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Research Paper

Review on voltage stability improvement using STATCOM and UPFC

Engineering

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ABSTRACT

The reconstructed power systems under deregulation are confronted with new challenges to build in new transmission lines for accommodating significantly increased power transactions. In order to improve system transmission line and derive high operational efficiency and system security, other than to build large interconnected systems, however, another viable way is the use of the Flexible AC Transmission systems (FACTS) devices. Voltage stability is a reactive power problem and can be solved by providing adequate reactive power support at some critical buses. FACTS devices are being increasing used to provide not only the reactive power support but also to control other aspects of a power system.

Voltage instability problems increasing day by day because of increase demand in power. It is very important to analyze the power system with respect to voltage stability .This thesis will be based on the voltage stability analysis of IEEE 14 BUS and IEEE 30 BUS systems using STATCOM and UPFC devices.

Hossain et.al. says the model of a STATCOM which is controlled externally by a newly designed Power Oscillation Controller (POC) for the improvements of power system stability and damping effect of an on line power system. The proposed POC consists of two controllers (PID & POD). 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 STATCOM, With STATCOM but no externally

controlled, STATCOM with Power Oscillation Controller (POC). Simulation result shows that without STATCOM, the system parameters becomes unstable during faults. When STATCOM is imposed in the network, then system parameters becomes stable. Again, when STATCOM is controlled externally by POC controllers, then system voltage & power becomes stable in faster way then without controller. [1]

Vandana et.al. says with the increasing population the power demand is increasing simultaneously. Increase in power demand is the cause of Blackout and causes the system to become incapable to supply or absorb the reactive power. Therefore, the problem of voltage instability occurs in the system. FACTS are the new technology which can be used for many different problems in the system, among which voltage instability is one of them. The optimal location of FACTS in the system will allow the system to absorb or supply the sufficient reactive power. The optimal location can be done in the better way by using metaheuristic approach called Genetic Algorithm. It is the natural method of selection which uses certain parameters such as selection; mutation, crossover and fitness function, and the load flow analysis will be carried out by using Newton Raphson Method. [2]

Nandi et.al. says investigates the effects of Static Var Compensator (SVC) and Static Synchronous Compensator (STATCOM) on voltage Collapse of a power system. The effect of Critical Fault Clearing Time [CFCT] of the system due to facing the fault, to prevent permanent voltage instability has been analyzed. Comparative performance evaluation of SVC and STATCOM has been examined. A Power System Computer Aided Design /Electromagnetic Transients including DC (PSCAD/EMTDC) is used to carry out simulations of the system under study and detailed results are shown to access the performance of SVC and STATCOM on the voltage collapse of the system. [3]

Rai et.al. says the modern power distribution network is constantly being faced with an ever-growing load demand. Distribution networks experience distinct change from a low to high load level every day. Electric load growth and higher regional power transfers in a largely interconnected network becoming more complex and less secure power system operation. Power generation and transmission facilities are unable to meet these new demands. Voltage control is a difficult task because voltages are strongly influenced by random load fluctuations. Voltage profile can be improved and power losses can be considerably reduced by installing Custom

Power Devices or Controllers at suitable location. FACTS are devices which allow the flexible and dynamic control of power systems. Enhancement of system stability using FACTS controllers has been investigated. These controllers which are also named Distribution Flexible AC Transmission System (DFACTS) are a new generation of power electronics based equipment aimed at enhancing the reliability and quality of power flows in low-voltage distribution networks. This work includes first the optimal location of FACTS devices, second voltage stability analysis and third control of reactive power of system. The model can be simulated in MATLAB. The performance of the whole system such as voltage stability, transient stability, frequency and power swings will be analyzed and compared without FACTS and with FACTS device. For stability analysis after creating the faults (disturbances) in the system the FACT device (SVC, STATCOM, SSSC, and UPFC) and power system stabilizers (PSS) can be used to improve transient stability and power oscillation damping of the system. The model of a D-STATCOM was analyzed and developed for use in simulink environment with power system block sets. Here a control system is designed in MATLAB simulink. [4

Kamarposhti et.al. says the purpose of this paper is to study the effects of four FACTS controllers: STATCOM, TCSC, SSSC and UPFC on static voltage stability in power systems. Continuation power flow is used to evaluate the effects of these devices on system load ability. Applying saddle node bifurcation theory with the use of PSAT, effects of these devices controllers on maximum loading point are determined. Static voltage stability margin enhancement using STATCOM, TCSC, SSSC and UPFC is compared in the modified IEEE 14-bus test system. In this paper, voltage stability assessment of the modified IEEE 14-bus test system with STATCOM, TCSC, SSSC and Maximum loading point and mega Watt margin with various FACTS devices. UPFC is studied. UPFC provides higher voltage stability margin than STATCOM, TCSC and SSSC. [5]

Sode Yome et.al. says simple simulation approach to study static voltage stability in power systems. Symbolic and Optimization toolboxes in MATLAB are used to simulate load flow, continuation power flow and optimization techniques to easily access and understand static voltage stability of power systems. P-V curves are constructed to calculate load ability margins. These margins are verified with the help of direct optimization method. Time taken to calculate various outputs are also tabulated to given an idea about computational effort involved in the proposed approach. Three-bus and IEEE fourteen-bus test systems are used to demonstrate the proposed technique. The proposed approach may be of interest to utilities and researchers who wish to study voltage stability of medium size power systems in a simple way. This paper proposes a new simulation approach for static voltage stability study. This may be used by utilities or researchers to perform voltage stability assessment for medium size power systems in a simple way. [6]

Voltage Stability Improvement Using UPFC

Sarvi et.al. says power systems operation becomes more important as the load demand increases all over the world. This rapid increasing of load demand forces power systems to operate near critical limits due to economical and environmental constraints. The objective in power systems operation is to serve energy with acceptable voltage and frequency to consumers at minimum cost. In this paper, voltage stability is studies by using continuation power flow method. Also steady state modeling of Static VAR Compensator (SVC) and Unified Power Flow Controller (UPFC) for continuation power flow studies has been represented and discussed in details. The results for the standard 11 bus network show SVC and UPFC can be used to increase system stability in practical power systems. The effects on static voltage collapse or maximum loading level are presented. Simulation results show that by installing SVC at bus 8, the bus voltage is increased and maximum loading parameter increased. [7]

Goyal et.al. says the application of the FACTS controllers used in power system for balancing the Reactive Power, Voltage Stability & Power Factor through-out the process of the transmission of the power. In this paper the simulation model of the UPFC & STATCOM Facts Controllers are taken for observation so that a complete comparison can be carried out so that the output result can be more useful for the further application. The Matlab Simulation is used here to carry out the whole process. In this paper the after the comparison of all three devices the best one is chosen among them for results. The above simulation shows the complete results waveform of both the taken Facts Devices and also the values of V1(rms), P(MVA) & Q(MVA). The results show that among both of them STATCOM & UPFC, the UPFC Controller is the best to give the output waveform in the stable and the desired manner at the 400 kv , 100MVA on 48 cycle pulse GTO.[8]

Mathad et.al. says the application of UPFC in improving the voltage profile and enhancement of the power system stability. Five bus test system is considered for investigating the effect of UPFC. MATLAB Simulink models of test system and UPFC are developed. In Five bus test system UPFC is incorporated between the bus 1 and 4. Two case studies are taken up; where faults created at two different locations i.e. Bus 4 and 5. For both cases the faults are applied at 1 second and cleared at 1.5 second. Results reveal that, without UPFC, rotor angle oscillations increased in generator and lost synchronism. With UPFC system oscillations damped in 6 seconds and system remained stable. Voltage profile of all 5 buses and rotor angle variations at both generators are analyzed. [9]

Shankar et.al. says the optimal placement of UPFC in the power system is being analyzed. Load flow analysis results are obtained and the strength of buses is identified by using stability indices. A comparative study is performed where optimal placement of UPFC is performed by the conventional algorithm and by using Genetic Algorithm. By the conventional NR method the power flow has been carried out for the IEEE 5 Bus system. The location of the UPFC is optimized by conventional method and is compared with the proposed method. L-Index value is computed for the system and it is observed that bus Elm is more sensitive. Hence UPFC is incorporated in between Elm and Main. Another node Elmfa is created. By the conventional NR-Algorithm the UPFC is incorporated in between Lake and Main. Hence another node Lakefa is created. [10]

Vijayarpiya et.al. says increasing stability and maximum load ability of a system and minimizing the losses in the power system network by optimal placement of Unified Power Flow Controller (UPFC). Unified Power Flow Controller (UPFC) is one of the versatile FACTS devices which has shown great potential in enabling power system engineers to maintain the required level of security of a large interconnected power systems by controlling the active and reactive power flow through any lines(s) in the system. Identification of a suitable location for installation of this costly device is a vital task. Several criteria are to be satisfied before selecting the best location. In this paper the best location for UPFC placement is identified and analyzed based on minimizing the losses and increasing the load ability of the line. [11]

Conclusion

From the above review, it can be concluded that using same rating of STATCOM and UPFC, UPFC is more efficient and provide better voltage profile for given loading condition. The losses are also reduced with the use of STATCOM and UPFC.

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