Chapter 7
Optimal Power Flow and Optimal Reactive Power Dispatch Incorporating TCSC-TCPS Devices Using Different Evolutionary Optimization Techniques

ABSTRACT

The introduction of flexible AC transmission system (FACTS) has added a new dimension in power system operation and planning. Various types of FACTS controllers such as static compensator (STATCOM), static synchronous series compensator (SSSC), thyristor control series compensator (TCSC), thyristor control phase shifter (TCPS), unified power flow controller (UPFC), etc. are successfully used by various researchers in order to get optimal performance of power system. In this chapter, the various population-based nature-inspired techniques such as grey wolf optimization (GWO), teaching-learning-based optimization (TLBO), biogeography-based optimization (BBO), krill herd algorithm (KHA), chemical reaction optimization (CRO), and hybrid CRO (HCRO) are used to find the optimal size of TCSC and TCPS devices in order to find the optimum performance of IEEE 30-bus power system. The simulation results of various cases demonstrate the effectiveness and robustness of the proposed techniques to solve TCSC-TCPS-based OPF and ORPD problems.

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INTRODUCTION

The developing countries like India, commercial as well as industrial power demand grows unpredictably; thereby supplying reliable and secure power to the consumer is a challenging task. The McKinsey & Company's 'Electric Power and Natural Gas Practice' made a survey on India of 'Powering India: The Road to 2017'. Above analyses suggested that if India grows at an average rate of 8% for the next 10 years, then India's demand for power is likely to soar from around 120 GW at present to 315–335 GW by 2017, 100 GW higher than most current estimates. Four main factors behind the analysis are: (i) Rise of Industrial Power demand, (ii) Commercial demand rising at 14% over the next 10 years, (iii) 'Power for all by 2012' and (iv) the realization of demand suppressed due to load shedding. To achieve the demand by 2017, India needs a generation capacity of 415–440 GW (McKinsey & Company, 2017).

In recent years Environment, deregulation of power utilities has delayed the construction of both generation facilities and new transmission lines. However, due to the increasing load demand, more and more power is required to be pushed over the existing transmission lines but the increase in the power flow above a certain operating level increases power loss, reduces the voltage profile and decreases the overall stability of the system. To achieve better power flow control over the existing transmission lines without violating the stability margin of the system, application of flexible ac transmission system (FACTS) may be adopted.

The optimal power flow (OPF) problem has been well known since 1960s. The first person to introduce the concept of OPF was Carpentier in the year 1962 (Carpentier, 1962). Nowadays, modern methods like differential evolution (DE) (Panda, 2009), evolutionary algorithm (EA) (Panda, 2009), genetic algorithm (GA) (Rashed et al., 2007; Narayana et al., 2012), particle swarm optimization (PSO) (Singh et al., 2015; Shayeghi et al., 2010), bacctoria foraging algorithm (BFA) (Edward et al., 2013), symbiotic organisms search algorithm (SOA), (Prasad & Mukherjee, 2016), Brainstorm optimisation algorithm (BSOA) (Jordehi, 2015), Cat Swarm Optimization (CSO) (Nireekshana et al., 2016), whale optimization algorithm (WOA) (Raj, 2017) to solve OPF must be adjusted in order to satisfy the new challenges of the power industry coming from market and technological transformations. In

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