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Load Margin Expansion for Sustainable Power System Operation

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ABSTRACT
An efficient reactive power management is important in providing secured operation for a power system in terms of maintaining its stability condition. Lack of safe operating margin and reactive power support were known to cause a system to operate in an unstable voltage condition. Hence, voltage stability improvement must be planned properly so that the likeliness to instability event could be determined before the more severe event of blackout could occur in a system. For that reason, the application of the developed a new optimization technique namely Adaptive Tumbling Bacterial Foraging (ATBO) was to obtain the most possible optimal Reactive Power Planning (RPP) solution. The objective of RPP problem not only to minimize the total power losses in a system but was also extended in terms of voltage stability and now termed as security constrained RPP (SCRPP). In order to ensure maximum benefit while ensuring secure operating condition and minimum impact to environment, the proposed ATBFO and Multi objective ATBFO (MOATBFO) were utilized to solve for the single and multi-objective for SCRPP issues. The performance of the proposed techniques were comprehensive analyzed between two other familiar optimization methods known as original Bacterial Foraging Optimization (BFO) algorithm and Meta heuristic Evolutionary Programming (Meta-EP) for standard IEEE 57 bus system. From the results it shows that the multi objective ATBFO optimization is able to give better overall improvement among all objective functions of SCRPP.

Index Terms: RPP, SCRPP, ATBFO, MOATBFO

I. INTRODUCTION

Many countries have claimed that millions of dollars were lost due to voltage collapse events. The voltage instability may occur in a network sufficient reactive power support is not given to the stressed busses [1]. Major countermeasures correspond to voltage stability control are categorized into preventive and corrective actions. The corrective methods involve adjustment of on load transformer tap change, capacitor switching, active and reactive power rescheduling and load shedding. While, the preventive control measures involve reactive power planning or centralized voltage and reactive energy control methods.

Large voltage stability margin could be obtained through shunt connected reactive power support and hence granting in higher system security. Various voltage stability analysis methods were explained in reference [2]. This reference organized those methods into two important categories as static and dynamic methods. It was proven that the load margin assessment is important to measure of closeness to voltage collapse [3]. Most literature agreed that maximum loadability and VSM depend on the solvability of load flow [4]. An approach called direct interior algorithm was discussed in reference [5] for determining maximum loadability of a power system. This algorithm is much faster than the conventional simplex method and suitable for enormous linear programming solution [6]. Subsequently, the Continuation Power Flow (CPF) was developed and used to identify load margin by calculating the solution path [7]. During dynamic analysis, a power system is represented by a set of algebraic differential equations and time domain simulation was performed [8]. Normally this technique needs for extensive computation schemes. Therefore, Quasi Steady State (QSS) methods that integrated from static and dynamic approaches were introduced largely to speed up the computation [9]. Generally, the studies on and the computation of load margin are more concentrated on static voltage analysis as compared to dynamic conditions since required less computational time with reliable solution [10]. Recently, the application of Artificial Intelligence (AI) techniques been employed which aimed for faster searching results during load margin estimation [4,11]. Many researchers have been conducted in improving the load margin to meet the growing in load demand. Many published papers presented fuzzy set theory to determine the optimal operating point [12]. The author from reference [13] has introduced GA to search for the active and reactive power dispatch in multi-objectives ED problem and utilized the fuzzy set theory decision making