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Reconfiguration Of Radial Distribution System To Minimize Active Power Loss

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Abstract— *This paper proposes to apply the Henry Gas Solubility Optimization algorithm as an effective and recent optimization technique to find the most optimal solution to the problem of reconfiguring the radial distribution network to minimize total power losses. The developed algorithm is validated using the standard IEEE 33-bus radial distribution system. The algorithm is easy and simple to implement.*

Keywords— reconfiguration; henry gas solubility optimization algorithm; radial distribution system

1. INTRODUCTION

The modern distribution system is considered too important a part of the entire electricity system. This is the main connector between load centers and the power supply system. Modern distribution systems contain many interconnected radial circuits that contain busbars, distribution feeders, a large number of switches, which are divided into tie switches and section switches. These switches are used to adjust the operating state of the feeders (on / off) in order to reduce the load on the feeder by transferring some of the weights from the heavily loaded feeder to another lightly loaded feeder, this transfer process is done by opening / closing the sectioning and tie switches. [1-2].

The reconfiguration process is a powerful procedure to minimize power loss. The reconfiguration problem is seen as a global optimization problem because it aims to find the best global solution among the many possible solutions. The reconfiguration process is accomplished by modifying the network topology by assisting the network on / off switches until an optimal topological configuration is obtained, with the value of all feeder power losses in the network being minimized provided the network constraints are met [3]. The optimal configuration enables open combinations. The remaining network switches are closed. A reconfiguration problem is a nonlinear global optimization problem that aims to select the best global solution from a set of reasonable local best solutions. In the last decade, meta-heuristic algorithms have become very popular, and this is because they are gradient-free algorithms, flexible and avoid local optimization. The first two are advantages because metaheuristic algorithms depend only on input and output in solving the optimization problem [4].

2. MAIN MATHEMATICAL FORMULATION OF THE STUDIED OPTIMIZATION PROBLEM

The main objective function is the minimizing total active power losses that can be given as follows:

$$F_{obj} = minimize(P_{loss}) \tag{1}$$

Where, Fobj acts as an objective function that minimizes the overall power loss in the network, subject to the following restrictions:

(1) Radiality: it is necessary that the network after reconfiguration does not contain loop loops, which can be mathematically modeled as "the sum of the topological status of all 32 branches is 1, as shown below:

$$\sum K_{fg} = 1 \qquad 1 \leq \text{f} \leq \text{N-1} \tag{2}$$

where, $2 \leq$ g $\leq$ N

(2) Feasibility: That any load in the reconfiguration system should not be lost due to the reconfiguration procedure.
(3) Bus Voltages: The bus must not go beyond the limits indicated in table 1.

$$V_f min < |V_f| < V_f max \tag{3}$$

(4) Currents: The branch current must be within the acceptable range.

$$K_{fg} I_f < I_f max \quad , \text{f} \in [1, 2, \ldots \ldots Nb] \tag{4}$$

(5) Kirchhoff's laws of current and voltage, respectively.

$$g_i(I,K) = 0 \quad (5)$$

$$g_v(V,K) = 0 \quad (6)$$

3. HENRY GAS SOLUBILITY OPTIMIZATION ALGORITHM (HGSO)

Henry's Gas Solubility Optimization (HGSO), which simulates Henry's Law behavior to solve complex optimization problems. Henry's Law is the basic gas law that relates the amount of a given gas dissolved in a given type and volume of liquid at a fixed temperature. The HGSO algorithm simulates gas thickening to balance development and exploration in the search space and avoid local optima [5]. The flow chart of HGSO is shown in Fig.1.

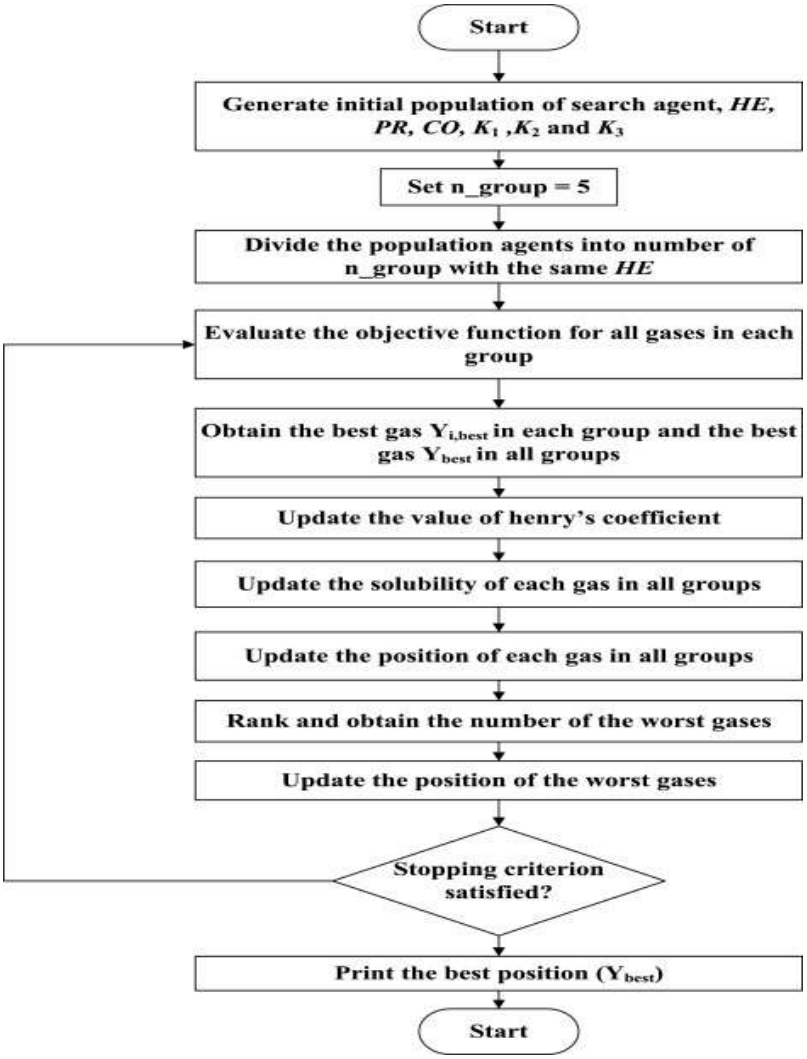

Fig. 1. Flow chart for DEA

4. SIMULATION AND RESULTS

From the simulation results, it can be seen that the method of optimization of the swarm of salps provided the minimum total loss of system power when switching 4, 14, 15, 22, 33. In this article, it is assumed that the population of size is 50, which is a search agent that generates 50 solutions per iteration. At each iteration, each crawler generates a solution in which five switches are selected from the network to be opened and form a new proposed topological design methodology.

The proposed method of reconfiguring the distribution system uses a standard IEEE 33-bus radial distribution system. MATLAB code is used to perform the proposed technique to achieve the objective function. The main data of the test system: the base voltage of the substation is 12.66 kV, the total active power of the system is 3715 kW, and the total reactive power is 2300

kVar, respectively [4]. Before reconfiguration, the total active power loss is 210.986 kW, it has 5 tie switches and 32 sectionalizing switches as in Fig. 2.

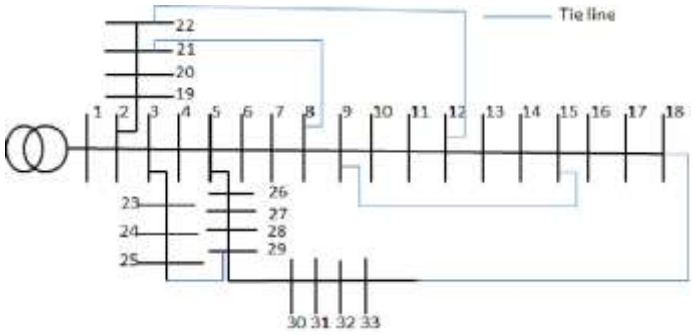

Fig. 2. IEEE 33-bus radial distribution system

The observed results are presented in Table 1.

Table 1: The observed results

Method	HGSO
Power loss (KW)	132.8164
Open switches combination	4, 14, 15, 22, 33
Loss Reduction (%)	38.010

5. CONCULISION

In this paper, the problem of the best reconfigured radial distribution system using recent optimization techniques (HGSO) to minimize power losses has been solved. HGSO has been used successfully to reconfigure the distribution system and find the optimal switch combination to minimize power loss of the standard IEEE 33-bus radial distribution system. The simulation results prove that the percentage of power loss reduction due to the reconfiguration process was reduced to 38.01074%. Numerical results have shown that the advantages of HGSO is an effective way to reconfigure a radial distribution system to reduce active power losses.

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