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Flower Pollination Algorithm based optimal setting of TCSC to minimize the Transmission line losses in the Power System

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Abstract

To avoid the problems of voltage stability, losses and security of power system is needed to monitor frequently and these problems are controlled by using the Flexible AC Transmission System (FACTS) devices. They help to improve the voltage profiles, security of the system and minimize the transmission line losses. Thyristor Controlled Series Capacitor (TCSC) is one of the FACTS devices which is easier to control than other control devices. The device was placed such that it also meets the constraint of having minimum losses. Further for setting of the TCSC Flower Pollination Algorithm is employed, it is a nature inspired algorithm developed from the pollination of flowers. For Placement of TCSC, a Fast Voltage Stability Index (FVSI) is proposed. For the verification of the proposed method, simulations are carried on IEEE 14 bus system and the results are presented and analyzed to ascertain the effectiveness in reduction of the losses in the power system.

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1. INTRODUCTION

In the present days the quality of the electric supply has been reduced due to the improper planning of the power system which is unable to meet the load demands. There is a increase in private industries to meet the requirements which are causing the problems in power system security, voltage deviations, collapse of the system due to losses. To overcome these problems new transmission lines are constructed but this task is becoming difficult due to political and environmental challenges [1]. Due to the present terms and conditions the security of the power system could not be improved even though there are techniques like load shedding, generation rescheduling. The better solution to overcome these problems is the usage of FACTS devices. [2].Thyristor controlled series compensator (TCSC) is one of the best FACTS devices. It has a faster response when compared to the other FACTS devices. This is because it has better control over line impedance, by changing its reactance it can reduce the line impedance. This helps in increased power flow in the system. Placing the device would just not be sufficient for achieving the objectives .It must be placed at proper location and with proper settings for its efficient usage [3].

Samimi et al. [4] have proposed a method to determine optimal location and best setting of Thyristor Controlled Series Compensator (TCSC). Seeking the best place is performed using the sensitivity analysis and optimum setting of TCSC is managed using the genetic algorithm. M. Sarvanan [5] has applied PSO technique for proper placement of FACTS devices such that the installation cost is reduced. For the proper placement of TCSC and to achieve optimal power flow fast Voltage Stability Index (FVSI) a factor is used to determine the line for placing the device. For the settings of the device a nature inspired algorithm, Flower Pollination Algorithm (FPA) is employed. Now a day's FPA algorithm is employed widely due to its less computation time and accuracy. It has less number of parameters when compared to other algorithms which makes it flexible to use for both single and multi-objective functions. Here the methodology used to identify affected line is by considering one of the indices of voltage stability margin i.e. FVSI. TCSC is placed at the affected line based on this factor. For the optimal setting of the device FPA is used. Different results have been observed like with and without placing the device and also for with and without using the algorithm for setting the TCSC on IEEE 14 bus system.

2. PROBLEM FORMULATION

2.1. Objective Function

Here the primary objective is to minimize the transmission losses of the power system by placing the device optimally. The objective function considered for the minimization of losses is taken as

Min F = Min (Total real power loss of the system)

2.1.1. Power Loss:

$$TL = min\left(\sum_{i=1}^{nl} real(S_{jk}^{i} + S_{kj}^{i})\right) \quad (1)$$

Where nl = number of transmission lines and S_{jk} is the total complex power flows from bus j to bus k in line i.

2.1.2. Placement Of TCSC

The most severe line affected is founded by a voltage stability index factor called Fast Voltage Stability Index Factor (FVSI). It is introduced by Musirin and Rahman. It calculates the voltage stability of a given bus under any loading conditions. It is defined as follows

$$FVSI = 4\frac{Z^2 Q_j}{V_i^2 X} \quad (2)$$

Where Z is the impedance of line, X is the line reactance, V_i is the voltage at the sending end and Q_j is the reactive power at the receiving end. The line with highest FVSI value is considered as the most sensitive line. Here the Newton raphson analysis for the 14 bus system has been performed and has determined the FVSI values for all the