ISSN: 2350-0328

International Journal of AdvancedResearch in Science, Engineering and Technology

Vol. 6, Issue 2, February 2019

Minimization of Losses in Distributed Power Networks by Genetic Algorithms

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ABSTRACT: In the article the mathematical forming of the problem of minimization of losses in distributed power networks taking into account all the regime and technological limitations and genetic algorithm of its solving are presented. Using of genetic algorithm creates the possibility of solving many problems connected with taking into account of various limitations in solving of discussed task.

KEYWORDS: Power network, losses in electrical networks, losses minimization, target function, limitation, penalty function, algorithm of solving, genetic algorithm.

I.INTRODUCTION

Minimization of losses in distributive electric networks, generally, represents a challenge of nonlinear mathematical programming with assemblage simple and functional in the form of equalities and inequalities. Therefore, till now there is no universal algorithm of its solution on the basis of use of matching mathematical models. In this connection questions of development existing and workings out of new algorithms of the solution of this problem in a direction of overcoming of the difficulties, connected with use of traditional algorithms remains an actual problem.

In the given work the new effective algorithm of minimization of active losses in distributive electric networks by optimization of adjustable reactive powers of knots is offered.

The problem, generally, mathematical is formulated in a following aspect [1, 2]:
To minimize functions of total losses of an active-power in the electric networks, representing an algebraic sum of active-powers of all knots

$$\pi = \sum_{i=1}^{n} P_i \tag{1}$$

Under conditions:
Balance of power of knots:

$$\left.\begin{aligned} W_i^{'} &= P_i - P_{iз} = 0, \quad i = G + L; \\ W_i^{''} &= Q_i - Q_{iз} = 0, \quad i \in G_1 + L \end{aligned}\right\}; \tag{2}$$

Accomplishments of regime and technical restrictions in the form of inequalities:

$$U_{i,\min} \le U_i \le U_{i,\max}, \quad i \in G + L; \tag{3}$$

$$Q_{i\min} \le Q_i \le Q_{i,\max}; \quad i \in G - G_1; \tag{4}$$

$$K_{Tl\min} \le K_{Tl} \le K_{Tl}, \max; \; l \in T; \tag{5}$$

$$I_{l\min} \le I_l \le I_{l\max} \; l \in l_I; \tag{6}$$

Where n - number of knots in an electric network (except balancing); L - assemblage of loading knots; G - assemblage of generating knots; G1 - assemblage of generating knots with noncontrollable reactive powers T -

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 6, Issue 2, February 2019

assemblage of the branches containing transformers with adjustable transformation ratios; l_1 - assemblage of branches in which currents are controlled.

Despite existence of assemblage of methods and algorithms of the solution of an observed problem of a problem of maintenance of efficiency of calculations for modern electric networks in the conditions of presence of simple and functional restrictions is not till the end of solved. In this connection in the given work the algorithm of the solution of the given problem by optimization of adjustable reactive powers of knots on the basis of genetic algorithm is offered effective.

Genetic algorithms offer the new and powerful approach to an optimization problem solving. Their application became possible thanks to expansion of possibilities of computing means at rather low expenses. Lately these algorithms find application in the solution of global problems of search optimization when traditional algorithms of optimization cannot be used. They use the parallel and global search methods simulating natural genetic operators. Probability of convergence of genetic algorithm to the global solution of a problem the highest as it, simultaneously, sizes up assemblage of points in space of parameters. These algorithms also do not demand differentiability and continuum space of search [2-4].

Simple genetic algorithm consists of sequence of following operations:

1. Generation of casual population of binary or material rows of candidates of the solution.
2. Calculation of function of conformity for each row in population.
3. Creation of posterity of lines (chromosomes) by selection, crossings and mutations.
4. An estimation of new rows (chromosomes) and calculation for each of them of conformity function.
5. Check of achievement of the purpose of search or admissible generation. In case of performance of this condition - delivery of the best chromosome (the candidate of the solution); otherwise - retrace to item 3 item.

The population sizing up is carried out for revealing more and less fitted individuals. For definition of extent of fitness of each individual conformity function is used. In optimization problems in the capacity of such function can use criterion function.

Selection (selection) is necessary for sampling of more fitted individuals for crossing. There are many options for selection. [5]. Most known of them are roulette selection, selection by truncation and tournament selection.

The individuals selected as a result of selection named parents, are crossed and give posterity. Created in the course of an exchange of the genetic information between parental individuals (with application of the operator of a crossover) descendants make population of following generation. Crossing can be carried out on the basis of integral-valued or material coding of individuals. As a result of crossing of two casually chosen individuals (parents) two descendants are created. Such process repeats before reception as much individuals, how many they were in initial population. At this stage of algorithm in important parameter the probability of crossing defining number of crossings concerning total number of individuals in population is.

At use of integral-valued coding each chromosome (individual) represents a bit line in which parameters of the solution of a task in view are coded.

At material coding gets rid of operations of coding and the decoding, used in integral-valued coding. The instance of material coding is resulted in drawing.

Chromosome

216,788	428,256	643,528	528,251

Figure 1.An instance of material coding

For crossing can 1-dot, 2-dot and homogeneous operators of a crossover will be applied.

According to this algorithm the problem of conditional minimization of the function representing function of total losses of an active-power in electric networks π (1) taking into account all restrictions is reduced to unconditional

minimization of the generalized function consisting of the sum of criterion function of an initial problem and penal functions, considering restrictions (2), (3) and (6). Simple restrictions (4) and (5) are considered automatically according to procedure of genetic algorithm.
The penal functions, considering these restrictions should be equated to null at their performance and increase at infringement of proportionally extent of infringement.
According to it for the account of restriction in the form of equality (2) penal function in an aspect is accepted

$$Ш_p = \frac{\alpha}{2}\left(\sum_{i=1}^{n} P_i - P_H\right)^2. \quad (7)$$

Restrictions (3) and (5) are considered by penal function in an aspect

$$Ш_l = \beta e^{\gamma\left(P_l - P_l^{\max}\right)} \text{ or } Ш_l = \beta e^{\gamma\left(-P_l + P_l^{\min}\right)}, \quad (8)$$

Where α, β, γ - weight (penal) factors.

Thus, the generalized criterion function, at minimization by genetic algorithm taking into account restrictions by the presented methods, is represented in a following aspect

$$F=\pi+Ш_p+Ш_Q+\sum Ш_l \quad (9)$$

Efficiency of the presented algorithm is investigated on an instance of minimization of active losses by optimization of adjustable reactive powers of knots of a real distributive electric network 35 sq.
Thus function (9) is accepted as conformity function. Population took place from 50 chromosomes of individuals. The probability of crossing is accepted as Ps=0,6, and probability of a mutation of P_m=4-1=0,25.

Optimization is made by the presented genetic algorithm with use of a 1-dot and 2-dot crossover. Convergence of iterative process at use of material coding with a 2-dot crossover it appeared more sweepingly than with 1-dot crossover.

Accuracy of calculation was mustered by offered algorithm on the basis of comparison of results with the results gained at use of classical algorithms.
Results of researches showed high efficiency of the presented genetic algorithm of minimization of losses in electric networks taking into account all aspects of restrictions.
Leading-outs:

1. The effective genetic algorithm of minimization of active losses in electric networks taking into account regime and technological restrictions is offered.

2. The genetic algorithm of minimization of losses in electric networks possesses enough split-hair accuracy and reliable convergence of iterative settlement process. He also does not demand differentiability and continuum of space of search.

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