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A Review Article analysis of Distribution Grid, Power Loss Reduction and Fault Detection In 33 Bus System Using Optimization

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***Abstract*- Power flow is nothing but the flow of active and reactive power. Power flow analysis is used to determine the steady state operating condition of a power system. In short it is to find the approximate values of various bus voltages, their phase angle, active and reactive power flows through different branches, generators and loads under steady state condition. Newton Raphson methods are generally referred as experience based techniques for solving problem, learning and discovery. Heuristics are simple and efficient rules coded by evolutionary processes. In this Work, ANN, one of such GS have been used to do the power flow analysis in a simple three bus system.**

Keywords- Continuous Genetic Algorithm, Chromosome Crossover, Load Flow Analysis, Newton Raphson Method, Mutation, Multi-Objective Minimization.

I. INTRODUCTION

Electrical distribution networks are built as interconnected and meshed networks. However, they are arranged to be radial in operation. Their configurations may be varied with manual or automatic switching operations so that, all the loads are supplied and reduce power loss. Reconfiguration also relieves the overloading of the network components. Feeder reconfiguration is performed by opening sectionalizing (normally closed) and closing tie (normally open) switches of the network. These switching are performed in such a way that the radiality of the network is maintained and all the loads are energized.

A normally open tie switch is closed to transfer a load from one feeder to another while an appropriate sectionalizing switch is opened to restore the radial structure. The problem to be addressed is, to determine the status of the network switches such that the reduction in power loss is achieved. A number of papers have appeared on the general topic of feeder reconfiguration as it applies to normal operating conditions. An early work on loss reduction through network reconfiguration was presented by Civanlar et al. [1] which described a formula to estimate the loss change resulting from the transfer of a group of loads from one feeder to another feeder.

This is done through the closing of a single tie switch and the opening of a single sectionalizing switch. Baran et al. [2] described a reconfiguration methodology for loss reduction and load balancing based upon considering branch exchange type switching. Shirmohammadi et al. [3] described a technique for the reconfiguration of distribution networks to decrease their resistive line losses and included results pertaining to large scale system examples. Lubkeman et al. [4] presented an expert system using heuristic rules to shrink the search space for reducing the computation time. However, only a feasible solution can be obtained for knowledge based methods. Chiang et al. [5], [6] proposed new solution methodologies using the simulated annealing algorithm for the network reconfiguration.

Goswami et al. [7] presented a heuristic algorithm for the reconfiguration of feeders. Kochi Nara et al. [8] proposed network reconfiguration techniques for minimum loss configuration using genetic algorithm (ANN).Kim et al. [9] proposed a neural network-based method with mapping capability to identify various network configurations corresponding to different load levels. Borozan et al. [10] proposed an algorithm for calculating Zloop matrix using the ordered network elements. Taleski et al. [11] proposed a method to determine the network reconfiguration with minimum energy losses for a given period.

Jeon et al. [12] presented the simulated annealing algorithm with Tabu search for loss reduction. The Tabu search attempted to determine a better solution in the manner of a greatest - descent algorithm, but it could not give any guarantee of the convergence property. Chin et al. [13] presented a ranking index method to determine the distribution network reconfiguration problem for loss reduction. Morton et al. [14] presented a brute-force solution for determining a minimal-loss radial

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configuration. The graph theory involving semi sparse transformations of a current sensitivity matrix was used, which guaranteed a globally optimal solution but needed an exhaustive search. Lin et al. [15] presented a refined genetic algorithm (RANN) to reduce losses. In RANN, the conventional crossover and mutation schemes were refined by a competition mechanism. Veerareddy et al. [17] presented a two stage approach for determining the network reconfiguration, which involves determining the loop for maximum loss reduction and distance center technique. Prasad et al.

[18] presented a fuzzy mutated genetic algorithm for optimal reconfiguration of radial distribution systems. This method involves a new chromosome representation of the network and a fuzzy mutation control for an effective search of solution space. Hong et al. [16], [19] presented a method based on genetic algorithms (ANN) and fuzzy multi objective programming for determining the network reconfiguration in distribution systems. A vertex encoding based on Prufer number was adopted in ANN for encoding the chromosomes. SivanaANNraju et al. [20] presented a method to determine the voltage stability of radial distribution systems by network reconfiguration.

This paper discusses the problem of reducing power losses in distribution feeders via feeder reconfiguration. The genetic algorithm is successively applied to the loss minimum reconfiguration problem. In the proposed algorithm, strings consist of sectionalizing switches, tie switches and fitness function consists of total system losses are formulated. Numerical example is provided to show the validity and effectiveness of the proposed algorithm.

II. PRELUDE

The rapidly increasing construction costs of electrical generating stations and the fuel used therein have focused attention on the need to reduce the power and energy losses in transmission and distribution lines. Accordingly there is interest in methods that lead to energy savings and deferment of need for construction of new facilities. Generally throughout the developed industrialized countries, the consumers of electrical energy are guaranteed a good quality of power, which means within certain tolerance of voltage (±5%), frequency (±0.5%) with minimum harmonics and with as possible interruption time. It is important to continue to make improvements in the distribution system to satisfy the load demand at a lower cost [1].

III. SYSTEM LOSSES

The amount of power losses in the electric distribution system and where they largely occur in the system are of a great interest to the engineers in developing a rate structure for different classes of customers.

It is necessary to supply additional energy over that required to satisfy the load to compensate for the losses in the system. The locations of these losses may be found in the various components of the power system as follows:

1. Transmission system losses

- High voltage transformer losses (the stepping-up transformer).
- Transmission line losses.
- Substation transformer losses (the stepping-down transformer).

2. Distribution system losses

- Primary feeder and line equipment losses.
- Distribution transformer losses.
- Secondary and service losses.
- Meter losses.

Generally, loss reduction techniques on the transmission network are not as effective as those on the distribution network. Hence, this thesis focuses only on the reduction of power losses in distribution networks.

The aim of this thesis is Studying the electrical losses in a distribution system (causes and effected factors), feeder reconfiguration methods, and applying of genetic algorithm in an electric distribution power system. In the end, this study introduces an optimization technique based on genetic algorithm for distribution network reconfiguration to reduce the network losses to minimum. Simulated results are drawn to show the accuracy of the technique.

IV. DISTRIBUTION SYSTEM LOSSES REDUCTION

In recent years, there has been a continuous need to accommodate higher loads and overcome delays in the construction of new generating facilities arising from environmental concerns and higher investment costs. Distribution systems have been reported over the years [13] and these will be critically reviewed. There are three basic methods to reduce system losses in the distribution system:

- Reduce the equivalent resistance.
- The placement of compensating capacitors.
- Network reconfiguration.

The first method is to reduce the equivalent resistance of the system conductors. The power loss in the conductor is given by I2R. Where I is the conductor current, and R is its equivalent resistance. Reducing the value of R results in a proportional reduction in the power losses. This can be achieved by replacing the small size conductors (overhead lines and underground cables) with a larger cross-sectional area, as the resistance is inversely proportional to the cross-sectional area, or by installing auxiliary conductors to work in parallel with the existing ones. So that the equivalent resistance is reduced. Although these methods could give a large loss reduction, it is not cost effective, and it is not used unless there is a

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special need, as the cost of conductors and their installation are usually in excess of the cost of the energy saved. The second method of power loss reduction in distribution system is the placement of compensating capacitors at specific load nodes. The reactive power flow in power system produced losses. These losses can be kept to a minimum by applying compensating capacitors in distribution points, to inject reactive power, and thus compensate for the inductive load power. Using this method, the reactive power flowing in the system conductors are reduced, and consequently the losses there from.

As the compensating capacitors affect the losses due to the reactive power component, their effect is more pronounced when the power system has a low power factor. Additional advantages of the installation of capacitors include the boosting of voltage. This is to provide the feeder with the prescribed voltage range within the maximum and the minimum allowable values, respectively at light and heavy load conditions and improving the power factor. The optimum size and location of the capacitor can be determined on the basis of the maximum cost savings in the energy loss and on the peak power loss reduction [5] on the condition that the voltage limits are not violated. The trend in recent years has been to install the capacitors in the primary distribution feeders rather than in the substations .This trend has been due to both the availability of pole-mounted equipment and because it is more economical to place the capacitors close to the reactive loads.

The third method to reduce the power and energy losses on distribution systems is by system reconfiguration. Reconfiguration of the distribution system can be used as a planning tool as well as a real-time control tool. Most of the distribution systems are reconfigured radially [2], and modifying the radial structure of the distribution feeders from time to time, by changing the open/closed states of the switches to transfer loads from one feeder to another,may significantly improve the operating conditions of the overall system. Feeders reconfiguration allows the transfer of loads from heavily-loaded feeders to relatively lightly-loaded feeders and from higher-resistance routes to lower resistance routes to obtain the least I2R, where the resistance route is the total resistance from the source to the load point. Such transfers are effective not only in terms of altering the level of loads on the feeder being switched, and reducing the losses, but also in improving the voltage profile along the feeders and affecting reductions in the overall system power losses. Studies and experiments on feeder reconfiguration are ongoing in several utilities. In this thesis the first two methods for reducing the system losses are considered. So the last method (network reconfiguration) for loss reduction is performed in this study.

V. LITERATURE REVIEW

A Hasibuan[1], S Masri[2] and W A F W B Othman, "Effect of distributed generation installation on power loss using genetic algorithm method" Injection of the generator distributed in the distribution network can affect the power system significantly. The effect that occurs depends on the allocation of DG on each part of the distribution network. Implementation of this approach has been made to the IEEE 30 bus standard and shows the optimum location and size of the DG which shows a decrease in power losses in the system. This paper aims to show the impact of distributed generation on the distribution system losses. The main purpose of installing DG on a distribution system is to reduce power losses on the power system.Some problems in power systems that can be solved with the installation of DG, one of which will be explored in the use of DG in this study is to reduce the power loss in the transmission line. Simulation results from case studies on the IEEE 30 bus standard system show that the system power loss decreased from 5.7781 MW to 1,5757 MW or just 27,27%. The simulated DG is injected to the bus with the lowest voltage drop on the bus number 8.

B. KarthikaVigneswari, N.B. Rajesh, B. Viswanathan, S. Ramya, "Real power loss reduction in distribution system by optimal placement of distributed generation after network reconfiguration using genetic algorithm"Power loss reduction is one of the main targets in power industry and so in this paper, the problem of finding the optimal configuration and optimal allocation of Distributed Generation in a radial distribution system is considered. Optimal Network Reconfiguration and identification of the optimal location and sizing of Distributed Generation gives the reduction in power losses and the improvement in voltage profile. Genetic Algorithm is used to find the optimal reconfiguration, Distributed Generation size and location and also find the losses at the condition with Distributed Generation and with Reconfiguration. The method has been tested on 33-bus radial distribution system to demonstrate the performance and effectiveness of the proposed method.

SubburajPerumal, Ramar K, LakshmananANNnesan, P. Venkatesh, "Distribution System Reconfiguration for Loss Reduction using Genetic Algorithm"Feeder reconfiguration is defined as altering the topological structures of distribution feeders by changing the open/closed states of the sectionalizing and tie switches. In network reconfiguration for loss reduction, the solution involves a search over relevant radial configuration. In this paper, a method, based on genetic algorithm (ANN) to determine the minimum configuration is presented. A genetic algorithm (ANN) is a search or optimization algorithm based on the mechanics of natural selection and natural genetics. Since ANN is suitable to solve combinatorial optimization problems, it can be successfully applied to problems of loss minimization in distribution systems. Test results are included to show the performance of the proposed method.

Yanzhu Ji,[1] Zhuoqun Shi,[2] and Robert M. O'Connell[1], "Improved Genetic Algorithm for Distribution System Performance Analysis by Taking Advantage of Essential Spanning Trees"Growing interest in the smart grid, increasing use of distributed generation, and classical distribution system reconfiguration (DSR) and restoration problems have led to the search for efficient distribution automation tools. One such tool, the improved Fast Nondominated Sorting Genetic Algorithm (FNSANN), not only is effective in finding system configurations that are optimal with respect to voltages, currents, and losses, but also considered parametric study to determine minimum values of N and Gen. In this paper, the essential spanning tree concept is expanded to improve the computational efficiency of the algorithm.

Results of the study show that for relatively small test systems, optimum system configurations are obtained using values of N and Gen that require very small CPU times. In larger systems, optimum values of N and Gen requiring reasonable CPU times can also be found, provided that certain carefully chosen branches are removed from the pool of possibilities when producing the initial population in the algorithm. By using essential trees, the efficiency of the calculation is improved.

B. Karthika Vigneswari(1*), N. B. Rajesh(2), B. Viswanathan(3), S. Ramya(4*),* "Real Power Loss Reduction in Distribution System by Optimal placement of Distributed Generation after Network Reconfiguration using Genetic Algorithm" Power loss reduction is one of the main targets in power industry and so in this paper, the problem of finding the optimal configuration and optimal allocation of Distributed Generation in a radial distribution system is considered. Optimal Network Reconfiguration and identification of the optimal location and sizing of Distributed Generation gives the reduction in power losses and the improvement in voltage profile. Genetic Algorithm is used to find the optimal reconfiguration, Distributed Generation size and location and also find the losses at the condition with Distributed Generation and with Reconfiguration. The method has been tested on 33-bus radial distribution system to demonstrate the performance and effectiveness of the proposed method.

Ahmed Samir Amin Ahmed Adail, "Network Reconfiguration for Loss Reduction in Electrical Distribution System Using Genetic Algorithm" Distribution system is a critical links between the utility and the nuclear installation. During feeding electricity to that installation there are power losses. The quality of the network depends on the reduction of these losses. Distribution system which feeds the nuclear installation must have a higher quality power. For example, in Inshas site, electrical power is supplied to it from two incoming feeders (one from new abu–zabal substation and the other from old abu–zabal substation). Each feeder is designed to carry the full load, while the operator preferred to connect with a new abu–zabal substation, which has a good power quality. Bad power quality affects directly the nuclear reactor and has a neANNtive impact on the installed sensitive equipments of the operation. The thesis is Studying the electrical losses in a distribution system (causes and effected factors), feeder reconfiguration methods, and applying of genetic algorithm in an electric distribution power system. In the end, this study proposes an optimization technique based on genetic algorithms for distribution network reconfiguration to reduce the network losses to minimum. The proposed method is applied to IEEE test network; that contain 3 feeders &16 nodes. The technique is applied through two groups, distribution have general loads, and nuclear loads. In the groups the technique applied to seven cases at normal operation state, system fault condition as well as different loads conditions. Simulated results are drawn to show the accuracy of the technique.

Perumal Nallagownden ; Lo Thin Thin ; Ng Chin Guan ; Che Mat Hadzer Mahmud, "Application of Genetic Algorithm for the Reduction of Reactive Power Losses in Radial Distribution System" Power losses in distribution system have become the most concerned issue in power losses analysis in any power system. In the effort of reducing power losses within distribution system, reactive power compensation has become increasingly important as it affects the operational, economical and quality of service for electric power systems. This paper presents the application of genetic algorithm approach for reactive power loss reduction in radial distribution system. IEEE 34-bus Standard Test System is used together with the ERACS and MATLAB as powerful tools for the analysis and simulation work. ERACS is used to perform load flow analysis while MATLAB is used for the identification of capacitor current via ANNtool, and algorithm for the calculation of loss savings, its particular capacitor size and location. The result is then compared with the heuristic search strategies to evaluate the performance of genetic algorithm.

Chidanandappa R.aT. Ananthapadmanabha Dr. b RanjithH.C.c, "Genetic Algorithm Based Network Reconfiguration in Distribution Systems with Multiple DGs for Time Varying Loads" This paper describes the implementation of an algorithm which predicts optimum reconfiguration plan for power distribution system with multiple PV generators. Since network reconfiguration is a multi objective and multi constrained problem, genetic algorithm is used for optimization. Forward backward load flow method with time varying load condition is considered. The objective function of the genetic algorithm incorporates all the objectives and constraints required for the reconfiguration plan. The algorithm

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developed predicts the switching pattern for reconfiguration which gives minimum loss and minimum voltage deviation. It also reduces the number of switching operations along with satisfying the defined limit constraints.

Ching-TzongSu,Chung-Fu Chang &Chu-Sheng Lee, "Distribution Network Reconfiguration for Loss Reduction by Hybrid Differential Evolution" This article introduces a hybrid differential evolution (HDE) method for dealing with optimal network reconfiguration aiming at power loss reduction. The network reconfiguration of distribution systems is to recognize beneficial load transfers so that the objective function composed of power losses is minimized and the prescribed voltage limits are satisfied. The proposed method determines the proper system topology that reduces the power loss according to a load pattern. Mathematically, the problem of this research is a nonlinear programming problem with integer variables. This article presents a new approach that employs the HDE algorithm with integer variables to solve the problem. One three-feeder distribution system from the literature and one practical distribution network of Taiwan Power Company are used to exemplify the performance of the proposed method. Two other methods, the genetic algorithm and the simulated annealing, are also employed to solve the problem. Numerical results show that the proposed method is better than the other two methods.

Neeraj Kanwar, Pawan Saini, Nikhil Gupta, Anil Swarnkar and K. R. Niazi, "Genetic Algorithm based Method for Capacitor Placement using New Sensitivity based Approach" This paper proposes a new methodology for optimal allocation of shunt capacitors in distribution systems. The proposed method combines various objectives and constraints into a comprehensive constraint multi-objective function (CCMF). The function has been optimized using a Genetic Algorithm (ANN) based method. Attempts have also been made to improve the computational efficiency of ANN. The search space of ANN is reduced by introducing a new reactive power flow sensitivity approach that determines the set of candidate nodes suitable for capacitor placement and also by employing a new constrained chromosome structure. The proposed method is tested on 69-bus test distribution system and the application results are promising.
MoeinKhosraviP 1*P, Dr. Mahdi MozaffariLeghaP 2 P, GholamrezaMirzaeiP 3, "Loss Reduction with Optimization of DG Placement Using Genetic Algorithm and Comparison with PSO Method - A Case Study in IRAN" Increasing application of DG units on distribution networks is the direct impact of development of technology and the energy disasters that the world is encountering. To obtain these goals the resources capacity and the installation place are of a crucial importance. Line loss reduction is one of the major benefits of DG, amongst many others, when incorporated in the power distribution system. The quantum of the line loss reduction should be exactly known to assess the effectiveness of the distributed generation. In this paper, a new method is proposed to find the optimal and simultaneous place and capacity of these resources to reduce losses, improve voltage profile too the total loss of a practical distribution system is calculated with and without DG placement and an index, quantifying the total line loss reduction is proposed. To demonstrate the validity of the proposed algorithm, computer simulations are carried out on actual power network of Kerman Province, Iran and the simulation results are presented and discussed.

Rajesh K. Samala* , Mercy R. Kotapuri, "Power loss reduction using distributed generation" This research paper has been presenting a comparative analysis of power flow in radial distribution system before and after optimal locating and sizing of Distributed Generation (DG). In this paper the power flow analysis is using to obtain the real power loss and voltage at each bus with the BAT Algorithm (BA) and the conventional Gravitational Search Algorithm (GSA). Finally the conventional GSA has been comparing with the BA to prove that the BA will provide the better solution for optimal placement of DG and size.

This research also presenting the optimal placement of DG and its size in order to reduce power loss and improve the voltage profile at each bus in the system. By using forward and Backward (FW/BW) sweep analysis initially analysing the power losses in the system. Then by using GSA and BA the power loss and voltages at each bus will be calculate and also the optimal location and size of the DGs to reduce these losses will calculate. For this research the Photo Voltaic (PV) energy is considering as DG. All the methods for this research are computing by using MATLAB software and for the test the IEEE-33 radial bus system has considered.

Hasibuan, A.; Masri, S.; Othman, W. A. F. W. B., "Effect of distributed generation installation on power loss using genetic algorithm method" Injection of the generator distributed in the distribution network can affect the power system significantly. The effect that occurs depends on the allocation of DG on each part of the distribution network. Implementation of this approach has been made to the IEEE 30 bus standard and shows the optimum location and size of the DG which shows a decrease in power losses in the system. This paper aims to show the impact of distributed generation on the distribution system losses. The main purpose of installing DG on a distribution system is to reduce power losses on the power system. Some problems in power systems that can be solved with the installation of DG, one of which will be explored in the use of DG in this study is to reduce the power loss in the transmission line. Simulation results from case studies on the IEEE 30 bus standard system show that the system power loss decreased from 5.7781 MW to 1,5757 MW or

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just 27,27%. The simulated DG is injected to the bus with the lowest voltage drop on the bus number 8.

VI. SYSTEM RECONFIGURATION FOR LOSS REDUCTION

Generally, electric distribution feeders are configured radially [2], for effective coordination of their protective systems. Distribution feeders contain switches some of which are normally open. In response to a fault, some of the normally closed switches are opened in order to isolate the faulted network branch. At the same time, some of the normally open switches are closed in order to transfer part or all of the isolated branches to other feeders. All switches are restored to their normal positions after the clearance of the fault [3].

Under normal operating conditions, distribution engineers periodically reconfigure the feeders by opening and closing switches (switching operation) in order to increase the network reliability and/or reduce line losses. The resulting feeders must remain radial and satisfy all load requirements and voltage constraints. Coordination of the protective scheme of the newly configured system is also necessary to ensure that the reliability is maintained at the required level. Many previous techniques [4-18] for system reconfiguration have been reported to obtain loss reduction.
The following section summarizes these different techniques:

- Linear programming method.
- Discrete branch and bound method.
- Branch exchange method.
- Loop cutting method.
- Heuristic search method.
- Other system reconfiguration methods and research:
- Transshipment.
- Simulated annealing.
- Genetic algorithms.
- Neural networks.
- Discrete ascent optimal programming.

VII. BASIC OF OPTIMIZATION ALGORITHM

Among the methods which can give us a global optimal solution is ANN. Genetic algorithms use the principle of natural evolution and population genetics to search and arrive at a high quality near global solution. Due to the nature of the reconfiguration design variables (Switches status), the required design variables are encoded into a binary string as a set of genes corresponding to chromosomes in biological systems [2].
The most important components in aANN consist of

- Representation (definition of individuals)
- Evaluation function (or fitness function)
- Population
- Parent selection mechanism
- Variation operators (crossover and mutation)
- Survivor selection mechanism (replacement)

Unlike the traditional optimization techniques that require one starting solution, ANN uses a set of chromosomes as initial solutions. The group of chromosomes is called a population. The merit of a string is judged by the fitness function, which is derived from the objective function and is used in successive genetic operations. During each iterative procedure (referred to as generation), a new set of strings with improved performance is generated using three ANN operators (namely reproduction, crossover and mutation). This paper shows that performance of ANN in reconfiguration problem [2].

Project Objective:
Our project work as follow some point

1. A optimization of total power loss bus system.
2. To comparison of old methods result and proposed ANN based result.
3. To identify of iteration based result accuracy and decimal values.

Loss Reduction by reconfiguration and Capacitor Placement:
A recent work has been published by Lee and Brooks et al, [2, 3] dealing with the continuous system reconfiguration of switches and capacitors with Automated Distribution Control. Lee and Brooks suggested a scheme for reconfiguration and capacitor application, and it can be summarized in six steps:

- Determine the losses of the existing system.
- Remove capacitors and optimally reconfigure the system.
- Determine losses of the reconfigured system.
- Apply capacitors to the reconfigured system.
- Perform final load flow analysis to determine losses.
- Tabulate and compare system load and loss results.

VIII. CONCLUSION

Also Lee and Brooks included the load variation during the year in the calculation by dividing the year into a finite number of periods assuming the load is constant during each of them. They used a program named Constrained Multi-Feeder (CMF) for the system reconfiguration, but they did not show the mathematical algorithm of the program or even a reference to it. Also they used a capacitor application technique based on installing a pre-estimated number of capacitors at each feeder in the network. Lee and Brooks technique for capacitor application depends on changing the- physical locations of the capacitors to have minimal losses whenever the load changes.

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