Interactive Compromise Approach with Particle Swarm Optimization for Environmental/Economic Power Dispatch

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***Abstract*—**In this paper, an Interactive Compromise Approach with Particle Swarm Optimization(ICA-PSO) is presented to solve the Economic Emission Dispatch(EED) problem. The cost function and emission function are modeled as the nonsmooth functions, respectively. The bi-objective including both the minimization of cost and emission is formulated in this paper. ICA-PSO is proposed to solve EED problem for finding a better compromise solution. The solution methodology can offer a global or near-global solution for decision-making requirements. The effectiveness and efficiency of ICA-PSO are demonstrated by a sample test system. Test results can be shown that the proposed method provide a practical and flexible framework for power dispatch.

***Keywords*—**Interactive Compromise Approach, Emission Control, Economic Dispatch, Particle Swarm Optimization.

I. Introduction

THE primary objective of the economic dispatch (ED) is a scheme to minimize total fuel cost subject to several unit and system constraints. For a more effective operation, efficient strategies have been developed in [1-6]. Those strategies are mainly operated in such a way that the operating cost is minimized regardless of emissions produced. The passage of the 1990 U.S. Clean Air Act Amendments[7] has forced the utilities to modify their operating strategies to meet environmental standards set by legislation. In recent year, some operating strategies including emissions dispatch and fuel switching have been developed in[8-12]. Emissions dispatch adds a second objective to the operating problem, which can obtain both emissions reduction and minimizing power production cost. Fuel switching uses the fuel co-firing technique to reduce the emissions. These techniques not only intended to reduce emission into atmosphere but also want to minimize the operation cost.

Due to the conflicting and noncommeasurable natures of fuel cost and emission control, a single objective function seems not appropriate for this problem. Considering the emission, a trade-off between economy and environment need to be considered in the optimization process. With increased requirements for environmental protection, alternative strategies are required. It is a complicated problem, which includes two objectives. An efficient and reliable technique is needed to solve this Economic Emission Dispatch(EED) problem. Most previous studies[8-12] formulated this problem with only a single objective and emissions are treated as binding constraints. Since the emissions are important to both the power utilities and customers, it is beneficial to tackle the emissions as another objective function instead of just constraints. Various optimization techniques had been developed to solve the bi-objective problem[13-15]. The major disadvantage in solving the EED problem is that they are incapable of handing nonsmooth fuel cost and emission functions. An efficient and reliable technique is needed. This paper proposes the use of Particle Swarm Optimization(PSO) [16] to solve the nonsmooth functions. PSO searches from a population of points, not a single point. The population can move over hills and across valleys. It can search a complicated and uncertain area to find the solution. Therefore, PSO can discover a globally or near globally optimal point. Since PSO is a global searching technique, it is more capable of getting away from the local minimum to improve the quality of solution.

In this paper, an Interactive Compromise Approach[17] with Particle Swarm Optimization(ICA-PSO) is presented to solve the Economic Emission Dispatch(EED) problem. The bi-objective function considered the economy and emission level. Nonsmooth fuel cost functions, nonsmooth emission functions, and the transmission losses are taken into account. The PSO is used to seek for a global or near-global optimal solution when the ICA procedure interacted with the Decision Makers(DMs). The type of information such as trade-offs can make available to DMs in the interactive procedure. DMs also adjusted single-objective dependent upon their satisfactory strategies. By using the ICA-PSO, it easily enables the Decision Makers(DMs) to alternative a paerto-optimal solution. Effectiveness of the proposed method is demonstrated on an example system. Results show that the proposed method provides a set of flexible best selection for operation dispatch by following the instructions of DM's.

II. Problem Formulation

The bi-objective function including cost model($C(\bullet)$) and emission model($E(\bullet)$) can be formulated by

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