Chapter 2
Economic Load Dispatch:
Optimal Power Flow and Optimal Reactive Power Dispatch Concept

ABSTRACT

The main objective of the power system is to deliver electric energy to its loads economically and efficiently in a safe and reliable manner. Due to the complicated structure of the present power system network and competitive environment introduced by deregulation, optimal power flow (OPF) and optimal reactive power flow (ORPD) provide efficient exploitation of existing power generations. This chapter describes the detail problem formulation of OPF and ORPD problems. In this study, three different single objectives, namely fuel cost minimization, voltage profile improvement, and transmission loss minimization, are considered. Moreover, in order to judge the effectiveness of the proposed methods for multi-objective scenario, two bi-objectives, namely simultaneous minimization of fuel cost and voltage deviation; simultaneous minimization of fuel cost and transmission loss; and one tri-objective function, namely simultaneous minimization of fuel cost with voltage deviation and loss, are considered.

DOI: 10.4018/978-1-5225-6971-8.ch002

INTRODUCTION

The main objective of any electrical power utility is to ensure reliable and stable power supply economically to the consumers. For smaller size power systems, it is comparatively a trivial problem. In earlier days, individual power systems were used and operated separately using regional concept. However, the state of the art is to have interconnection of different supply agencies to form very large complex power systems in order to achieve several advantages. In an interconnected power system, the real and the reactive powers of the generators are required to vary within operating limits in order to meet the particular load demand with minimum fuel cost. In the generation plant, there are two factors which are to be considered at every load change. These are the division of load and economic factor. But due to the deregulation of the industry, optimal power flow (OPF) is used to handle such problems. OPF is one of the fundamental issues of power system operation and planning. It was first introduced by Dommel and Tinney (Dommel & Tinney,1968). Thereafter, several methods of OPF have been proposed by the power system research community. At present, OPF has become reliable enough for practical use and has taken a place on standard power system analysis tools. Thus, the main purpose of OPF solution is to schedule the power generation in such a way that minimizes the fuel cost while satisfying all the equality and inequality constraints. In addition to the minimization of fuel cost, the OPF may also be used to achieve the other benefits such as reduction of system loss, improvement of voltage profile and improvement of system security. Thus, the objective of the OPF is to find steady state operating point which minimizes generation cost, system loss, voltage deviation etc while maintaining an acceptable system performance in terms of limits on generators' real and reactive powers, line flows, outputs of various compensating devices etc.

Due to the continuous growth in the demand for electricity with unmatched generation and transmission capacity expansion, voltage instability is emerging as a new challenge to power system planning and operation. Unavailability of sufficient reactive power sources to maintain normal voltage profiles at heavily loaded buses are the main reasons for the voltage collapse. This problem may be overcome by reallocating reactive power generations in the system. This can be achieved by adjusting transformer taps, var injections of shunt compensators and generator voltages. In addition, the system losses can be minimized via redistribution of reactive powers in the system. Optimal