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PARAMETER ANALYSIS OF HYBRID POWER SYSTEM WITH UPFC

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Abstract: The focus of this paper is on a FACTS device known as Unified Power Flow Controller (UPFC), which can provide simultaneous control of basic power system parameters like voltage, active power flow, reactive power flow, impedance and phase angle. In this paper, simulation model for different multi machine systems are carried out, e.g. a hybrid power system, a power system with two synchronized hydro power stations etc., with UPFC located at the load end of the power system, has been developed. Simulation model has been incorporated into MATLAB based Power System Toolbox (PST) for their voltage stability analysis. The model was analyzed for voltage, active power flow, and reactive power flow and phase angle, with UPFC. The result of the power system with UPFC and the conclusion is given at the end.

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, a power transfer capability of long transmission line is limited by stability consideration.[2] 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.

A. Basic types of FACTS Controllers

FACTS controller can be classified into four categories:

- a) Series Controller (e.g. Static Synchronous Series Controller (SSSC))
- b) Shunt Controller (e.g. STATCOM, D-STATCOM)
- c) Combined Series – Series Controller
- d) Combined Series – Shunt Controller (e.g. Unified Power Flow Converter (UPFC))

FACTS devices are used as power flow controller and the voltage source converter in a line ultimately resulting into oscillation damping [1]. Series controllers are used to control power flow and oscillations damping in a line. Shunt devices are effective to control voltage. UPFC is a series-shunt controller that can control active & reactive power, voltage through a line. UPFC can also be used to analyze transient stability of a single machine system.

A Unified Power Flow Controller (UPFC) is a typical FACTS device capable of instantaneous control of three system parameters. Unified Power Flow Controller (UPFC) is able to control both the transmitted real power and the reactive power flows at the sending- and the receiving-end, at the midpoint of the transmission line. A control structure with a predictive control loop and pre control signal for a dc-voltage control is used for better stability and transient performance of UPFC, in comparison with the classical decoupled strategy. Generation of electricity using wind power has received considerable attention worldwide in recent years. In the beginning, the wind energy was used for standalone purposes. But as the power demand is growing day by day, there is a need for connecting this wind power to the grid. A lot of methods are adopted for connecting this power to the grid. Here is also one strategy which can be used for connecting this wind energy to the grid. And after connecting to the grid, the analysis is done [3].

The Unified Power Flow Controller (UPFC), with its unique combination of fast shunt and series compensation, is a powerful device which can control three power system parameters. In planning and designing such devices in power systems, power engineers must consider the impact of device internal limits on its performance.

B. Unified power flow controller principle & operation

The Unified Power Flow Controller is a sort of multi-function controller which can play an important role in solving various transmission system problems. UPFC is able to control, simultaneously or selectively, all the parameter effecting power flow in the transmission line i. e, voltage, impedance and phase angle [7]. This unique capability is signified by the adjective "UNIFIED" in its name, alternatively it can independently control the real and reactive power flow in the line [4]. The objective of this chapter is to describe the construction, principles and different modes of operation of the UPFC. For clarity a simple single-phase circuit is considered in this chapter to describe the different modes of the UPFC operation.

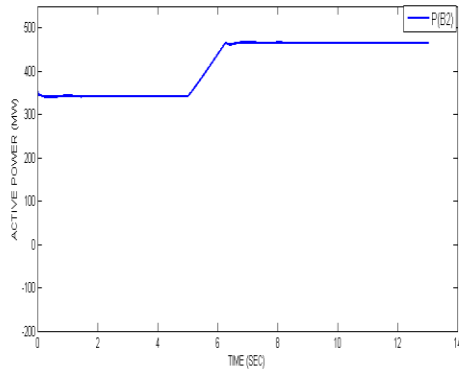


Fig 3 Active Power at Bus B2

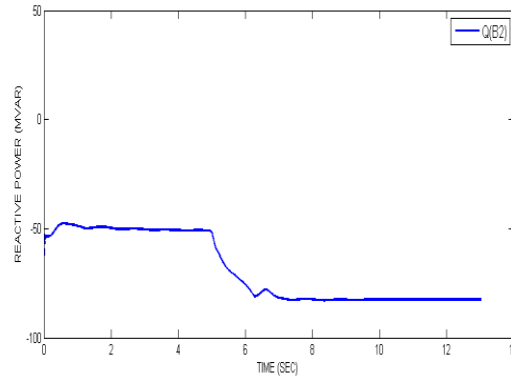


Fig. 4 Reactive Power at Bus B2

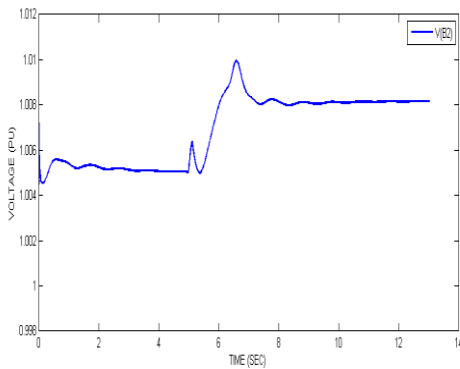


Fig. 5 Voltage at Bus B2

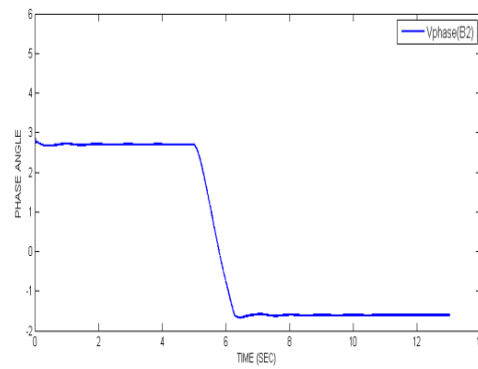


Fig. 6 Phase Angle at Bus B2

Here as can be seen from the table that the UPFC don't have much impact on the active power flow of the system but in case of fault, the oscillations produced in the system are much less in magnitude and also the time of clearing the fault is less when the system is provided with UPFC [8].

III. CONCLUSION

The unified power flow controller (UPFC) is a versatile controller that helps to control all the parameters (voltage, impedance, and phase angle) in a transmission line which ultimately decides the power flow through the line. The UPFC plays an important role in voltage regulation, phase angle regulation and thus in the power flow regulation in the system.

In this paper, simulation model for performance analysis in a 5 bus system with UPFC has been made. The system model is observed with two hydro power generating stations and Power system consisting of a combination of a hydro power generating station & a thermal power generating station is designed for performance analysis of UPFC. The work is extended with the addition of wind power generating farm, with UPFC. The analysis is done on the basis of active power flow, reactive power flow, voltage, and phase angle of the system. From the results and observations shown, following conclusions are obtained.

- 1) It is observed that with the help of the unified power flow controller, the active power flow in all the buses are improved although UPFC has significant effect on reactive power flow, voltage and phase angle of the system.
- 2) UPFC plays an important role even when the fault is at the other bus.
- 3) It is also observed that the time of clearing the fault and also the magnitude of oscillations is less when the system is provided with UPFC.
- 4) The research work shows that UPFC has no adverse effect on any line connected to the hybrid power system.

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