Abstract

The increase in global power demand has caused most of today's power networks to become overloaded especially in Sub-Saharan Africa. The increased load demand can be met through expansion of existing generation and transmission system. However, construction of new power infrastructure is limited by financing and technical constraints. Thus, power networks have been left to operate at overload conditions with high power losses and many power quality (PQ) problems. Flexible AC Transmission System (FACTS) devices can improve the power transfer capability of the existing transmission networks without the need of constructing new power infrastructure. In this paper, a multi-objective function comprising of minimization of power loss (PL), voltage deviation (VD) and operational cost (OC) was formulated and solved using a novel algorithm. A novel Genetic Algorithm-Improved Particle Swarm Optimization (GA-IPSO) technique is proposed in this paper for optimization of size and location of FACTS devices. Static Synchronous Compensator (STATCOM), Thyristor Controlled Series Capacitor (TCSC) and Unified Power Flow Controller (UPFC) are the three FACTS devices considered. The proposed technique was validated using IEEE-33 Bus Test System, which is a popular benchmark Radial Distribution System (RDS). The three FACTS devices were optimized separately and also in a combined manner. Under the separate optimization, the size and location of individual FACTS devices were optimized. For combined optimization, the sizes and locations of more than one device were optimized in the same test system. For separate optimization, UPFC produced the best results by reducing the active power losses by 38.44 % and OC from \$1.59 × 105 to \$ 1.15 × 105. Under the combined optimization, combination of TCSC, STATCOM and UPFC gave better results by achieving active power loss reduction of 56.09 % and reducing OC from \$1.59 × 105 to \$ 1.03 × 105. Comparison of GA-IPSO technique with other algorithms such as Particle Swarm Optimization (PSO), Genetic Algorithm (GA), Improved Grey Wolf Optimization (IGWO) and Differential Evolution Algorithm (DEA) showed that the proposed hybrid technique was superior and more efficient in solving the FACTS optimization problem.