et al, "Application of PWM based Static Synchronous Series Compensator (SSSC) to enhance Transient Stability of Power System", 6th international conference of APSCOM Nov.2003 pp. 409-41

[21]. P. Srivastava, R Pardhi "A Review on Power System Stability and Applications of FACT", International Journal of Engineering Research and Applications, Vol. 3, Issue 3, May-Jun 2013, pp.879-883.

[22]. P. Kumar, K. Namrat"Voltage Control and Power Oscillation Damping of Multi-Area Power System Using static synchronous Series", Journal of Electrical and Electronics Engineering, Issue 5 (July-Aug. 2012), PP 26-33.

BIOGRAPHIES

Akash Suman Shrivastava, M.Tech Scholar (Power System & Control) Department of Electrical Engg., Vishwavidyalaya Engineering college, Lakhanpur, Chhattisgarh

Sudeep Shrivastava, Assistant Professor, Department of Electrical Engg., Vishwavidyalaya Engineering college, Lakhanpur, Chhattisgarh