ABSTRACT

Electrical power systems, which are controlled by electrical and mechanical systems, are critical components of modern society. Economic dispatch is a critical process in the operation of a power system that aims to allocate power generation to match load demand at the lowest possible cost while satisfying all generators and system constraints.

The increasing use of sensitive equipment in modern power systems necessitates a strong emphasis on power quality. Quality issues such as voltage sags, swells, surges, interruptions, and harmonic problems cause significant economic loss in the power industry and necessitate immediate action. FACTS (Flexible Alternating Current Transmission Systems) can manipulate and improve the fundamental components of an electrical system used in conveyance to ensure the reliable and stable operation of the power system. The FACTS device solves critical issues such as voltage stability, line overloading, power loss, power flow, and so on. The FACTS device is important in improving power system operations, whether static or dynamic, and requires a capital investment. As a result, the FACTS device can be optimised in terms of position and size to improve the performance of the power system. In the power system, four different FACTS devices such as series, shunt, combine series and shunt, combine shunt and series devices are selected to place in suitable locations to raise the voltage level and reduce power losses. The effects of FACTS devices on various bus network parameters such as generation cost, power loss, and voltage stability, among others, are assessed. To reduce power loss and maintain a voltage level, the FACTS devices' size and location must be improved.

Voltage instability has recently been identified as a critical issue in the transmission line system due to its dynamic load pattern and increasing load demand. Flexible AC Transmission Systems (FACTS) devices are used to reduce voltage instabilities by controlling real and reactive power via the transmission line system. The location and size of FACTS in the transmission system are important considerations for ensuring proper power flow in the system. The optimal placement and sizing of FACTS devices is achieved in this work by combining the Kinetic Gas Molecular Optimization (KGMO) and Cuckoo Search Algorithm (CSA). In this study, three different FACTS devices were used: Static VAR compensator (SVC), Thyristor Controlled Series Compensator (TCSC), and Unified Power Flow Controllers (UPFC). The proposed hybrid KGMO-CSA method's primary objectives are to minimise installation costs, Total Voltage Deviation (TVD), Line Loading (LL), and real power loss. Furthermore, by analysing the IEEE 14, 30, and 57 bus systems, the optimal placement using the hybrid KGMO-CSA method is validated in MATLAB software. Finally, when compared to existing Quasi-

Oppositional Chemical Reactions, the hybrid KGMO-CSA achieved 3.6442 MW power loss and 0.1007 p.u. TVD which is less when compared to existing Quasi-Oppositional Chemical Reaction Optimization (QOCRO).