ABSTRACT

The electricity market reforms and economic operations provide considerable benefits. One of the most important aims of establishing markets in power system is to promote competition among participants and improve the economy of the region or country. The power system operation fulfilling these objectives has been termed as "*Social Welfare*". In multi-transaction system, the market agents of various transactions try to maximize their welfares which results into optimal social welfare of the system. Sometimes, the agreements of bilateral/multilateral contracts among participants create operational problems in multi-transaction power markets. These operational problems may be technical or economical. Therefore, a control over the operations of transactions is required for establishing a healthy competitive market in the power system. Mostly, these operational controls are centrally governed by independent system operators (ISOs) which results into the centralized decision based system operation. However, sometimes the centralized decision based operations adversely affects the welfares of participants. This situation becomes more and more complex when various technical and coordination related issues are added in market operation during contingency conditions. A decentralized decision based market operation can overcomes the shortcomings of centralized decision based market operation. In decentralized decision based operation, the market agents formulate the contracts among the transactions for fulfilling their technical and social objectives unlike ISO in centralized decision based operation. In this, only the system information is shared through these agents to optimize the welfares of various transactions. The main aim of decentralized decision support is to maximize the total social welfare at minimum operational disputes in multi-transactions market. Another reason behind decentralization of markets is their operational benefits over centralized decision making in multi-transaction during contingency conditions. The congestion problem is one of the contingent conditions in the operation of

the power system. Thus, the congestion management with social welfare is considered as an important issue in multi-transaction power market.

In the present work, an attempt has been made to view the congestion management with social welfare maximization problem as an optimization problem in multi-transaction power market. The consumer's interest is also taken into account while deciding the operational strategy of the system. Therefore, in the formulation of problem objective, the benefits of consumer's have also been considered in the present work. The optimal rescheduling of power is one of the effective methods among existing methods. In present investigation, the centralized and decentralized decision supports are used to obtain the optimal schedules for generators and loads in order to eliminate congestion in the system while maximizing the social welfare congestion management in the system.

Contribution of various transactions towards losses also need to be properly addressed otherwise conventional procedure of allocating cost of losses to slack bus may be an economically violable proposition. Therefore, the presents work incorporates the power losses due to various transactions also and subsequently their cost in the problem formulation. The effects of loss cost on welfares of various transactions and social welfare of the system are also analyzed in this work. In the power system, the required generation corresponding to losses are supplied by the slack bus. Therefore, the cost coefficient of slack bus is used to evaluate the cost of losses in the system. In COPF, total power loss in the system and its cost is allocated to the slack bus. However, allocation of losses due to each transaction becomes more complex in multi-transaction system. The COPF formulation provides only the total losses and their costs but does not provide contribution of various transactions towards cost of losses. The DOPF based problem formulation provides a solution to this problem by allocating the cost of losses due to individual transactions in this work.

The solutions of COPF and DOPF problems can be solved using different optimization techniques. Various optimization techniques have been successfully applied over the years for OPF solutions. In the present work, Interior Point (IP) and Particle Swarm Optimization (PSO) methods have been used to obtain the solution of above proposed problem. The IP provides a faster convergence and the PSO gives global solution of the problem. In addition, a new hybrid PSO method has also been proposed in the present work to obtain the solution for the congestion management with social welfare. This method relies on solution by PSO whose initial solution includes a solution of IP named as IP initialized PSO (IP-PSO). This can be considered as second major contribution of this work. It is a known fact that IP provides fast optimal solutions as compared to other conventional techniques, yet does not guarantee a global solution. On the other hand, PSO produce global solution as compared to IP and yields slower convergence if initial particles are far away from global optimal solution. With the intention of taking benefits of both the methods, the solution obtained by IP has been used as one of the particles/solutions among the initial particles of PSO. This results into a fast search mechanism. The accuracy of the proposed IP-PSO based DOPF has been authenticated by comparing the results with that of the COPF. The results of COPF and DOPF obtained through IP-PSO are also compared with the results of them obtained through IP and PSO separately.

The test system model is one of the required entities to demonstrate the performance of IP, PSO and IP-PSO methods. In this work, two test models have been selected to demonstrate the effectiveness of COPF and DOPF using IP, PSO and IP-PSO. To study the problem objectives, these test systems are restructured as multi-transaction market models. The test system models are the modified IEEE-30 bus and modified IEEE-118 bus systems. In order to make a multi-transaction system for the present case study, the IEEE-30 bus system is modified by considering six generators and only nine demand buses. In this, all generators and loads form three

sets of transactions out of which each transaction has three loads and two generators. In this way there are nine demand and six generation bidders. Similarly, the IEEE-118 bus system is also modified to frame a multi-transaction system. In this, IEEE-118 bus system is partitioned into six transactions and formulates a multi-transaction system. It is assumed that each transaction has three loads and two generators in this and there are eighteen demands and twelve generation bidders altogether.

The test results show that the DOPF provides better social welfare in the multi-transaction system. The test results obtained for COPF and DOPF using IP-PSO are compared with the results obtained through IP and PSO. To prove the effectiveness of the proposed IP-PSO method with DOPF, the results obtained are also compared with results of COPF. The test results reveal that the proposed IP-PSO yields better results as compared to IP and PSO in terms of improved social welfare and computational times. It has also been shown that the results obtained by the proposed IP-PSO method produces better social welfare as compared to results of covariance matrix adaptation evolution strategy (CMAES) reported in literature.