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A Comparative Analysis of Power Loss Reduction using optimization Techniques and Solvers

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Abstract

This paper presents a review of real and reactive power loss of various bus radial distribution systems using local search optimization for dg placement at optimum location. It describes active power loss, reactive power loss and voltage profile of radial distribution system as well as distributed generation. Here also discuss local search optimization, forward-backward sweep method to determine voltage and current from sending end and receiving end as well as load flow study of various bus. To minimize distribution losses considering cost function for distribution system load flow planning. To reduce the losses of radial distribution system, it also comprises ring main system and radial distribution system. To minimum real and reactive power losses by placement of distribution generation at particular location, this will be identified by local search optimization. The method named local search method is adopted for finding suitable locations to provide distributed generation & the optimum value of the real power source at that site.

Keywords:Distribution system, Power quality, Network reconfiguration, Branch exchange technique.

I. INTRODUCTION

In electrical distribution systems, the system power loss and voltage stability are the most significant factors indicating the power quality delivered to the costumers. These factors also depend on several uncertain circumstances such as distribution network expansion, load complexity and installation of distributed generation (DG) [1, 2].

The power loss minimization in distribution systems is generally known as a main achievement in power system operations. Meanwhile, a rapid growth in load demand usually brings more voltage instability into the system. Therefore, several implementations have been proposed for power loss reduction and voltage stability enhancement e.g., network reconfiguration, DG installation, capacitor placement, installation of energy storage system, etc. [3–5]. Especially, the network Power loss and handle the unstable voltage profile, which can improve the overall performance of the distribution system [6]. Network reconfiguration is a process of altering the open/close status of sectionalizing and tie-line switches of the distribution system in order to change the topology of a system, and this process can improve the performance of the system according to different particular objectives and constraints [7].

Normally, the major objectives for network reconfiguration are power loss reduction, voltage profile improvement, voltage stability improvement and load balancing [8]. For example, A.M. Imran indicated that performing the system reconfiguration could essentially reduce the power loss while enhancing the voltage profile of the system [4]. The meta-heuristic is generally known as a capable approach to solve the network reconfiguration problems. Several meta-heuristic algorithms have been proposed in the literatures for solving these problems such as Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Fireworks Algorithm (FWA), Cuckoo Search Algorithm (CSA), Ant Colony Search Algorithm (ACS), Runner-Root Algorithm (RRA) and Shuffled Frog Leaping Algorithm (SFLA) [4,6,9–12]. Especially, the SFLA, which mimics the culture of frogs while searching for food, is a recently proposed algorithm that indicates an efficient performance for solving the optimization problems due mainly to its high accuracy in local optimal searching [11–12]. In [12], it was found that the SFLA could efficiently find the optimal solution within less iteration than the GA and Simulated Annealing (SA). We noticed, however, that the performance SFLA could be further improved by developing the generating and searching mechanisms of this algorithm.

II. OBJECTIVES OF NETWORK RECONFIGURATION

In recent years various power quality problem, harmonics, voltage sag and voltage unbalance issues are solve with intense attention because of the increased use of sensitive load in distribution system. The network reconfiguration problem has been solved to voltage sag, harmonics and minimization of power loss problem. In this method loss minimization, reliability and voltage sag access are incorporate in the network reconfiguration problem. Branch exchange technique [2] has been applied to determine the optimum reconfiguration strategy, so as to minimize the effects of various power quality issues along with the network losses. Thus, the objectives of network reconfiguration may be formulated as [2]:

1. Minimize Power loss in the network.
2. Maximize Sag voltage in the network during fault or switching.
3. Minimize Harmonic distortion of the node voltages.
4. Minimize System unbalances.

III. OPTIMIZATION TECHNIQUE TO ALLOCATE DISTRIBUTED GENERATION

The sources of Distributed generation can be placed at fewer buses in system to have lower line losses & that too with lower economical cost of system. Here we have set sites for distributed generation on the basis of calculations for sensitivity of the buses. 42 KW true power source was applied once at every bus then the change in total real power losses was observed. Each Local Search technique prescribes a variant strategy for dealing with the foggy situation. The application of Local Search algorithms to optimization problems Local Search algorithms are non-exhaustive in the sense that they do not guarantee to find a feasible solution, but they search non-systematically until a specific stop criterion is satisfied. Nevertheless, these techniques are very appealing because of their effectiveness and their widespread applicability.

IV. RELATED WORK

Yuntao Ju, Wenchuan Wu, Boming Zhang, Hongbin Sun, proposed an efficient method for handling PV nodes based on loop analysis incorporated in forward backward sweep framework. In this paper, the PV nodes refer to nodes connected by distributed generators & the generators are provided with constant voltage control. Looking further into the paper, it is found that the proposed extension of forward backward sweep has satisfactory convergence even when the number of PV nodes increases for a wide range of branch resistance/reactance ratios. Authors performed numerical simulations with three-phase models to check the performance of forward backward sweep method, & the results were found satisfactory.

G. W. Chang, S. Y. Chu, H. L. Wang, explained an improved forward backward sweep algorithm for load flow analysis of radial distribution systems. In the backward sweep, Kirchhoff's

Current Law and Kirchhoff's Voltage Law are used to calculate the upstream bus voltage of each line of distribution network. In the forward sweep, the voltage at each downstream bus is then updated by the real and imaginary components of the calculated bus voltage multiplying with the corresponding ratio of distribution system. The proposed algorithm is tested by the authors on three IEEE distribution systems. The results show that the algorithm is accurate and computationally efficient in comparing with two other methods.

Bompard, E. Carpaneto, G. Chicco, R. Napoli, explained that the most effective method for the load-flow analysis of the radial distribution systems is forward backward sweep. In the paper various properties of the forward backward sweep method are performed, taking into account different line resistance/reactance ratios and different types of voltage dependent loads. In the paper test results are also included for a tutorial two bus system and also for a real 84-bus system. The evolution of the forward backward sweep method has been analyzed at different loads, showing the differences for various load models at high load level, up to the theoretical load ability limit of the system. The paper also describes that in the normal operation of the distribution network, the load level is typically low and very distant from load ability limit, evenwith such conditions, the forward backward sweep method generally exhibits a fast and reliable convergence for any load model and with different initial conditions.

A. Augugliaro, L. Dusonchet, S. Favuzza, M.G. Ippolito, E. Riva Sanseverino, proposed a new forward backward methodology for the analysis of radial distribution systems with constant power loads, in this method, the loads are considered as constant impedances in the backward sweep & all the network variables (bus voltages and branch currents) are then evaluated considering a scaling factor. The forward sweep is eliminated and the node voltages calculation does not demand the sequentially needed forward backward sweep methodology. As per author, as compared to the latter method, the performances of the proposed algorithm are improved as far as the computation times are concerned, whereas the number of iterations is larger and increases as the number of PV nodes increase too. But the proposed solution methodology can find an efficient utilization, especially in the design problems for distribution systems with PV nodes. The improvements of the convergence features (for the use in working problems of the electrical systems) were the main aim of the authors' publication.

The authors also came up with a solution process which is iterative and at every step loads are simulated by impedances. The paper further explains that it is necessary to solve a network made up only of impedances for example radial systems by expressing all the voltages and currents as linear functions of a single unknown current and for mesh system & two unknown currents for each independent mesh. Advantages of this method are: the method's possibility to take into account of any dependency of the loads on the voltage very reduced computational requirements and high precision of results.

K.Krushna Murthy, S.V. Jaya Ram Kumar, published a new, efficient power flow method for unbalanced radial distribution systems based on improved forward backward sweep algorithm. The proposed method utilizes simple and flexible numbering scheme and takes full advantage of the radial structure of distribution systems. The authors have tested the algorithm on an 8-bus three-phase unbalanced distribution system. The obtained numerical test proves that this method is very robust and has excellent convergence characteristics.

A. D. Rana, J. B. Darji, Mosam Pandya presented forward backward Sweep algorithm for power flow analysis of distribution network. In backward sweep, KCL and KVL are used to determine the bus voltage from farthest node. In forward sweep, downstream bus voltage is updated starting from source node. The method stops after the mismatch of the calculated and the specified voltages at the substation is less than a convergence tolerance. Transmission line losses are also calculated afterwards using updated bus voltage. This method is used to load flow solution for a distribution network can be obtained without solving any set of simultaneous equations. The authors tested the algorithm with IEEE 33 bus radial distribution system. The results are obtained by programming using MATLAB.

V. SAMPLE DATA SETS OF 6 BUS SYSTEMS

Table -1: Sample data sets of 6 bus system.

Bus	Type of Bus	Voltage	Phaseangle	Pgi	Qgi	Pli	Qli	Qmin	Qmax	Phaseangle
1	1	1.05	0	0.0	0	0	0	0	0	0
2	2	1.05	0	0.5	0	0	0	-0.5	1.0	0
3	2	1.07	0	0.6	0	0	0	-0.5	1.5	0
4	0	1.0	0	0.0	0	0.7	0.7	0	0	0
5	0	1.0	0	0.0	0	0.7	0.7	0	0	0
6	0	1.0	0	0.0	0	0.7	0.7	0	0	0

VI. ADVANTAGES OF DISTRIBUTED GENERATION

The basic merits of Distributed Generation are given below:

1. Reduces the cost as there is no use of long transmission line.
2. Reduces the complexity.
3. Environment friendly.
4. Avoid the impact of massive grid failure.
5. Easy to maintain and easy to operate as it consist of simple construction.
6. Better power quality and reliability.

- The factor of high peak load shortage gets eliminated.
- Improves the efficiency of providing electric power.
- Main reasons for the increasingly widespread use of DG:
- It may be more economic than running a power line to remote locations.
- It provides supplementary support to the main power source.
- It can provide backup power during utility system outages, in case the end user requires uninterrupted service.
- It can provide higher power quality for electronic equipment's.
- It can provide reactive power supply and voltage control by injecting and absorbing reactive power to control grid voltage.
- It can provide support for the system black-start.

VII. CONCLUSIONS

Development of intelligent systems which can control the fault current to low level by cutting out distributed generation sources at the time of fault. Development of systems can cut out the section which is facing fault & switch in the active & reactive power source at the healthy bus. Development of method based on exact algorithm like integer programming for radial distribution system analysis.

Searching of optimal buses used for DG placement through some other search methods like tabu search etc. The resizing of DC source using other methods like simulated annealing, artificial bee colony algorithm etc. Verification sweep up of DG site & size allocation by communally using particle swarm optimization & the differential evolution techniques.In this paper, we provide various losses in distributed system. The network reconfiguration is one of the most useful approach for various power quality issues such as voltage unbalance, voltage sag and harmonic distortion. Network reconfiguration has been formulated incorporating as above power quality problems component objective function and solution suggested using Branch exchange technique. The Impression of the Branch exchange technique is most economic approach for loss reduction compare with other techniques in 25-bus unbalance radial distribution network.

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