Optimal Reactive Power Flow in a Deregulated Power System – A Case Study

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ABSTRACT:- Optimal reactive power flow is an optimization problem with one or more objective of minimizing the real power losses. The ancillary service for a generator has two components that have been recently recognized, i.e., one for sustaining its own real power communication and the other for providing reactive demand, enhancing system security, and scheming system voltage; and that only the next part should get financial compensation in aggressive power markets. The power flow equations and the inequality constraints of basic system operation are the equality constraints, such as voltage magnitude limits. In this paper planned incorporated technique will be united with fuzzy logic and cuckoo search algorithm. One of the knowledge base intelligence techniques which will be utilized for verifying the generator reactive power operating limits was the fuzzy logic. Cuckoo search is solitary of the optimization algorithms which will be used for optimizing the purpose function parameters. Representative results are presented using the IEEE 30 bus system by using MATLAB working platform and the ORPF presentation will be estimated.

Key words: Reactive power, Optimum Reactive Power Flow (ORPF), Fuzzy Logic Controller (FLC) and Cuckoo Search Algorithm (CS)

I.INTRODUCTION

The important operating task of power utilities is to keep voltage within an allowable range for high quality customer services [1] [3]. Electric power loads vary from hour to hour and voltage can be varied by change of the power load [2]. Power utility operators in control centers handle various equipment such as generators, transformers, static condenser, and shunt reactor, so that they can inject reactive power and control voltage directly in target power systems in order to follow the load change [4] [5]. Voltage stability constrained reactive power dispatching in deregulated power networks is a difficult task facing an Independent System Operator (ISO) that is mandated to provide equitable ancillary services [6]. In a vertically integrated power system, reactive power facilities are operated under a monopoly by the system operator to meet technical requirement [9] [15], such as improving the voltage profile and reducing the loss of transmission lines or, even, increasing the voltage stability margin to avoid instability, due to load perturbation or equipment failure [7] [8] [10].

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Optimal Reactive Power Flow (ORPF) is an important tool for power system operators both in planning, operating stages and avoids instability [11] [16]. The loads acquire reactive power for magnetizing purposes at no load conditions and the electric power loads vary from hour to hour. The change of load causes variation in the reactive power requirement [12]. The amount of reactive power needed for operating loads should maintain load bus voltages within their acceptable operating limits [14]. A power system needs to be with sufficient reactive re-serves to meet the increased reactive power demand under heavily loaded conditions and to avoid voltage instability problems [13].

A wide variety of conventional optimization techniques used for optimal reactive power flow such as linear programming [17], Newton approach, interior point methods and dynamic programming have been developed to solve ORPF problem [20]. Generally these techniques suffer due to algorithmic complexity, insecure convergence, and sensitivity to initial search point. The soft computing techniques fuzzy logic, fuzzy linear programming, and evolutionary programming (EP) are used for setting optimal reactive power limits [18] [19].

II.RECENT RESEARCH WORKS: A CASE STUDY

Numerous related works are already available in literature which based on optimal reactive power selection in distribution system. Some of them reviewed here.

H. Wu *et al*. [21] have discussed an important ancillary service for secure and reliable operation in power markets. It has recently been recognized that the reactive power support for a generator has two components: one for supporting its own real power transmission and the other for supplying reactive demand, improving system security, and controlling system voltage; and that only the second part should receive financial compensation in competitive power markets. This makes the problem of separating these two components a focus of current research. An OPF based reactive power optimization model along with a power flow tracing based method was proposed to tackle this problem.

Ali Ozturk *et al*. [22] have studied RPO with ABC algorithm in a power system. During this application, the reactive power optimization was applied in a manner that has rare application in the literature. Not only was there active power loss minimization, the reactive power cost and the quality of voltage transferred to the customers were also optimized. At the minimization of the voltage deviations, the more optimum result was taken as the cost function. With these values, the active power loss could be reduced and the compensators could be run at a minimum cost.

P.R.Sujin *et al*. [23] have developed reactive OPF to solve the optimal reactive dispatch problem. The total reactive cost was separated into generators duty and loadings duty.

Cost duty on the generation side was allocated to real power selers by evaluating their reactive power requirement for real power transportation. The method of evaluation adopted in this paper has a common basis for every market participant and hence it was consistent and equitable. Each generator would be paid according to the difference between it was actual incurred cost of contributing of reactive power support and its cost of reactive power requirement for real power selling. The theory and implementation was illustrated through a simple example. The results were obtained using PSO illustrates that the proposed algorithm was simple and practical. This method was compatible with the competitive market structure and economic efficiency could be achieved.

J. V. Parate *et al*. [24] have generalized the problem of reactive power control viewed from two aspects: load compensation and voltage support. This was utilized to reduce the total system real power loss or voltage deviation as an objective to compute optimal settings of reactive power output or terminal voltages of generating plants, transformer tap settings and output of other compensating devices such as capacitor banks and synchronous condensers. They considered the setting of flexible AC transmission system (FACTS) devices as additional control parameters for transmission loss reduction in power system and the impact on system loss reduction in power system. Static models of two FACTS devices consisting of static var compensator (SVC), thyristor controlled series compensator (TCSC) have been included in the problem formulation.

Kursat Ayan *et al*. [25] have studied optimal reactive power flow (ORPF) based on ABC algorithm to minimize active power loss in power systems. The advantage of ABC algorithm was that it does not require these parameters, because it was very difficult to determine external parameters such as cross over rate and mutation rate as in case of genetic algorithm and differential evolution. The other advantage was that global search ability of the algorithm was implemented by introducing a neighborhood source production mechanism which was similar to mutation process. Because of these features, ABC algorithm attracts much attention in recent years and has been used.

III.MOTIVATION FOR THE RESEARCH WORK

The review of the recent research work shows that, reactive power regulation is an important ancillary service for secure and reliable operation in power markets. Because, the reactive power support for a generator has two components: one for supporting its own real power transmission and the other for supplying reactive demand. The first components used for improving the system security, and controlling system voltage; and the second part should receive financial compensation in competitive power markets. In power markets, the amount of generator's reactive power that can be traded is usually considered as the generator's actual reactive power output, or the reactive power output beyond certain mandatory operational ranges. If the reactive power exceeding the operating range which maximized the charge for reactive power as well as aspire to active energy limitation, in result, increasing the fare for electrical energy. For maintaining the reactive power operating range, an optimum power flow (OPF) based optimization model along with a power flow tracing method. In this method, the optimal allocation of reactive power is based on the objective function of the system. So, an alternative method required for allocating reactive power losses. In literature very few works are presented to solve this problem and the presented works are ineffective. These drawbacks and problems have motivated to do this research work.

IV.PROPOSED METHOD

Here, I have intended to propose an integrated optimum reactive power flow (ORPF) base model along with optimized power flow tracing method. The proposed method will assess a generators minimal reactive power component that will be used to ship its real power. The optimization model will be developed based on the total reactive power generation of the generators which will subject to the equality constraints. The equality constraints will be the power flow equations and the inequality constraints of basic system operation, such as voltage magnitude limits. In the proposed integrated technique will be combined with fuzzy logic and cuckoo search algorithm. The fuzzy logic is one of the knowledge base intelligence techniques which will be used for determining the generator reactive power operating limits. Cuckoo search is one of the optimization algorithms which will be used for optimizing the objective function parameters. The proposed integrated technique will be implemented in MATLAB working platform and the ORPF performance will be evaluated.

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