Energy Conversion and Management 50 (2009) 682–690

Contents lists available at ScienceDirect

Energy Conversion and Management

journal homepage: www.elsevier.com/locate/enconman

A novel approach for optimum allocation of FACTS devices using multi-objective function

M. Gitizadeh *, M. Kalantar

Center of Excellence for Power System Automation and Operation, Department of Electrical Engineering, Iran University of Science and Technology, Tehran 16844, Iran

ARTICLE INFO

Article history:
Received 17 July 2007
Received in revised form 14 March 2008
Accepted 20 October 2008
Available online 4 December 2008

Keywords:
FACTS devices allocation
Multi-objective optimization
Simulated annealing
Goal attainment

ABSTRACT

This paper presents a novel approach to find optimum type, location, and capacity of flexible alternating current transmission systems (FACTS) devices in a power system using a multi-objective optimization function. Thyristor controlled series compensator (TCSC) and static var compensator (SVC) are utilized to achieve these objectives: active power loss reduction, new introduced FACTS devices cost reduction, increase the robustness of the security margin against voltage collapse, and voltage deviation reduction. The operational and controlling constraints as well as load constraints are considered in the optimum allocation procedure. Here, a goal attainment method based on simulated annealing is used to approach the global optimum. In addition, the estimated annual load profile has been utilized to the optimum siting and sizing of FACTS devices to approach a practical solution. The standard IEEE 14-bus test system is used to validate the performance and effectiveness of the proposed method.

1. Introduction

These days, high efficiency, maximum reliability, and security in 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, makes it necessary to utilize the maximum capacity of transmission lines. Therefore, it would be difficult to provide the voltage stability even in normal condition. 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 systems (FACTS) devices, 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 due to perturbations in the urgent circumstances is fast, their performance in the normal conditions is flexible, and they could be used in dynamic situations.

It is well documented in the literature that the effectiveness of the FACTS controllers mainly depends on their locations [1]. According to characteristics of FACTS devices, various criteria have been considered in allocation problem. Some of the reported objectives in literature are: static voltage stability enhancement [2–5], violation diminution of the line thermal constraints [6], network loadability enhancement [7,8], loss reduction [9], voltage profile improvement [7], power plants fuel cost reduction using optimal power flow [10], and economical approach which has minimized the overall system cost function [11]. It should be noted that each of the mentioned objective improves the power system network operation and approaching them is desirable in all power system networks. But improvement in one objective does not guarantee the same improvement in others. For instance, satisfying the voltage magnitude constraint does not result in the satisfaction of the voltage stability requirement [12]. Also it is obvious that the minimum power loss leads to power system lines optimum operation, whereas it may exacerbate the static voltage stability limit. Therefore, none of the mentioned technical objectives can be neglected in FACTS devices allocation. On the other hand, allocation of the unlimited FACTS devices due to one or more objectives without considering the cost of the devices cannot be justified despite assumption in [7]. Therefore, both technical and economical objectives should be involved in FACTS allocation problem. In previous efforts to approach these objectives some simplifications have been made such as allocation based on decoupled active and reactive components [5], or definition of cost function without including the interest rate and active power loss price [11]. In [13], although a multi-objective genetic algorithm (MOGA) approach has been implemented for FACTS devices allocation, only two objectives with different dimension, including line overload and voltage violation reduction, have been simplified and augmented to constitute a single objective function. In addition, in economic objective function definition, interest rate has not been included. These assumptions causing some problems such as: inability to use all achievable advantages of FACTS devices, impractical allocation results, and inaccurate solution of the problem.

* Corresponding author. Tel.: +98 21 77240492.
E-mail addresses: gitizadeh@ee.iust.ac.ir, (M. Gitizadeh).

0196-8904/$ - see front matter © 2008 Elsevier Ltd. All rights reserved.
doi:10.1016/j.enconman.2008.10.009