ABSTRACT

Due to huge increase in load, modern power system networks are being operated under highly stressed conditions. As a result, power system networks find it extremely difficult to meet reactive power requirement and maintain the bus voltage of power system within acceptable limits. Voltage instability in the system occurs in the form of a progressive decay in voltage magnitude at some of the buses. Voltage instability and the resultant voltage collapse are the major concerns in the operation of power system. This research work aims to provide a system that will solve the problems of voltage instability and voltage collapse.

Reactive power compensating devices other than Flexible AC Transmission System (FACTS) device give only fixed compensation whereas FACTS device provides variable compensation to improve voltage stability, enhance voltage profile, reduce power losses and also increase the loadability of the system. Voltage Collapse Proximity Indicator, L-index, the minimum singular value of power flow Jacobian matrix, the loading margin, minimum eigen value of reduced Jacobian matrix etc. are some of the conventional methods that place the FACTS based on their respective voltage stability indices in the power system. The other method available is through biologically inspired optimization techniques.

This research work has chosen the biologically inspired optimization techniques such as Particle Swarm Optimization (PSO), Genetic Algorithm (GA) and hybrid PSOGA because it offers a solution to the problem better than the conventional method. They enable placing SVC device in the best possible position and also finding its susceptance rating. In addition, this research work has taken up the following objectives: minimization of the voltage stability index, total power loss, load voltage deviation, cost of generation and cost of SVC device. In this research work, best location for SVC device and susceptance rating of SVC device have been found for different loading scenario using PSO, GA and hybrid PSOGA.

It is observed from the results that the voltage stability margin is improved, voltage profile of the power system is increased, load voltage deviation is reduced, cost of generator units is reduced, cost of SVC device is reduced and real power loss is also reduced by optimally locating SVC device in the power system. Also, it is found that hybrid PSOGA results are better than that of GA, PSO and conventional method. This proposed work was verified with IEEE 14 bus, IEEE 30 bus, IEEE 57 bus and IEEE 118 bus power systems. Optimal location and rating of SVC have been found for different load scenarios for IEEE 14 bus, IEEE 30 bus, IEEE 57 bus and IEEE 118 bus using GA, PSO and PSOGA techniques.

In case of IEEE 14 bus system real power loss is reduced by 0.133 MW when optimal location of SVC is found using conventional method, real power loss is reduced by 0.058 MW when optimal location of SVC is found using PSO, real power loss is reduced by 0.15 MW when optimal location of SVC is found using GA and real power loss is reduced by 0.174 MW when optimal location of SVC is found using hybrid PSOGA. In case of IEEE 30 bus system real power loss is reduced by 0.012 MW when optimal location of SVC is found using conventional method, real power loss is reduced by 0.044 MW when optimal location of SVC is found using PSO, real power loss is reduced by 0.057 MW when optimal location of SVC is found using GA and real power loss is reduced by 0.063 MW when optimal location of SVC is found using hybrid PSOGA.

In case of IEEE 57 bus system real power loss is reduced by 0.412 MW when optimal location of SVC is found using conventional method, real power loss is reduced by 0.445 MW when optimal location of SVC is found using PSO, real power loss is reduced by 0.518 MW when optimal location of SVC is found using GA and real power loss is reduced by 0.865 MW when optimal location of SVC is found using hybrid PSOGA. In case of IEEE 118 bus system real power loss is reduced by 0.294 MW when optimal location of SVC is found using conventional method, real power loss is reduced by 0.4 MW when optimal location of SVC is found using PSO, real power loss is reduced by 0.362 MW when optimal location of SVC is found using GA and real power loss is reduced by 0.489 MW when optimal location of SVC is found using hybrid PSOGA, hence hybrid PSOGA results are better than that of GA, PSO and conventional method.