Available online at: http://www.ijmtst.com/vol4issue12.html

International Journal for Modern Trends in Science and Technology

ISSN: 2455-3778 :: Volume: 04, Issue No: 12, December 2018

Optimal Allocation of Distributed Generators for Network Reconstruction and Reconfiguration in Distribution System

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To Cite this Article
Swetha G and Dr. R Prakash, "Optimal Allocation of Distributed Generators for Network Reconstruction and Reconfiguration in Distribution System", *International Journal for Modern Trends in Science and Technology*, Vol. 04, Issue 12,December 2018, pp.-58-67.

Article Info
Received on 08-Dec-2018, Revised on 18-Dec-2018, Accepted on 24-Dec-2018.

ABSTRACT

Distributed generation (DG) units have an important number of economic, environmental and technical features, which can contribute to the improvement of the reliability and security of the electric grid. However, all benefits that mentioned before cannot be maximized and enhanced unless the best sizing and position of distributed generation units are accurately determined. The Distributed generation is an emerging concept in the power sector, which represents good alternatives for electricity supply instead of the traditional centralized power generation concept. Due to sharp increase in power demand, voltage instability & line overloading has become challenging problems for power engineers. Voltage collapse, unexpected line & generator outages & blackouts are the major problems associated with voltage instability. So that the problem of enhancing the voltage profile and decreasing power losses in electrical systems is a task that must be solved in an optimal way. This type of problem is in single phase & three phases, therefore to improve & enhance the voltage profile & stability of the existing power system, FACTS devices and load flow analysis are the alternative solution. This paper describes a Particle Swarm Optimization (PSO) method-based approach for load flow analysis in radial distribution system to improve voltage stability and to minimize the transmission line losses considering cost function for entire power planning

KEYWORDS: *Distributed Generation, Voltage Profile Improvement ,Optimal Allocation,Particle Swarm Optimization*

I. INTRODUCTION

Electrical distribution networks are built as interconnected 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 of the loads are supplied with reduced 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. This switching's 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.

The loss minimum reconfiguration problem in the open loop radial distribution system is basically one of the complex combinational optimization, since the normal open sectionalizing switches must be determined appropriately. From the limit of the computational burden, methods such as branch and bound cannot be applied to even a normal scale distribution problem.

Important DG characteristics for continuous power include:
Peaking Power –DG Units can be operated to reduce demand charges, to defer buying electricity during high-price periods, or to allow for lower rates from power providers by smoothing site demand. Important DG characteristics for peaking power include:
Green Power – DG is operated by a facility to reduce environmental emissions from its power supply. Important DG characteristics for green power include:
Premium Power - DG is used to provide electricity service at a higher level of reliability and/or power quality than typically available from the grid.
Important DG characteristics for premium power (emergency and standby) include:
Transmission and Distribution Deferral – DG can be used by a cooperative to delay investment in new transmission or distribution facilities or upgrades. In some cases, placing DG units in strategic locations can help delay the purchase of equipment such as distribution lines and substations. A thorough analysis of the life-cycle costs of the various alternatives is important, and contractual issues relating to equipment deferrals need to be examined closely.
Ancillary Service Power – DG is used by a cooperative to provide ancillary services (i.e., interconnected operations necessary to impact the transfer of electricity between purchaser and seller) at the transmission or distribution level. Location of the DG is also important when providing ancillary power – these services are usually only needed at in certain areas. Finally, DG that is used to supply ancillary service generally needs sophisticated dispatch hardware, so that the grid operator can coordinate operation of the DG with the grid's needs.

II. LITERATURE REVIEW

In this review, the new inspired optimization technique Dragonfly Optimization (DO) is a nature that imitates the static and dynamic swarming activities of dragonflies. This paper applies DO in solving reconfiguration problem of distribution systems with an objective of enhancing the voltage profile. It presents the results of 33 and 69-node distribution systems for illustrating the superiority of the proposed method [1].
The proposed schemes have been applied on 33-bus and 69-bus IEEE standard radial distribution systems. To insure the suggested approaches validity, the numerical results have been compared with other techniques like Backtracking Search Optimization Algorithm (BSOA), Genetic Algorithm (GA), Particle Swarm Algorithm (PSO), Novel combined Genetic Algorithm and Particle Swarm Optimization (GA/PSO), Simulation Annealing Algorithm (SA), and Bacterial Foraging Optimization Algorithm (BFOA). The evaluated results have been confirmed the superiority with high performance of the proposed MFO technique to find the optimal solutions of RDGs units' allocation. In this regard, the MFO is chosen to solve the problems of Egyptian Middle East distribution network as a practical case study with the optimal integration of RDGs [2].
Lévy-mutation to force MSA jump out of stagnation and enhance its exploration ability. The validation of the proposed algorithm has been tested and verified through small, medium and large scales of standard RDN of IEEE (33, 69, 85-bus) systems and also on ring main systems of 33 and 69-bus. In addition, the obtained results are compared with other algorithms to highlight the advantages of the proposed approach. Numerical results stated that the MSA can achieve optimal solutions for losses reduction and capacitor locations with finest performance compared with many existing algorithms [3].
Numerical approaches for optimal location and size are considered in [4]. Test systems are evaluated and it shall be noted that these approaches are easy to implement with high computational efficiency, fast response, robust and effective to achieve the objective, but limited application to linear systems, fail to achieve global optima, and not efficient for large number of load flow computation. [5-6]

Recent optimizations are carried out using Meta-heuristic algorithms which are robust, susceptible to global optima, efficient to solve multi objective functions. Genetic Algorithm (GA) is the oldest algorithm, which are used for optimal placement and sizing of DGs, though they are efficient it is found from [7, 8] they are not accurate when required for high quality solution, premature and excess convergence time. [9-11] considered three different algorithms Ant Colony Search (ACS), Artificial Bee Colony (ABC) and Harmony Search Algorithm (HSA) are used for multiple DG placements, for constant and variable power load models.

Particle Swarm Optimization (PSO) [12] is easy to analyse, non rational, robust, highly efficient to find near optimal solution in many difficult practical optimization problem. PSO computational time is more and shall be reduced by using Accelerated PSO (APSO) [13], where PSO is modified for faster convergence.

There are many new optimization algorithms which have been developed, and one of the most efficient emerging algorithm is Frog Leap algorithm [14], and to its modified form is more used by researchers is Shuffle FLA (SFLA).

According to recent researches the hybridization of two or more techniques is found to be more efficient to solve the problem of optimization in DG[15]. APSO is one of the suitable algorithms for optimization, but there may be chances of premature convergence, which shall be overcome by SFLA. Therefore hybridization of APSO-SFLA shall be introduced for maximum benefit.

The various technical based indices are used in [16] to determine the benefits of DG in terms of voltage profile improvement, line-loss and environmental impact reduction of the distribution system. The various technical issues and negative impacts of DG on the network are discussed [17, 18]. To identify the most sensitive node in the radial distribution system a new voltage stability index (VSI) has been used [19, 20]. In [21], the author presented the network reconfiguration using a fuzzy genetic algorithm for improvement of voltage stability in the radial distribution system. Reliability and economic indices of a microgrid equipped with high reliability distribution system switches, implemented at the Illinois Institute of Technology, USA, are analyzed in [22]. In [23] and [24], analytical methods are proposed for reliability assessment of multiple DG enhanced distribution system and microgrid, respectively, while accounting DG operational modes, restoration order of DG units, and load duration curve.In [25], the reliability of a distribution system with the inclusion of WTGs is estimated using a wind speed prediction technique.. In [26], an analytical approach has been proposed, to evaluate distribution system reliability with specific consideration of DG modeling..

Therefore it is clear that a probabilistic based analytical method is proposed, to account for the time-dependent patterns of load demand and DG power output, leading to demand-generation mismatch, during restoration period under emergency system conditions. a new methodology needs to be developed for reliability assessment of distribution systems with renewable DG units as in [27].

Optimal DER placement can improve network performance in terms of better node voltage profiles, reduced power flows, reduced feeder losses, improved power quality and reliability of electric supply, but inappropriate DER placement may increase system losses as well as network capital and operating costs [28].

Zou et al. [29] proposed an analytical approach for the simultaneous placement of SCs and DGs for minimizing investment cost. They reduced the search space by identifying voltage support zones using analytical approach and solved the problem using particle swarm optimization (PSO). A coordinated approach is proposed for the simultaneous allocation of DERs and optimal network reconfiguration using an improved PSO (IPSO) method. The proposed approach maximizes the annual profit of electric utility by reducing the annual charges on energy losses, peak power losses and substation capacity release against the annual charges incurred to purchase DERs[30].

The literatures above discuss that Meta heuristic algorithm shall be used for optimal placement of DG, but it is noted that using a performance index helps to improve the voltage in the system compared to other placement methods. location of DG plays an important role in not only reducing losses but maximizing the cost benefits and improving reliability by reducing the customer interruptions.

III.PARTICLE SWARM OPTIMIZATION [PSO]

The optimization processes begins with a randomly created population which constituted by the agents (particles), each number of population is moved in a search space according to three vectors called inertia, memory, co-operation. The inertia leads the particle in its previous direction, memory keeps

track of the particles previous best position and co-operation refers to the particle best solution ever found by entire population these are summarized in the equation (1)

Concept of Searching

The basic concept of PSO lies in accelerating each particle toward its Pbest and the Gbest locations, with a random weighted acceleration at each time step as shown in Fig.1.1 It has quick convergence speed and Optimal searching ability for solving large-scale optimization problems the searching points gradually get close to the global optimal point using its Pbest and Gbest [3] The features of the searching procedure can be summarized as follows; it is shown in Fig.1.1 Initial positions of Pbest and Gbest are different. However, using the different direction of Pbest and Gbest, all agents gradually get close to the global optimum.

The modified value of the agent position is continuous and the method can be applied to the continuous problem. However, the method can be applied to the discrete problem using grids for XY position and its velocity. There are no inconsistency in searching procedures even if continuous and discrete state variables are utilized with continuous axes and grids for XY positions and velocities [3]. Namely, the method can be applied to mixed integer nonlinear optimization problems with continuous and discrete state variables naturally and easily. The above concept is explained using only XY axis (2 dimensional spaces). However, the method can be easily applied to n dimensional problem. Each particle tries to modify its position using the following information. The current positions, the current velocities, the distance between the current position and Pbest, the distance between the current position and Gbest.

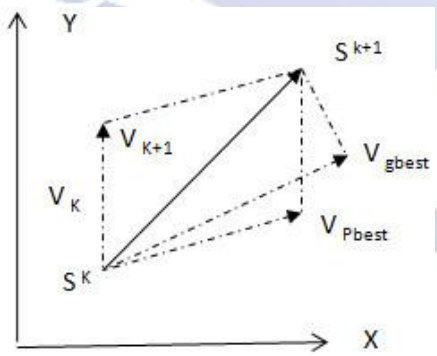

Fig. 1.1. Concept of modification of a searching point.

Velocity and position of each agent can be modified by the following equation (1) [4].

$$V_{ik+1} = WV_{ik} + C1 \times rand1 \times (P_{best\,i} - S_{ik}) + C2 \times rand2 \times (G_{best\,i} - S_{ik}) \quad (1)$$

$$S_{ik+1} = S_{ik} + V_{ik+1} \times \Delta t \quad (2)$$

Steps to solve the problem

The PSO-based approach for solving Optimal Placement of Distributed Generation (OPDG) problem to minimize the loss takes the following steps, the flow chart of PSO method is shown in Fig.1.2

Step 1: Input line data, bus data, and bus voltage limits.

Step 2: Calculate the loss using Newton Raphson method.

Step 3: Randomly generates an initial population (array) of particles with random positions and velocities on dimensions in the solution space. Set the iteration counter k=0.

Step 4: For each particle if the bus voltage is within the limits, calculate the total loss. Otherwise, that particle is infeasible.

Step 5: For each particle, compare its objective value with the individual best. If the objective value is lower than Pbest, set this value as the current Pbest, and record the corresponding particle position.

Step 6: Choose the particle associated with the minimum individual best Pbest of all particles, and set the value of this Pbest as the current overall best Gbest.

Step 7: Update the velocity and position of particle.

Step 8: If the iteration number reaches the maximum limit, go to Step 9. Otherwise, set iteration index k=k+1, and go back to Step 4.

Step 9: Print out the optimal solution to the target problem. The best position includes the optimal locations and size of DG, and the corresponding fitness value representing the minimum total real power loss.[5]

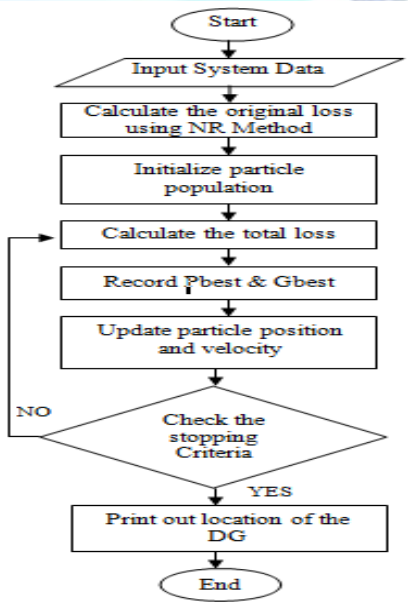

Fig.1.2. Flowchart of PSO method.

OBJECTIVE

In this method, location and size of DG units are decided in such way that minimum system power loss is obtained. So it is needed to define system power loss as a function of DG size and system bus voltage.

Hence objective function is to minimize total active power loss of the system is given by

Minimize F=Ploss=PL

$$P_L = \sum_{j=1}^{Nbr} (R_j I_j)^2$$

Constraints

While minimizing total system real power losses certain constraints need to be satisfied which are listed below.

- Line loading limit

Pline(i,j) ≤ Pline(i,j)max

- Bus voltage limit

Vimin ≤ Vi ≤ Vimax

METHODOLOGY

Optimal location for DG integration is the one which gives minimum power loss of system when DG is connected at that point. To get the power loss of system and voltage at various buses, load flow analysis need to be done. Here load flow algorithm is combined with PSO to obtain acceptable result. Here load flow analysis used is Newton- Raphson method.

The reason for selection of Newton-Raphson method is because it uses polar co-ordinates which uses less memory than Gauss-Seidal method and for larger systems the Newton-Raphson method is faster, more accurate & more reliable because of its Quadrature convergence characteristics.

IV.PLACEMENT OF DISTRIBUTED GENERATION

Power system deregulation and the shortage of transmission capacities have led to increased interest in distributed generation (DG) sources. Proper location of DGs in power systems is important for obtaining their maximum potential benefits. Placement of Distributed generation will continue to be an effective energy solution under certain conditions and for certain types of customers, particularly those with needs for emergency power, uninterruptible power, and combined heat and power. However, for the many benefits of DG to be realized by electric system planners and operators.

A constraint for DG source, similar to central generation, is active power constraint. It can be formulated as:

$$P_G^{min} \le P_G \le P_G^{max}$$

The reactive power output of DG units is also important and must be considered. Small and medium sized DG units mostly use asynchronous generator reactive power. Several options are available to solve this problem. On the other hand, DG units with a power electronic interface are sometimes capable of delivering a certain amount of reactive power (Pepermans et al, 2003). These interfaces or power converters can generate and inject reactive power (Q) to the network, but ratings of elements increase.

The reactive power generation of DG units which use synchronous generators, depends on reactive power control strategy control. Constant Q,constant power factor mode, Voltage regulated mode. Considering this point, the bus connected to the DG can be modelled as PQ or PV bus, depending on control strategy.

- ❖ DG type one: Certain type of DGs like photovoltaic will produce real power only. To find the optimal DG size at bus 'i', when it supplies only real power, the necessary condition for minimum loss is given by:

$$P_i = P_{DGi} - P_{Di} = -\frac{1}{A_{ij}} \sum_{\substack{j=1 \\ j \neq i}}^{n} (A_{ij})\, p_j - B_{ij}\, Q_{ij} \qquad 3.1$$

From equation, we obtain the following relationship:

$$P_i = P_{DGi} - \frac{1}{A_{ij}} \sum_{\substack{j=1 \\ j \neq i}}^{n} (A_{ij})\, p_j - B_{ij}\, Q_{ij}$$

Equation (3.2) gives the optimal DG size for each bus so as to minimize the total power loss. Any size of DG other than P_{DGi} placed at bus i will lead to a higher loss. This losses however is function of loss coefficient of loss coefficients Aij , Bij when DG is installed in the system, the values will change as it depends on the state variable voltage and angle.

- ❖ DG type two: For synchronous condenser DG, it provides only reactive power to improve voltage profile. To determine the optimal DG placement, we again differentiate the loss equation on either side with respect to Qi . The optimal DG size for every bus in the system is given by equation (3.3)

$$Q_{DGi} = Q_{DGi} - \frac{1}{A_{ij}} \sum_{\substack{j=1 \\ j \neq i}}^{n} (A_{ij})\, Q_j - B_{ij}\, P_{ij} \qquad 3.3$$

- ❖ DG type three: Here we consider that the DG will supply real power and in turn will absorb reactive power. In the case of the wind turbines, induction generator is used to produce real power and the reactive power will be consumed in the process [7]. They require is an ever increasing function of the active power output.

The reactive power consumed by the DG wind generation in simple form can be given as in equation (3.4) [8]

$$Q_i DG_1 = -(0.5 + [0.04P]DGQ_2 \qquad 3.4$$

The loss equation will be modified. After following the similar methodology of the two types, optimal DG size can be found by solving

$$0.03AijP_{DGI}^3 + PDGi[1.004Aij + 0.08AijQDi - 0.08Yi] + (X1 - AijPD1) = 0 \qquad 3.5$$

Equation (3.5) gives the amount of real power that a DG should produce when located at bus 'i', so as to obtain the minimum system loss.[9]

Implementation of PSO algorithm

The PSO algorithm is used to place the DG in the IEEE standard 33 bus radial distribution system shown in Fig.3.1, as stated before, PSO simulates the behaviors of bird flocking. Suppose the following scenario, a group of birds are randomly searching food in an area. There is only one piece of food in the area being searched. All the birds do not know where the food is. So what's the best strategy to find the food? The effective one is to follow the bird which is nearest to the food. PSO learned from the scenario and used it to solve the optimization problems. In PSO, each single solution is a "bird" in the search space. We call it "particle". All of particles have fitness values which are evaluated by the fitness function to be optimized, and have velocities which direct the flying of the particles. The particles fly through the problem space by following the current optimum particles.

PSO is initialized with a group of random particles (solutions) and then searches for optima by updating generations. In every iteration, each particle is updated by following two "best" values. The first one is the best solution (fitness) it has achieved so far. (The fitness value is also stored.) This value is called Pbest. Another "best" value that is tracked by the particle swarm optimizer is the best value, obtained so far by any particle in the population. This best value is a global best and called Gbest. After finding the two best values, the particle updates its velocity and positions with following equation (3.6) & (3.7).

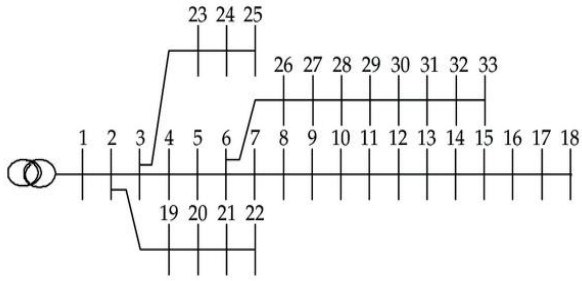

Fig. 3.1. Single line diagram of 33-bus radial distribution system.

$$v[] = v[] + c1 * rand() * (pbest[] - present[]) + c2 * rand() * (gbest[] - present[]) \qquad 3.6$$

$$present[] = present[] + v[] \qquad 3.7$$

s

v[] is the particle velocity, present[] is the current particle (solution). Pbest [] and Gbest [] are defined as stated before. rand () is a random number between (0,1). c1, c2 are learning factors. Usually c1=c2=2.

While maximum iterations or minimum error criteria is not attained ,Particles' velocities on each dimension are clamped to a maximum velocity Vmax if the sum of accelerations would cause the velocity on that dimension to exceed Vmax, which is a parameter specified by the user. Then the velocity on that dimension is limited to Vmax. In the fig.3.2 the flow chart of placement of DG is shown.[10]

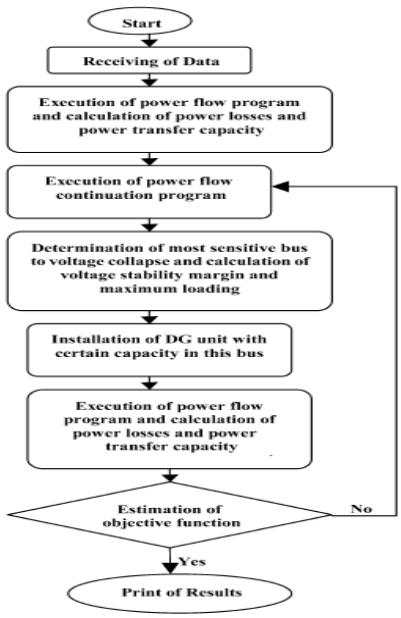

Fig.3.2. Flow chart of Placement algorithm

For placement of DG units, it is necessary to define objective function to solving this problem. According to structure of placement algorithm in Fig.3.2, the objective function should be selected

for reducing of power losses, increasing of power transfer capacity and maximum loading, or increasing of voltages stability margin in the system. So, for this purpose, the precise active power losses reduction as an objective function has selected. According to Fig.3.2, in this method the place of installation DG units in the distribution network was implemented based on execution of an iteration algorithm. This algorithm is based on determination of buses that are the most sensitive to voltage collapse. For this purpose, we used continuation power-flow program. By execution of this program most sensitive bus to voltage collapse or maximum loading were determined. After determination of sensitive bus, one DG unit or even compensator with certain capacity can be installed on that bus. After installation of the DG unit, the power-flow program was executed and then the objective function calculated. If the estimation of objective function was inappropriate, then this algorithm would iterate. Namely with execution of the Newton-Raphson in the system where the DG unit was installed, most sensitive bus to voltage collapse or maximum loading was determined again. This algorithm will be continued until the objective function is estimated. If the objective function is estimated, this iterative algorithm will stop.

V.RESULTS

Without placement of distributed generation (DG)

The system is the radial distribution system with the total generation of 4.093 MW, 2.53Mvar, total load is 3.72 MW, 2.30MVar, minimum and maximum voltage is 0.95 to 1.05p.u respectively, the population size is 10 and maximum iteration (itermax) is 50. Obtained results are tabulated in Table 3.1 it shows the voltage of 33 busses, in which the 18th bus has very low voltage 0.8525p.u i.e. below acceptable voltage limits. the active power losses is 360.0kW and reactive power losses is 241.00kVar. Fig.3.3 shows the voltage magnitude along the 33 bus system.

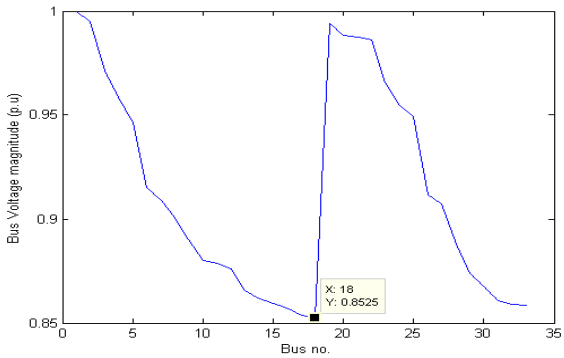

Fig. 3.3. Voltage profile for IEEE-33 bus system before implementing DG.

With placement of one distributed generation(DG)

The maximum iteration is 50 and population size 10, Table 3.1 indicates that the minimum power loss is achieved and improvement in the voltage profile is observed. The active power loss is 99.0kW and reactive power loss is 75.00kVar reduction in the power loss is tabulated in Table 3.1. Fig.3.4 shows the improvement in the voltage profile along the 33 bus. The best placement of DG is at bus number 29 and size is 2.308MW, in 13.72 seconds the proposed PSO algorithm calculated the result this is tabulated

After the execution of PSO algorithm for placement & sizing of one DG, the voltage is being improved & tabulated in the Table.3.2. It can be seen, the voltages at bus 09,10,11,12,13,14,15,16,17,18,28,29,30,31,32,33 is successfully improved.

Conclusion

The placement of one DG in the radial distribution system improved the voltage profile and reduces active power losses, results shown in Table 4.1 the initial losses were 360.0KW i.e. without the placement of DG. After the allocation of one DG the loss reduction is 279.00kW and for the calculation of sizing and placement of one DG it has taken 13.72 seconds.Form the obtained results it can be concluded that by the optimal allocation and sizing of distributed generation successful improved the voltage profile and reduced the line losses of the IEEE standard 33-bus radial distributed system.

With two Distributed Generation Placement Implementation of PSO algorithm

Implementation of PSO algorithm is similar to section 3.2, but here we are doubling the random particles, for the placement of two DGs in the IEEE standard 33-bus radial distribution system.

Results

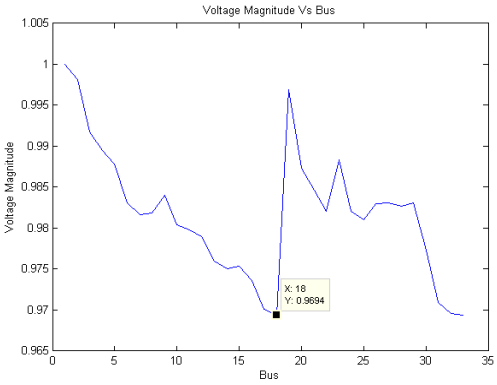

Fig. 3.5. Voltage profile for IEEE-33 bus system after implementing two DGs.

The two DG are placed at different busses and results are obtained, it can be noted from Table 3.3 that the voltage profile is considerably improved when compare with the previous result and losses are also reduced to 81.00kW and 61.00kvar. One DG is placed at bus number 25 another at 15 with the size of 0.9598MW and 0.0808MW respectively. The improved voltage profile along the bus is shown in the Fig.3.5, it has taken 13.64 seconds to obtain the result and it is tabulated in Table 4.2.After the execution of PSO algorithm for placement & sizing of two DG, the voltage is being improved & tabulated in the Table.3.3. It can be seen, the voltages at bus 09,10,11,12,13,14,15,16,17,18,28,29,30,31,32,33 is successfully improved.

Conclusion

The placement of two DG in the radial distribution system improved the voltage profile and reduces active power losses, results shown in Table.4.2 the initial losses were 360.0KW i.e. without the placement of DG. After the allocation of two DGs the loss reduction is 279.00kW and for the calculation of sizing and placement of two DG it has taken 13.64 seconds.

VI. RESULT DISCUSSION

The algorithm was tested on IEEE standard 33-bus radial distribution system Power factor is taken as cos ø= 0.70 the test system is simulated in MATLAB,whose results are tabulated in Table I, II &III. The test system for the case study is radial distributionsystem with IEEE 33 buses is shown in fig.1. The total loads for this testsystem are 3.72 MW and 2.30 MVR. The original total real power loss and reactive power loss in the system are 360kW and 241kVAR respectively.

The current carrying capacityof branch No.1-9 is 400 A, and the other remaining branches including the tie lines are 200A.The minimum and maximum voltages are set at 0.95 and 1.05p.u respectively.The load data and branch data is shown appendix1.

The distribution system characteristicsare

- Number of buses=33,
- Number of lines=32,
- Slack bus no=1,
- Base voltage=12.66kV,
- Base MVA=100.

PSO parameters are,

- Population size is 10,
- Maximum iteration is 50,
- Inertia weight is 0.9,
- Weighting factor C_1=C_2=1.2

TABLE. BEST PLACEMENT OF DG

BEST PLACEMENT OF DG	SIZE OF DG	LINE LOSSES		TIME TO CALCULATE THE RESULT
BUS NO	***MW***	***kW***	***kVar***	***Sec***
29	2.308	99.00	75.00	13.72

The placement of number of DG successfully improved the voltage profile and reduces active power losses, results shown in Table 4.3 the initial losses were 360.0kW without the placement of DG. After the placement of one DG in to the radial distribution system the losses reduced to 99kW. So, the loss reduction is 261.00kW the loss reduction percentage is 72.50% for two DGs the line loss reduced to 81kVar so, the line loss reduction is 279.00kW the loss reduction percentage is 77.5%.

As the complexity of the problem increases the time taken by PSO algorithm to calculate the result is also reduced, the time taken for the calculation of one DG is 13.72 seconds and for the calculation of two DG it has taken 13.64 seconds which is 0.08 seconds less than the time taken for the placement of one DG and it is tabulated in table 4.1 & 4.2. The time to calculate the placement and sizing of DG is very important factor in the online controlling of distributed generation (DG).

The line losses reduction and improvement in the voltage profile of the distribution system by allocation and sizing of distributed generation is successful. Loss reduction is 72.5% after the

placement of one DG of size 2.308MW at bus number 29 in 3.72 seconds, and loss reduction is 77.5% after the allocation and sizing of two DGs of size 0.9598MW & 0.0808MW at bus number 25 & 15 respectively in 13.64 seconds. In Fig.4.1 it can be observed that the voltage profile improved along the 33 busses as the DGs are placed in the distribution network. The distributed generation cannot be sized beyond the power export of the substation, because the sending end to the load centres the conductor sizes are gradually decreased from the substation to the customer point.

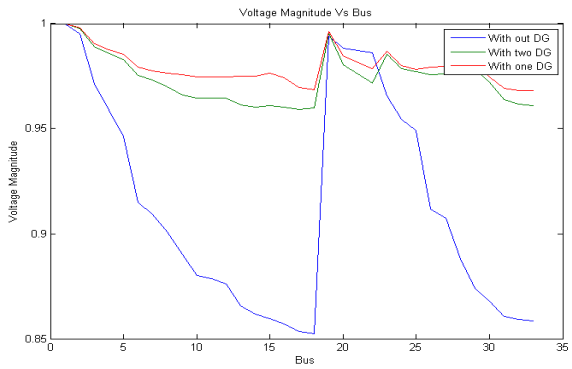

Fig.4.1.Voltage profile for IEEE-33 bus system after implementing DGs.

VII. CONCLUSION

It is clearly seen now that allocation and sizing of distributed generation (DG) by using the Particle swarm optimization (PSO) technique improved major objective, improving voltage profile and minimizing the power losses, The PSO algorithm is tested on IEEE standard 33 test bus system,the major merit of this method is to be less time consuming and the flexibility of modeling and better convergence, for online controlling of DG, simulation results signify that the proposed algorithm presents better results when the problem is more complex, the placement of DG effectively improved the voltage profile and minimizes the power losses.

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