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POWER OSCILLATIONS CONTROL TECHNIQUES: A REVIEW

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ABSTRACT

In today Modern world requirement of power is to be increased day by day so that highly efficient technique is to be required for power system. Power system is highly complex and interconnected so there is a great requirement to improve power utilization while still maintaining reliability and security. This paper presents a study of various researches which were come out in last few decades' for power oscillation control**.** This paper tells us an important review of power system stability and power oscillation control techniques. The paper demonstrates overview of various approaches and methods applied to achieve it. The paper provides helpful information and resources for the future studies for researchers those interested in the problem or to do additional research in this technical area.

KEYWORDS: Power Oscillation Control (POC), Statics Synchronous Series Compensator (SSSC),Power System Stability(PSS).

I. INTRODUCTION

In today's high complex and interconnected power systems, there is a great need to improve power utilization while still maintaining reliability and security. Reducing the effective reactance of lines by series compensation is a direct approach to increase transmission capability. However, power transfer capability of long transmission line is limited by stability consideration [13].

Oscillation of generator angle or line angle are generally associated with the transmission system disturbances and can occur due to step changes in load, sudden change of generator output, transmission line switching and short circuit [18]

Different modes of rotor oscillation are local mode, intra-area mode and inter-area mode. The frequency of oscillations of rotor swings varies from 0.2 to 4 Hz [2]. The lower end of frequency spectrum corresponds to inter-area modes, in which a large number of generators participated and their damping is difficult. This low frequency is important to damp as quickly as possible because they cause mechanical wear in power plants and cause power quality problem. If the electromechanical oscillations are not properly controlled in the electric power system operation, it may lead to a partial or total system outage [18].

Instability problems in power systems that can lead to partial or full blackout can be broadly classified into three main categories, namely voltage, phase angle and frequency related problems [3].

In early age this signal instability problem was solved by amortisseurs implemented in generator rotors, later with the application of fast excitation system this was solved by development & utilization of Power System Stabilizer (PSS) and however in modern power system due to the connection of power grids in vast area, for inter area oscillation damping due to the ability of controlling line impedence, power flow and bus voltage, Flexible AC transmission Systems (FACTS) devices implementation offers an alternative solution [19]

II. REVIEW OF PREVIOUS WORKS

Oscillation of generator angle or line angle are generally associated with the transmission system disturbances and can occur due to step changes in load, sudden change of generator output, transmission line switching and short circuit. Different modes of rotor oscillation are local mode, intra-area mode and inter-area mode. Instability problems in power systems that can lead to partial or full blackout can be broadly classified into three main categories, namely voltage, phase angle and frequency related problems. Previously these instability problem were solved by amortisseurs implemented in generator rotors, later with the application of fast excitation system by utilization of Power System Stabilizer (PSS) and now with the connection of power grid in large area, inter-area oscillation arises which can be solved perfectly by Flexible AC Transmission system devices. [2, 3, 18, 19]

Flexible AC transmission Systems (FACTS) are recognized as a transmission transfer capacity enhancement solution, minimizing the gap between system (transient, voltage and small signal) stability and thermal limits. STATCOM can control voltage magnitude and to a small extent, the phase angle in a very short time and therefore has the ability to improve the system damping as well as voltage profile of the system. Power electronic switching capabilities in terms of control and high speed prove FACTS devices more beneficial in power flow enhancement & control, control of voltage magnitude and transient stability during faults resulting in improvement in power system stability. [4, 6, 13]

The various types of instability issues involved in power system it also discussed the FACT devices, their working, Structure and placement in power system. Finally a comparison tablet is presented for comparison of the performance of FACT devices for different system conditions. The comparison results shows that the UPFC shows the best performance followed by the STATCOM while SSSC comes at the third position and the devices TCSC and VAR gets the last position in the table this is because of lower controllability of the thyristors. Finally it can be said that the paper provides a non mathematical explanation and a fair comparison of different FACT devices.[6,21]

The SSSC controller consists of a solid-state VSC with several GTO thyristor switches, or any other semiconductor switches with intrinsic turn-off capability valves, a dc capacitor, an injecting transformer, and a controller. SSSC converters are connected in series with the line through two banks of three single phase two winding transformers. With the capability to change its reactance characteristics from capacitive to inductive, the SSSC is very effective in controlling power flow in power systems. An auxiliary stabilizing signal can be superimposed on the power flow control function of the SSSC so as to improve the power system oscillation and stability. The Control circuitry consist of Phase locked loop (PLL), PI controller, Firing pulse generator, measurement circuit [4, 6, 8, 14, 15, 16]

By using Phase control technique of SSSC the phase and modulation index of pulse generator can be controlled to get desired value of voltage which is to be injected according to the requirement of the input signal to get capacitive or inductive compensation so as to increase or decrease the power transmission according to power demand. SSSC works in three modes of operation constant voltage injection, constant reactance control and constant power control mode. The maximum VA rating of SSSC is the product of maximum voltage injected and the maximum line current. In SSSC line current is taken as reference to synchronize the whole circuit with it. A total phase shift which is sum of phase angle of line current, angle of PI controller and ± 90° is provide to the SSSC injected voltage. [1, 6, 14, 20]

Simulation model of single machine & multi-machine power system, consist of different power system equipment generators, transformers, Hydraulic Turbine Governor system, Excitation system. Effect of 3-phase fault on the voltage, active and reactive power of the transmission line and the control of these effects by the SSSC-based damping controller is analyzed. [6, 9, 16]

Studied the non-linear dynamic model of the power system, and provide the liberalized equations according to this non-linear model to get the characteristics equation and eigen value of the power system. Variation of different parameters of power system with the variation in SSSC components injected voltage, dc voltage & modulation index are given so as to find the eigen values and the transfer function of the power oscillation damping controller. Design of damping controller depend upon various factors its location, control signal, control law, coordination among controller. [2, 4, 11, 15]

The structure of damping controller consist of gain block, low pass filter, washout block and lead-lag compensator block. These blocks are used to filter out high and low frequency signal to get proper signal of oscillation. The function of different blocks and their limiting value of T_1, T_2, T_w & K constants of these blocks are specified. Phase compensation block provide the appropriate phase between input & output signals. The control signal for this controller can be power, rotor speed & angle. This input signal can be control at a value by superimposing quadrature voltage of appropriate magnitude & angle through SSSC. [10, 16, 19]

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The studies, tells the techniques of twelve-pulse and PWM controlled SSSC, are conducted as well as the show the control circuits are presented. The SSSC working operation conditions and other factors such as constraints are compared to the operating conditions of other FACTS devices, showing that the SSSC offers several merits over other systems. The dc voltage pre-set value in PWM-based controllers has to be taken carefully. As the modulation ratio lies between zero and one, the dc voltage should not be lower than the maximum of the requested SSSC output phase voltage in order to obtain proper control. On the other hand, if the dc side voltage is too high, the rating of both devices the GTO valves and dc capacitor has to be increased, which means higher initial costs. Phase control allows the dc voltage to change according to the power system conditions, which is clearly meritorious, but it requires a more complicated controller circuit with costly costly series transformers. This shows that the use of SSSC is having better dynamic response.[4,21,22]

III. CONCLUSION

In this paper, an overview and important issues of different research studies for Power oscillations control is presented. Approaches based on different methods have been proposed and use to solve the stability of power system problem. The effectiveness of the developed methods was tested on different systems and the results were also compared with other methods. It was observed that by using the sssc with damping controller to control power oscillation, the quality of result's can be improved. The provided information in the paper can be helpful researchers can lead to additional studies in the field. This poses to power oscillations of two machine infinite bus system are of high amplitude as compared to SMIB and From the different machine systems, it is analyzed that the power oscillation of single machine infinite bus system can be controlled in a short time and more close to its normal value as compared to the two machine infinite bus system. The further scope of work can control the power oscillation of more than one bus simultaneously by using more than one damping controller.

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