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Optimum allocation of FACTS devices in Fars Regional Electric Network using genetic algorithm based goal attainment

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Abstract: This paper presents a novel approach to find optimum locations and capacity of flexible alternating current transmission system (FACTS) devices in a power system using a multi-objective optimization function. Thyristor controlled series compensators (TCSCs) and static var compensators (SVCs) are the utilized FACTS devices. Our objectives are active power loss reduction, newly introduced FACTS devices cost reduction, voltage deviation reduction, and increase on the robustness of the security margin against voltage collapse. The operational and controlling constraints, as well as load constraints, were considered in the optimum allocation. A goal attainment method based on the genetic algorithm (GA) was used to approach the global optimum. The estimated annual load profile was utilized in a sequential quadratic programming (SQP) optimization sub-problem to the optimum siting and sizing of FACTS devices. Fars Regional Electric Network was selected as a practical system to validate the performance and effectiveness of the proposed method. The entire investment of the FACTS devices was paid off and an additional 2.4% savings was made. The cost reduction of peak point power generation implies that power plant expansion can be postponed.

Key words: Flexible alternating current transmission system (FACTS) devices allocation, Multi-objective optimization, Genetic algorithm (GA), Goal attainment

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INTRODUCTION

These days, high efficiency, maximum reliability, and security in the design and operation of power systems are more important than ever before. The difficulties in constructing new transmission lines due to limits in rights for their paths make it necessary to utilize the maximum capacity of existing transmission lines. Therefore, it is difficult to provide voltage stability, even in normal conditions. The fact that the main duty of generation units is based on the active power generation requirements rather than the reactive power compensation makes the problem more serious.

Flexible alternating current transmission system (FACTS) devices, as modern active and reactive power compensators, can be considered as viable and feasible options for satisfying the voltage security constraints in power systems, since their response to perturbations in urgent circumstances is fast, their performance in normal conditions is flexible, and their operation can fit the dynamic situations.

It is well documented that the effectiveness of FACTS controllers mainly depends on their locations (Okamoto *et al.*, 1995). According to the characteristics of FACTS devices, various criteria have been considered in the allocation problem. Some of the reported objectives are: static voltage stability enhancement (Chang and Huang, 1998; Sharma *et al.*, 2003; Yorino *et al.*, 2003; Song, 2004), violation diminution of the line thermal constraints (Lu and Abur, 2002), network loadability enhancement (Jurado and Rodriguez, 1999; Gerbex *et al.*, 2001), loss reduction (Singh and David, 2000), voltage profile improvement (Gerbex *et al.*, 2001), power plants fuel cost reduction using optimal power flow (Ongsakul