Analysis of Feeder Reconfiguration and Dg Placement in Distribution Network

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***ABSTRACT**: This paper presents an efficient algorithm for network reconfiguration associated with DG allocation to reduce real power losses in radial distribution networks. A modified Binary Particle Swarm Optimization algorithm, referred to as Selective Particle Swarm Optimization algorithm (SPSO), is used to resolve network reconfiguration challenge. Allocation ofDG units has been achieved through sensitivity evaluation. A multipurpose perform is formulated to solve the drawback of actual power loss minimization and voltage profile growth in distribution process. The style-I DG (which offers only active power) is used right here. The effectiveness of proposed algorithmis tested on IEEE 33 bus radial distribution systems atthree different load phases particularly light, nominal and heavy loads. The result shows that improvement on network power losses is 54.92%from Distribution Network Reconfiguration (DNR) method. All three stages were tested on standardsIEEE 33 bus system by using Particle Swarm Optimization (SPSO) technique in MATLAB software. Thismethod proved that improvement of power losses and voltage profile by switching and DGs allocationmethod*

***Keywords:** Feeder Reconfiguration, Selective Particle Swarm Optimization algorithm (SPSO), Distributed Generation*

I.

I. INTRODUCTION

Electrical power distribution system includes agencies of interconnected radial circuits. They have got switches to configure the networks by way of switching operations to transfer loads amongst the feeders. There are two varieties of switches used within the distribution process, sectionalizingswitches (more often than not closed switches) and tie switches (mainly open switches), whose statesverify the configuration of network. The configuration of the distribution system ischanged by means of opening sectionalizing switches and shutting tie switches in order that the radial structureof the network is maintained and all of the loads are supported and lowered power losses, make stronger voltage profile, improve power quality, increase process safety, relieve overload inthe network [1]. However, because of dynamic nature of loads, whole system load is more than itsiteration potential that makes relieving of load on the feeders no longer feasible and as a result voltageprofile of the approach is probably not multiplied to the required degree. In an effort to meet required stage of load demand, DG units are built-in in distribution network to make stronger voltage profile, toprovide trustworthy and uninterrupted power provide and likewise to reap economic advantages such asminimum power loss, power effectively and loadlevelling. Network reconfiguration and DGplacement in distribution networks are regarded independently. But, within the proposed system,network reconfiguration after which DG set up are executed for increased loss minimization andvoltage profile.

For the reason that network reconfiguration is a tricky combinatorial, non-differentiable constrainedoptimization drawback, many algorithms are proposed previously. Merlin and back [2], firstproposed network reconfiguration crisis they usually used a branch-and- sure-sort optimization manner. The situation with this manner is the solution proved to be very time consuming as the feasible approach configurations are, the place line sections organized with switches is. Centred on the method of Merlin and again [2], a heuristic algorithm has been suggested via Shirmohammadi and Hong [3]. The main issue with this algorithm is simultaneousswitching of the feeder reconfiguration is just not considered. A heuristic algorithm [4] was oncesteered, where a simple method was once developed to determine change in power loss as a result of a department alternate. The drawback of this method is only one pair of switching operations is regarded at a time and reconfiguration of network relies on the preliminary switch status. An algorithm [5] was once provided centred on the heuristic rules and fuzzy multi-purpose approach for optimizing network configuration. The drawback in this is standards for settling on membership capabilities for ambitions are not supplied. An answer making use of a genetic algorithm (GA) [6] was once provided to appear for the minimal loss configuration in distribution procedure. A refined genetic algorithm (RGA) [7] was presented to reduce losses in the distribution system. In RGA, the traditional crossover and mutation schemes are subtle by way of a competition mechanism.

Harmony Search Algorithm (HSA) [8] was once proposed to resolve the network reconfigurationdifficulty to get most appropriate switching combos simultaneously in the network minimize real power losses in the distribution network. Many ways are proposed for the excellent placement and sizes of DG units which can be a problematic combinatorial optimization predicament. An analytical process [9] used to be offered to check optimal region to location a DG in distribution procedure for vigour loss minimization. ALagrangian based technique to examine surest locations for placing DG in distribution methods in view that economic limits and stability limits usedI. to be offered with the aid of Rose hart andNowicki [10]. A multi-objective algorithm utilising GA [11] was once provided for sitting and sizing of DG in distribution approach. Placement and penetration stage of the DGs below the SMDframework was once discussed via Agalgaonkar [12].

This paper grants a selective particle swarm optimization procedure for multi goal feeder reconfiguration obstacle within the presence of allotted generation. Sensitivity evaluations used to verify the size and area of kind-I DGs. Most of the researchers did not bear in mind DG penetration of their study. Of their paper the dimensions of the DG unit may be very excessive. In many practical cases together with financial constraints the scale of DG (kind-I) units aren't pragmatic. The high measurement of DGitems gives excessive fee of the system. On this paper, maximum penetration of DG is viewed in a variety of 0-30% of total approach load. The proposed method is experimented onIEEE 33-bus radial distribution network at special load stageand bought outcome are discussed.

II. RELATED WORK

This work presents a method to solve feeder reconfiguration problem with DG allocation in radial distribution system to reduce power losses and to improve voltage profile. In this section objective function of the problem is formulated.

A. Power loss in a radial distribution system

Fig. 1 shows the single line diagram of the feeder. The equations mentioned below are obtained from the single line diagram of the feeder.

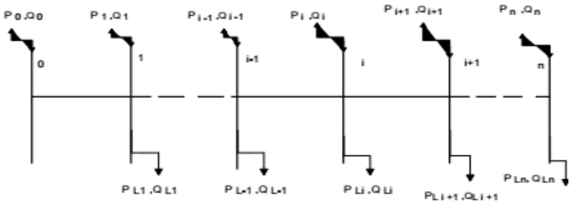

Figure 1: single line diagram of main feeder

B. Power loss reduction using feeder reconfiguration

The feeder reconfiguration problem in a distribution system isto find a configuration with minimum loss while satisfying theoperating constraints under a certain load pattern. The operating constraints are voltage drop, current capacity andradial operating structure of the system.

C. Power loss reduction using DG placement:

The objective of DG placement problem is to minimize thereal power losses of the distribution network throughdetermining the optimal DG sizing and location. Theoperating constraints of the problem are divided into equality and inequality constraints.

SOLUTION METHODOLOGY

In this paper, the feeder reconfiguration problem is solved by selective particle swarm optimization (SPSO) technique andoptimal sizing and location of DGs is solved by sensitivity analysismethod. Selective particle swarm Optimization is lately proposed artificial intelligence founded method for solving problematic non-linear combinatorial optimization issues. In [27] Gorpinichproposed selective particle swarm optimization manner forthe community reconfiguration quandary which is amendment to the Binary Particle Swarm Optimization to search in selective area. In the Selective Particle Swarm Optimization at each and every dimension in a search area $S_D = [S_{D1}, S_{D2} \ldots\ldots S_{DN}]$ is theassortment of DN positions, the place DN is the quantity ofselected positions in dimension D. In the traditional Particle Swarm Optimization technique, a health operate have got to be defined, but in Selective Particle Swarm Optimization each and every dimension from the DN position is mapped with the selective area SD, with the intention to lead to alter the role of every particle from being a factor in actual-value to be the point within the selected area. Therefore it leads to the change in the logistic sigmoid function $sig\left(v_{iD}^{k+1}\right)$ .The sigmoid function$sig\left(v_{iD}^{k+1}\right)$ is changed to

$$sig\left(v_{iD}^{k+1}\right) = DN\frac{1}{1+\exp(-v_{iD}^{k+1})} \quad (1)$$

The i^th particle position of each particle in dimension D is as elective value which is updated by

$$x_{iD}^{k+1} = \begin{cases} S_{D1} \; if \; sig\left(v_{iD}^{k+1}\right) < 1 \\ S_{D2} \; if \; sig\left(v_{iD}^{k+1}\right) < 2 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ S_{DN} \; if \; sig\left(v_{iD}^{k+1}\right) < DN \end{cases} \quad (2)$$

Where $S_D = [S_{D1}, S_{D2} \ldots\ldots S_{DN}]$ .V_{min}, $V_{max}$are the selected values in dimension D are the minimum and maximum velocity values illustrated in Eqn. (2). To evade the undulation of the velocity value of the i^th particle at each Dimension between the minimum and the maximum values and to avoid invariability of the velocity value of the it particle Equation (3) can be used to compel each particle to go through the search space.

$$v_{iD}^{k+1} = \begin{cases} v_{max} \ if \ v_{iD}^{k+1} > v_{max} \\ (v_{iD}^{k+1}) if \ |v_{iD}^{k+1}| \le v_{max} \\ \dots\dots\dots\dots\dots\dots\dots\dots.. \\ v_{min} \ if \ (v_{iD}^{k+1}) \le v_{min} \end{cases} \quad (3)$$

The flow chart of the SPSO technique [28] is shown in fig. 2

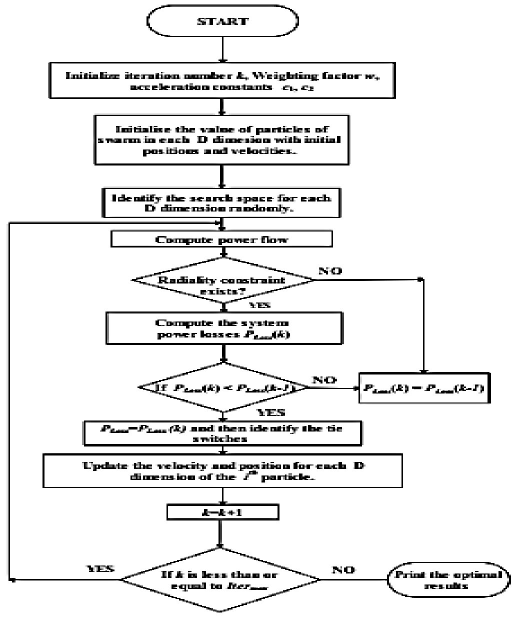

Figure 2: Flowchart of the proposed method

A. DG allocation using loss sensitivity analysis method.

Items	Case 1	Case 2	Case 3
Power loss (kW)	219.1	206.3	93
Loss reduction (%)	-	5.84	54.92
CPU time (s)	24.4	17.3	40.3
Switches	13 9 26 6 33	33 6 4 12 9	7 31 9 28 14

To solve the DG allocation and sizing problem, sensitivity analysis method is used. Sensitivity factors are evaluated at each bus, firstly using the values obtained from the base case power flow. The buses are ranked in descending order of the values of their sensitivity factors to form a priority list. The top-ranked buses in the priority list are the first to be selected for alternatives location. Computational procedure:

Step 1: Run load flow program for base case.

Step 2: Calculate the sensitivity factor of each bus and rank the sensitivity in descending order and form priority list.

Step 3: Select the bus which has highest priority and place DGat that bus.

Step 4: Now change the size of DG in ‘‘small’’ step and calculate real power loss for each size by running load flow program.

Step 5: Store the size of DG that gives the minimum loss.

Step 6: Repeat Step 3 to 5 to restore for first three candidate bus location

II. RESULTS AND ANALYSIS

The system used for this method is tested on standard IEEE 33 bus test system as shown in Fig. 3. The system load is assumed to be constant with Sbase= 100MVA and Vbase. The load and line data is referred in [20]. The total load of the system is 3715kW and 2300kVar. The maximum sizing for DG is set to 5MW and the population for test system is 50. All calculation is in per unit. Three cases are considered for this:

Case 1: The system with DNR by switches with radial configuration. =12.66kV.

Case 2: Feeder reconfiguration with allocation and sizing DG based on .

Case 3: DNR and DG sizing and allocation based on lowest voltage profile on case 1.0 software.

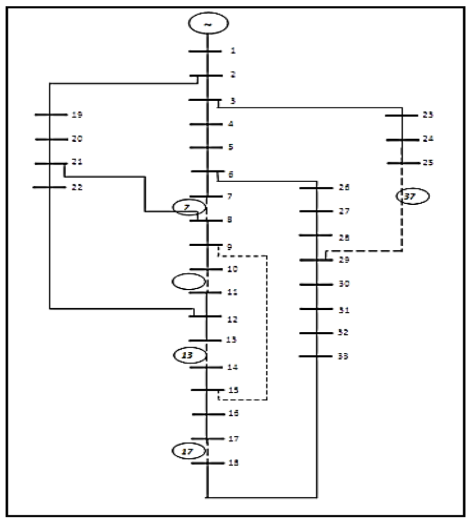

Figure 3: Single line diagram of IEEE 33 bus distributionsystem after reconfiguration and DG placement at nominalload

Table I: Results of case study.

The simulations were carried out by using MATLAB software and 20 results were collected. The result with minimum power loss is selected as shown in Table I. The result consists of 5 opened switches, total power losses, voltage profile and four DGs sizing.

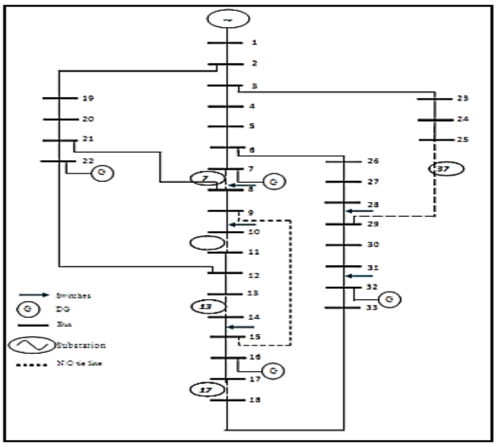

Figure 4: Network reconfiguration with allocation of DG

The result show that the power losses decrease from case 1 to case 3. Power loss for case 1 is 219.1 kW and reduces to 5.84% for case 2. More than half percent loss reduction occurs in case 3 where the power loss is 93kW reduce by 54.92%. The different between the power loss between case 2 and case 3 is 113.3 kW. From the impact of power loss, it shows that the allocation of DGs based on voltage profile can improve power losses in the system. The computing time taken for case 3 is the longest which is 40.3 seconds compared to case 1 (24.4seconds) and case 2 (17.3 seconds). Fig. 4 shows the network reconfiguration switches and DG allocation at bus7, 16, 22 and 32.

Table IIDGs sizing for case 2.

No of DGs	Location (bus no)	DGs size (MW)
DG 1	6	1.2329
DG 2	16	0.5795
DG 3	22	1.5391
DG 4	29	2.0315

Table IIIDGs sizing for case3

No of DGs	Location (bus no)	DGs size (MW)
DG 1	7	1.2217
DG 2	16	0.6416
DG 3	22	1.5618
DG 4	32	2.0300

DGs sizing for case 2 and case 3 is approximately the same because there is no big different between the size of the DGs for both cases. DGs allocation for case 2 is based on the stability of geographical of location methods [9]. Meanwhile for case 3 is based on observation of voltage profile from case 1. DGs are located at the lowest voltage profile from that case. The result is as shown in Table II and Table III. Allocation of DG based on voltage profile can improved power losses as discussed earlier

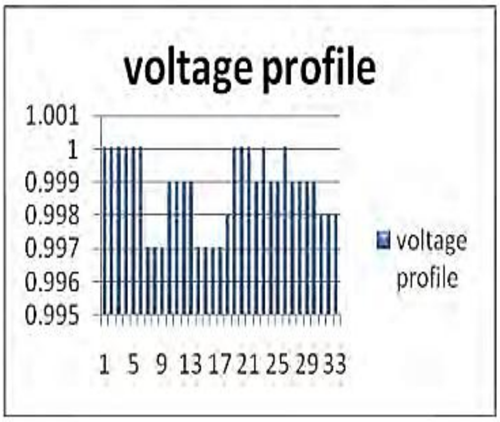

Fig. 5. Voltage profile for case 1

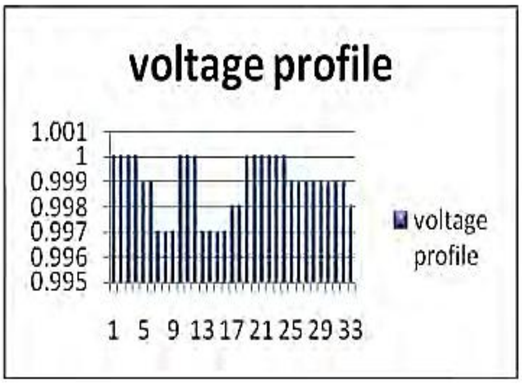

Fig. 6. Voltage profile for case 2

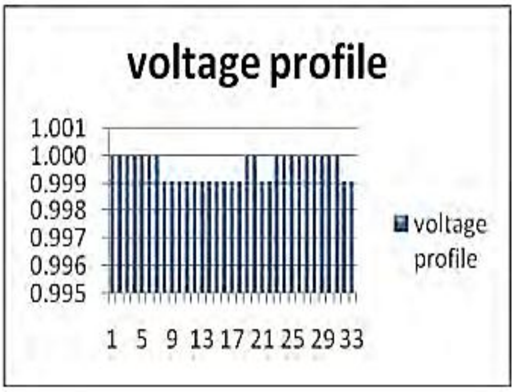

Fig. 7. Voltage profile for case 3

Fig. 5, Fig. 6 and Fig. 7 shows the voltage profile for case 1, case 2 and case 3. It shows that allocation DGbased on voltage profile can improved the voltage profile for the system as in Fig. 7. The minimum voltage profile for case 1 and case 2 is 0.997 compared to minimum voltage profile for case 3 is 0.999. Voltage profile for case 3 is more stable because the range is only between 0.999 and 1 compared to case 1 and case 2.In the other hand, allocation and sizing of DG also improves voltage profile because DG were located at bus with low voltage profile. This method has improved voltage profile slightly about 0.07% from case 1. For case 1, the minimum voltage profile is 0.997 occur at bus 7, 8, 9, 14, 15, 16 and 17. For case 2, the minimum voltage profile is 0.997 at bus 7, 8, 9, 13, 14, 15 and 33 meanwhile for case 3, the minimum voltage profile is 0.999.

III. CONCLUSION

In this paper, a brand new procedure for network reconfiguration hindrance associated with DG allocation has been proposed. The network reconfiguration hindrance is solved by using selective particle swarm optimization (SPSO) system. Dimension and place of DGs depends on sensitivity evaluation procedure. To validate the performance of proposed system, it has been established on 33 bus radial distribution method at unique loading stage i.e. Light, nominal, heavy. This paper proved that allocation of DG based on low voltage profile also can improve power losses and the voltage profile itself. Improvement of power losses is 54.92% from DNRmethod.

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