Optimal Power Flow problem solving in power systems in order to eliminate line congestion by considering the presence of Felexible AC Transmission Systems in the network

Abstract

The issue of optimal power flow is an extremely economically important one in studies on transmission networks. Optimal power flow is aimed at adjusting variables under control of power system optimally in such a manar that system requirements are not breached while a given objective function is optimized considering the momentary network changes and power system loads. It seems that creating new lines is necessary to increase transmission power and/or to exploit transmission lines with a capacity close to their thermal limits with respect to the fact that energy consumption is growing increasingly around the world and that there are some limitations facing the construction and development of new power systems. In addition, to produce new lines is time-consuming and highly expensive, on one hand, and reliability of power systems decreases due to reaching maximum capacity of lines, on the other. Therefore, making use of recently introduced flexible alternative current transmission system (FACTS) for power systems has become common in order to manage active power passing transmission lines so that it can pass intended courses in addition to increasing the reliability and safely of transmission systems. Because of high complexity, presence of different requirements, inability of traditional methods to give optimal absolute responses, and perfect use of FACT devices, it is required to determine variables related to the problem of optimal power flow besides the positions and size of variables of FACT devices optimally by means of evolutionary optimization algorithms. So, in present dissertation, we ar going to solve the problem of optimal power flow initially, without FACT devices, by genetic algorithm (GA), particle swarm optimization (PSO), combination of GA and PSO (HGAPSO) and imperialist competitive algorithm (ICA) in order to minimize the cost of generated power, active power losses and bus voltage deviation index. All the next step, by applying some of the most important FACT devices such as thyristor controlled series capacitors (TCSC), thyristor controlled phase shifter (TCPS) and unified power flow controller (UPFC) to the problem of optimal power flow, we embark on comparing the results from optimal power flow obtained with and without FACT devices in order to see how well such devices decrease/ increase costs and losses/ improvement of voltage profiles of buses. At the final step, we increase system loads uniformly to investigate congestion conditions of power systems. Next, by applying UPFC to optimal positions and sizes combined with problem of optimal power flow by means of mentioned algorithms, we evaluate performance of UPFC to lower and/ or to remove congestion. Optimization is performed on standard 30-bus IEEE network by MATPOWER toolkit being implemented with MATLAB software. In general, results indicate that application of UPFC to optimal position and size by means of said algorithm combined with problem of optimal power flow improves performance of power systems in steady state mode, lowers line congestion, and helps to manage the power passing transmission lines as better as possible.

Key words: optimal power flow, Unified power flow controller, Thyristor Controlled Series Capacitors (TCSC), thyristor controlled phase shifter (TCPS), Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Hybrid Genetic and Particle Swarm Optimization (HGAPSO), Imperialist Competitive Algorithm (ICA)

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