ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 10, Issue 1, January 2023

Reduction of Electricity Losses Due to Unification of Parameters of Distribution Electric Networks

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ABSTRACT: This article gives overall information of electricity losses also describes the ways of reduction electricity losses. In addition, gives the main information about reduction electricity losses with the help of unification of parameters of distribution electric networks.

KEY WORDS: Electricity losses, distribution electrical network, cross-section, line, cable core, transformer substation, unification.

I. RELATED WORK

Reduction of electricity losses in distribution electrical networks (DEN) of industrial enterprises, cities and agriculture is one of the main directions for the implementation of energy-saving policy in electric power systems.
In the problems of optimizing the parameters of electrical networks, in particular cable cross-sections, the reduction of power losses is functionally interconnected with the consumption of conductor material. When choosing the cross-sections of cables and wires, technical and economic proportionality is always considered for the cost of electricity losses and the consumption of conductor material (economic current density, economic intervals).

II. INTRODUCTION

The mass nature of DEN elements, the relatively small lengths of each line separately, the justification for the development of DEN based on the industrialization of the production of units and lines, as well as their installation and operation, create opportunities for developing specific principles for choosing wire and cable cross-sections, namely, the use of a very limited number of wire cross-sections and cables. The latter is the essence of the principle of unification of these parameters [1].
In the practice of designing and building DEN in some of the largest cities and industrial enterprises, the principle of unification of the capacities of transformer substations and cable line cross sections is also applied (Paris, Moscow, etc.) [1,2]
The study of the issue under consideration was carried out on the basis of specific mathematical models of cost criteria, power losses and conductor material costs, recorded as a function of the number of applied cable sections (N_F).
Complex optimization of the model parameters was carried out by the methods of criterion analysis and vector optimization [2,3].
The results of a quantitative analysis confirm the possibility of economically feasible unification of the cross sections of the DEN cables (the use of one or two standard sections depending on the density of electrical loads) [1].
The study of the stability of the technical and economic cost function to changes in parameters showed its significant resistance to the parameter of unification of cable sections. The area is equal to the economy of the unified parameter is $N_F^{r.e} = 0{,}37 \div 2{,}5$. The significant stability of the TE function, on the one hand, creates the prerequisites for the unification of sections, on the other hand, does not allow unambiguous selection of this parameter.

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

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To introduce certainty into the choice of the optimal number of recommended cable sections, it is advisable to use additional criteria. In this case, the method of vector optimization is applied according to additional criteria for power losses $\Delta E(N_{F,i})$ and the consumption of conductive metal $G(N_{F,i})$ based on mathematical models of these criteria:

$$\Delta E(N_{F,i})=A_{1(i)}\, N_{F,i}^{0,3} \qquad G(N_{F,i})= A_{2(i)}+ A_{3(i)}\, N_{F,i}^{-1} \qquad (2)$$

where Aj(i) j=1-3, - generalized constant coefficients, which are the initial data of the problem.

In accordance with the methodology used in such cases for solving the problem, the optimization of the efficiency vector is carried out [4]

$$Y(N_{F,i})=\lambda_1 \Delta E\,(N_{F,i})+ \lambda_2 G(N_{F,i}), \qquad (3)$$

where λ_1, λ_2 - are, respectively, the coefficients of importance of the criteria for energy losses and the consumption of conductive metal.

Since the additional criteria $\Delta E(N_{F,i})$ and $G(N_{F,i})$ have different dimensions, they are reduced to a single reference system by means of normalization. The normalized criteria for power losses $\Delta \overline{E}\,(N_{F,i})$and the consumption of conductor metal $\vec{G}\,(N_{F,i})$ for DEN 0.38-10 kV have the form [4]

The maximum number of cross-sections of cable cores NF,i-1 (max), which can be used in DEN 0.38-10 kV, is determined by the number of sections in each 0.38-10 kV; in turn, the number of sections is determined by the number of connections to the lines 0.38-10 kV.

The optimal solution based on the efficiency vector, taking into account the normalized criteria, is selected according to the model [4]:

$$\Delta E(N_{F,i})= \frac{\Delta E(N_{F,i})-\min \Delta E(N_{F,i})}{\max \Delta E(N_{F,i})-\min \Delta E(N_{F,i})} = (N_{F,i}^{0,3}-1)/(N_{F,i(\min)}^{0,3}-1) \qquad (4)$$

$$G(N_{F,i})=(N_{F,i}^{-1}-N_{F,I\,(max)})/(1-N_{F,i}^{-1}{}_{(max)})$$

The maximum number of cross-sections of cable cores $N_{F,i}^{-1}{}_{(max)}$, which can be used in DEN 0.38-10 kV, is determined by the number of sections in each 0.38-10 kV; in turn, the number of sections is determined by the number of connections to the lines 0.38-10 kV.

The optimal solution based on the efficiency vector, taking into account the normalized criteria, is selected according to the model [4]:

$$N_F^{opt} = F^{-1}\left[\min(\lambda_1 \Delta E(N_F)+\lambda_2 G(N_F)\right]$$

In this problem, the most uncertain and, at the same time, essential is the choice of ratios of the criteria importance coefficients $\lambda_1$and λ_2.

It seems to be of fundamental importance that the energy saving factor is preferable, since one of the main provisions of the government program of the Republic of Uzbekistan, which characterizes the state of our energy sector, is the implementation of an active energy-saving policy.

Thus, it may be considered expedient to solve this problem with the preference for the criterion of energy losses [$\lambda_1 > \lambda_2$] or, in the extreme case, its solution for$\lambda_1 = \lambda_2$. The solution at corresponds $\lambda_1 > \lambda_2$ to the use of one and two sections of the DEN cables.

Preliminary technical and economic calculations carried out for the actual development of the city area with transformer substations 10 / 0.38 kV Ix630 kVA [20piece] and 2x630 kV. A[22piece] showed that the use of one section of 150 mm2 in DEN 0.38 -10 kV instead of 6-8 standard sections, selected in accordance with current standards, leads to a decrease in electricity losses by about 16% per year. At the same time, the saving of specific power losses is 30 kWh/year per 1 kW load on the busbars of a 10/0.38 kV transformer substation.

Thus, the economic feasibility of unifying the cross-sections of the DEN cables is confirmed by the results of a technical and economic analysis, and is due to the simplification of the production, construction and operation of these DEN. With the practical implementation of the unification of cable core cross-sections, a significant reduction in electricity losses in distribution electrical networks (up to 15-20%) is achieved.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
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III. CONCLUSION

This article shows us one of the main ways of reduction electricity losses. Unification of parameters of distribution electrical networks is one of the necessary way to reduce electricity losses. Mathematical models are studied, optimal parameters and methods are studied and analysed for reducing energy losses in electrical networks.

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