Optimal Location and Capacity of STATCOM for Voltage stability Enhancement using ACO plus GA

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Abstract—Voltage security is a crucial issue in power systems especially under heavily loaded condition. In the new scheme of restructuring, voltage stability problem becomes even more serious. To solve the problem, we integrate reactive power compensation concept by Static Synchronous Compensator (STATCOM) with Equivalent – current Injection (ECI). We derive a new STATCOM with ECI model. This paper shows the application of Ant Colony Optimization (ACO) plus Genetic Algorithms (GA) for optimal capacity and location of a new STATCOM with ECI model in a power system. Finally simulation shows the optimal location and capacity of new STATCOM with ECI model to enhance power system voltage stability by using GACO. The proposed method demonstrates the improvement of voltage stability margin.

Keywords: Genetic Algorithms, Ant Colony Optimization, voltage stability, Static Synchronous Compensator (STATCOM), Equivalent -Current-Injection (ECI)

I. INTRODUCTION

Power systems components mainly consist of generators, transmission lines, transformers, switches, active or passive compensators and loads. Power system networks are complex systems that are nonlinear, non-stationary, and prone to disturbances and faults. Reinforcement of a power system can be accomplished by improving the voltage profile, increasing the transmission capacity and others. Flexible AC Transmission System (FACTS) devices are an alternate solution to address some of those problems [5].

The FACTS devices can be categorized into three types, such as series controllers, shunt controllers and combined series-shunt controllers. In principle, the series controllers inject voltage in series with the line and the shunt controllers inject current into the system at the point of connection. The combined series-shunt controllers inject current into the system with the shunt part of the controllers and voltage in series in the line with the series part of the controllers. Table 1 list the representative kind of FACTS devices with controlled parameters.

In the case of voltage support, shunt FACTS devices, such as STATCOM and SVC are typically used. This study is focused on the steady state performance of multiple STATCOM devices in the power system. Particularly, it is desired to determine their optimal location and capacity.

Traditional optimization methods such as mixed integer linear and non linear programming have been investigated to address this issue; however difficulties arise due to multiple local minima and overwhelming computational effort. In order to overcome these problems, Evolutionary Computation Techniques have been employed to solve the optimal allocation of FACTS devices. This study, which uses the Genetic algorithms (GA), has been tested for finding the optimal location and capacity, with promising results [3].

This paper applied the ability of the GA operated after can promote the Ant Colony Optimization (ACO) efficiency. The objective of GA is to improve the searching quality of ants by optimizing themselves to generate a better result, because the ants produced randomly by pheromone process are not necessary better. This method can not only enhance the neighborhood search, but can also search the optimum solution quickly to advance convergence. [1] [4].

The load flow analysis (commonly called load flow or power flow) is the basic tool for investigating power system state variables, and it is very important part of the system supervisory, planning and optimal operation. The unbalance three-phase load flows based on the Equivalent-Current-Inject (ECI) were applied successfully to the distribution system. It is unable to apply the ECI model to the high voltage transmission systems, because of the voltage – controlled buses (PV Bus). In this a new power flow approach based on ECI model and Cartesian coordination is presented. PV Bus model were developed, and according to the network characteristics, the decoupled models were also proposed.

This paper introduces the application of GACO for optimal location and capacity of a new STATCOM with ECI model in the power system. It is organized as follows: Section II STATCOM with ECI. Section III presents the basic concepts of GA. In section IV the objective function to be optimized is described. In section V simulation results are presented. In section VI conclusions and future work are given.

II. STATCOM with ECI MODEL

A. STATCOM Basic Concept

STATCOM is a second generation FACTS device used for shunt reactive power compensation. The principle of STATCOM is the reactive power compensation where the reactive power and voltage magnitude of the system can be adjusted such as shown in Fig. 1. It consists of three paths: