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Genetic Algorithm Based Fuzzy Multi-Objective Approach to FACTS Devices Allocation in FARS Regional Electric Network

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In this investigation, a novel approach is presented to find the optimum locations and capacity of Flexible AC Transmission Systems (FACTS) devices in a power system using a fuzzy multi-objective function. Maximising the fuzzy satisfaction allows the optimization algorithm to simultaneously consider the multiple objectives of the network to obtain active power loss reduction; i.e., new FACTS devices cost reduction, robustifying the security margin against voltage collapse, network loadability enhancement and a voltage deviation reduction of the power system. A Genetic Algorithm (GA) optimization technique is then implemented to solve the fuzzy multi-objective problem. Operational and control constraints, as well as load constraints, are considered for optimum device allocation. Also, an estimated annual load profile has been utilized in a Sequential Quadratic Programming (SQP) optimization sub-problem to find the optimum location and capacity of FACTS devices, accurately. A Thyristor Controlled Series Compensator (TCSC) and a Static Var Compensator (SVC) are utilized as series and shunt FACTS devices in this study. The Fars regional electric network is selected as a practical system to validate the performance and effectiveness of the proposed method.

Keywords: FACTS devices allocation; Multi-objective optimization; Genetic algorithm; Fuzzy.

INTRODUCTION

These days, the importance of a power system design and operation with high efficiency, maximum reliability and security has to be considered more than ever. Some difficulties, such as right of way and transmission line expansion, force the use of the maximum capacity of transmission lines and, therefore, providing voltage stability, even under normal conditions, becomes more difficult. This problem is serious, due to the fact that the main duty of generation units is based on active power generation rather than reactive power compensation.

Flexible AC Transmission Systems (FACTS) devices, as modern compensators of active and reactive powers, can be considered viable options in providing voltage security constraints and their feasibility in power systems, simultaneously, because of their fast responses against perturbations in urgent circumstances, flexible performance under normal conditions and their ability to be used in dynamic situations. Note that it is also possible to consider the global voltage stability indicator in FACTS devices allocation problems.

In order to allocate the FACTS devices according to their characteristics, various objectives have been considered. For instance, static voltage stability enhancement [1-4], violation diminution of the line thermal constraints [5], network loadability enhancement [6,7], power loss reduction [8], voltage profile improvement [6] and the fuel cost reduction of power plants using optimal power flow [9] are some objectives for tasks reported in the literature. Furthermore, to approach these objectives, some simplifications, such as using single objective optimization, neglecting the investment budget as a part of the objective function, and allocation, based on decoupled active and reactive components in the presence of a multi-objective function [9], have been made. These assumptions cause some problems such as, an inability to use the powerful

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