Electric Power Systems Research 80 (2010) 1286–1292

Contents lists available at ScienceDirect

Electric Power Systems Research

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

Differential evolution algorithm for emission constrained economic power dispatch problem

A.A. Abou El Ela[a], M.A. Abido[b], S.R. Spea[a,*]

[a] Electrical Engineering Department, Faculty of Engineering, Menoufiya University, Egypt
[b] Electrical Engineering Department, King Fahd University of Petroleum and Minerals, Saudi Arabia

ARTICLE INFO

Article history:
Received 27 July 2009
Received in revised form 2 January 2010
Accepted 29 April 2010
Available online 1 June 2010

Keywords:
Economic power dispatch
Differential evolution algorithm
Fuel cost minimization
Emission constraint
Environmental issues

ABSTRACT

In this paper, a differential evolution (DE) algorithm is developed to solve emission constrained economic power dispatch (ECEPD) problem. Traditionally electric power systems are operated in such a way that the total fuel cost is minimized regardless of emissions produced. With increased requirements for environmental protection, alternative strategies are required. The proposed algorithm attempts to reduce the production of atmospheric emissions such as sulfur oxides and nitrogen oxides, caused by the operation of fossil-fueled thermal generation. Such reduction is achieved by including emissions as a constraint in the objective of the overall dispatching problem. A simple constraint approach to handle the system constraints is proposed. The performance of the proposed algorithm is tested on standard IEEE 30-bus system and is compared with conventional methods. The results obtained demonstrate the effectiveness of the proposed algorithm for solving the emission constrained economic power dispatch problem.

Published by Elsevier B.V.

1. Introduction

The basic objective of economic power dispatch (EPD) of electric power generation is to schedule the generation unit outputs so as to meet the load demand at minimum operating cost while satisfying all unit and system equality and inequality constraints [1,2]. This problem has been tackled by many researchers in the past. The literature of the EPD problem and its solution methods are surveyed in [3].

The generation of electricity from fossil fuel releases several contaminants, such as sulfur oxides, nitrogen oxides and carbon dioxide, into the atmosphere. Recently the problem which has attracted much attention is pollution minimization due to the pressing public demand for clean air. Since the text of the Clean Air Act Amendments of 1990 and similar acts by European and Japanese governments, environmental constraints have topped the list of utility management concerns [4].

Several strategies to reduce the atmospheric emissions have been proposed and discussed. These include installation of pollutant cleaning equipment, switching to low emission fuels, replacement of the aged fuel-burners with cleaner ones, and emission dispatching. The first three options require installation of new equipment and/or modification of the existing ones that involve considerable capital outlay and, hence, they can be considered as long-term options. The emission dispatching option is an attractive short-term alternative in which both emission and fuel cost is to be minimized. In recent years, this option has received much attention since it requires only small modification of the basic economic dispatch to include emissions [5,6].

Several methods have been used to represent emission levels. A summary of environmental/economic dispatch algorithms dating back to 1970 using conventional optimization methods has been provided in [7]. In [4], the environmentally constrained economic dispatch problem is solved using the Hopfield NN method in which the energy function of the Hopfield Neural Network contains both the objective function, and equality and inequality constraints. Also, the emission is inserted as a constraint and the problem was solved using Neural Network in [8]. Abido [1,9–11] tried to find the best compromise between the conflicting targets of minimum cost and minimum emission by means of suitable Pareto-based multi-objective procedures. In other research direction, the emission/economic dispatch problem was converted to a single objective problem by linear combination of different objectives as a weighted sum [12].

A new evolutionary computation technique, called differential evolution (DE) algorithm, has been proposed and introduced recently [13–16]. The algorithm is inspired by biological and sociological motivations and can take care of optimality on rough, discontinuous and multi-modal surfaces. The DE has three main advantages: it can find near optimal solution regardless the initial parameter values, its convergence is fast and it uses few number of control parameters. In addition, DE is simple in coding and easy

* Corresponding author.
E-mail address: shi_spea@yahoo.com (S.R. Spea).

0378-7796/$ – see front matter. Published by Elsevier B.V.
doi:10.1016/j.epsr.2010.04.011