RESEARCH OF THE OPTIMUM SCALE OF STANDARD SECTIONS OF AGRICULTURAL PURPOSE LINES

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Abstract. In the article, for the optimal development of networks, the parameter of the network element is selected from the existing standard scale of standard sizes and the scale of standard sections of lines (cables) is optimized or their optimality is checked.

Introduction

For the optimal development of networks, it is important not only to select the optimal parameter of a network element from the existing standard scale (parametric series) of standard sizes, but also to optimize standard scales of equipment standard sizes or to check their optimality. At the same time, the standard scale of cable cross-sections does not meet the requirements of [1-5], and therefore the question arises as to whether the existing scale of cable cross-sections corresponds to the optimality requirements.

Since cable lines have not yet found widespread use in rural areas, there are conditions not only for checking the optimality of the existing scale of cable cross-sections, but also for establishing the optimal scale of cable conductor cross-sections intended for the construction of cable power lines in rural areas (if the existing scale is not meets the optimality conditions).

To construct a parametric series of sections of lines (cables) intended for cable power lines in rural areas, it is proposed to use the method of economic load intervals [6-10]. This method uses the principle of limiting the allowable increase in costs from the optimal ones. As an optimality criterion, it assumes the use of a minimum of total costs [11-15].

When establishing the optimal scale for equipment standard sizes, it is important to determine the initial and final value of the scale standard size. The initial cable section is mainly determined by the minimum loads. The final cross-section of the cables is determined by the highest actual current loads or the highest possible short-circuit currents.

For cables of rural electrical networks for long-term permissible current loads, the final cross-section can be chosen at least 75 mm^2, and under the conditions of thermal stability, the cross-section must be at least 100 mm^2. Thus, based on the analysis carried out for rural cable power lines, it is necessary to take the final section of the scale equal to 120 mm^2, and the initial section must be established in the course of research [16-18].

In the practice of design and scientific and technical research, it is accepted that two compared options are considered economically equivalent if their indicators differ by no more than 3-5%. This condition is the basis for one of the approaches to determining the optimal parametric series, which is that the deviation of the actual costs when using a section from the standard scale from the optimal is 3-5% [19-21].

The deviation of the actual costs when using the optimal section from the standard scale is determined by:

$$З_{ф} = (1+\delta)З_{э} \quad (1)$$

where δ is the deviation of the actual costs from the optimal ones, taken equal to 0.03-0.05.

The relative change in costs is:

$$\delta_i^{н} = \frac{З_i^{н} - З_{iэ}^{н}}{З_{iэ}^{н}} \quad \text{And} \quad \delta_i^{в} = \frac{З_i^{в} - З_{iэ}^{в}}{З_{iэ}^{в}} \quad (2)$$

or

$$\delta_i^{н} = \frac{\left(\sqrt{F_i} - \sqrt{F_{i-1}}\right)^2}{\frac{K_0}{k} + 2\sqrt{F_{i-1}F_i}} \quad \text{And} \quad \delta_i^{в} = \frac{\left(\sqrt{F_{i+1}} - \sqrt{F_i}\right)^2}{\frac{K_0}{k} + 2\sqrt{F_i F_{i+1}}} \quad (3)$$

From (2) and (3) it follows that the value of the relative deviation of total costs when deviating from the economic section is determined only by the ratio of adjacent standard sections and the ratio of the constant component of the line cost K_0, which does not depend on the section, to the rise in price k. Analysis of the data in Table 1 shows that the value of the ratio K_0/k varies within narrow limits - from 92.73 to 124.02 with the arithmetic mean of 116.62 and the mean square of 112.27. The calculated values $\delta_i^{в}$ are given in table. 1.

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Thus, taking into account the permissible (3-5%) deviation of actual costs from economic costs allows us to abandon the use of some sections from the standard series (Fig. 1), which confirms the relevance and legitimacy of raising the question of the expediency of the existing scale of nominal cable cross-sections and the need to develop a new scale satisfying the conditions of economy.

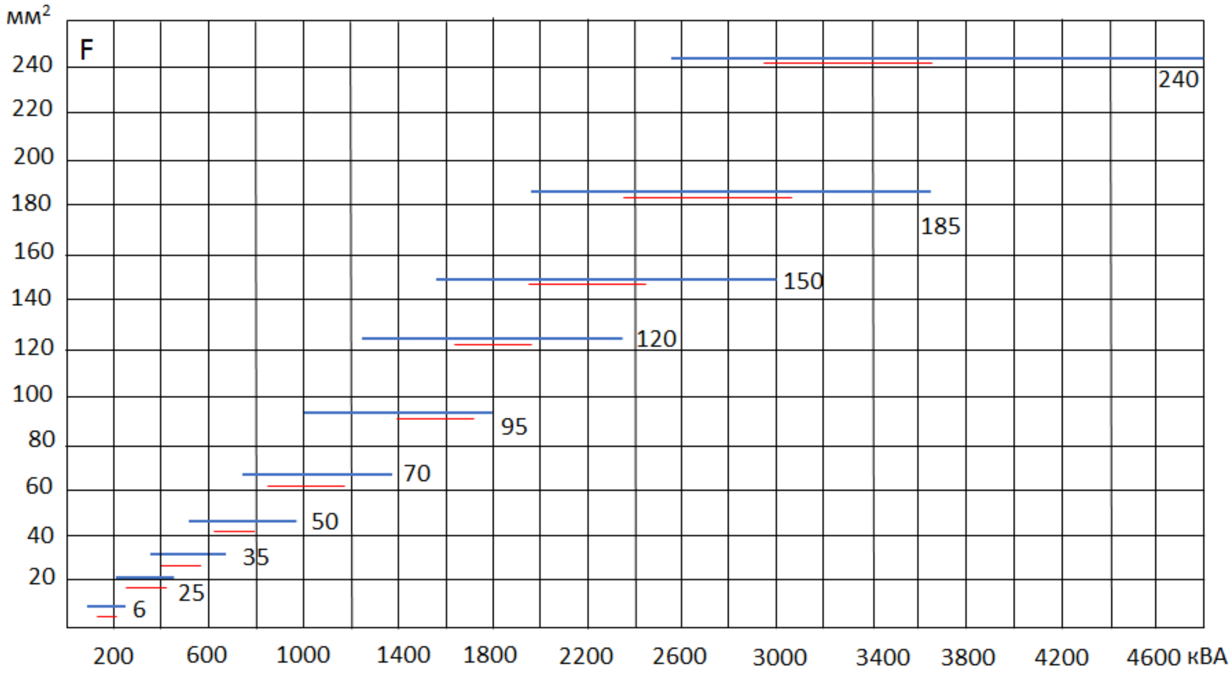

Fig. 1. Change in economic load intervals at.

Table 1

The magnitude of the relative changes in costs when deviating from the economic section

Section mm²	Relative change in costs with K_0/k							
	97,22	118,90	92,73	115,92	124,02	120,91	112,27	116,62
16	0,0073	0,0063	0,0075	0,0064	0,0061	0,0062	0,0066	0,0064
25	0,0054	0,0047	0,0055	0,0048	0,0046	0,0047	0,0049	0,0048
35	0,0074	0,0066	0,0076	0,0067	0,0064	0,0065	0,0068	0,0067
50	0,0078	0,0071	0,0080	0,0072	0,0069	0,0070	0,0073	0,0071
70	0,0073	0,0068	0,0074	0,0068	0,0066	0,0067	0,0069	0,0068
95	0,0047	0,0044	0,0048	0,0044	0,0043	0,0044	0,0045	0,0044
120	0,0046	0,0043	0,0046	0,0044	0,0043	0,0043	0,0044	0,0043
150	0,0043	0,0041	0,0043	0,0041	0,0040	0,0040	0,0041	0,0041
185	0,0069	0,0066	0,0070	0,0067	0,0066	0,0066	0,0067	0,0066

At present, it is recommended to build a standard series of standard sizes with a constant step according to the principle of arithmetic or geometric progression [6]. The existing number of cross-sections roughly obeys the principle of geometric progression. Then you can write.

$$\frac{F_{i+1}}{F_i} = q \qquad (4)$$

Or the scale step value is determined

$$\frac{F_{i+1}}{F_i} = q \qquad (5)$$

From the obtained expression (5) it can be seen that the size of the scale step is determined only by the value of the relative change in costs when deviating from the economic section and the ratio of the constant component of the cost of the line, which does not depend on the section, to the coefficient of rise in the cost of the line, and

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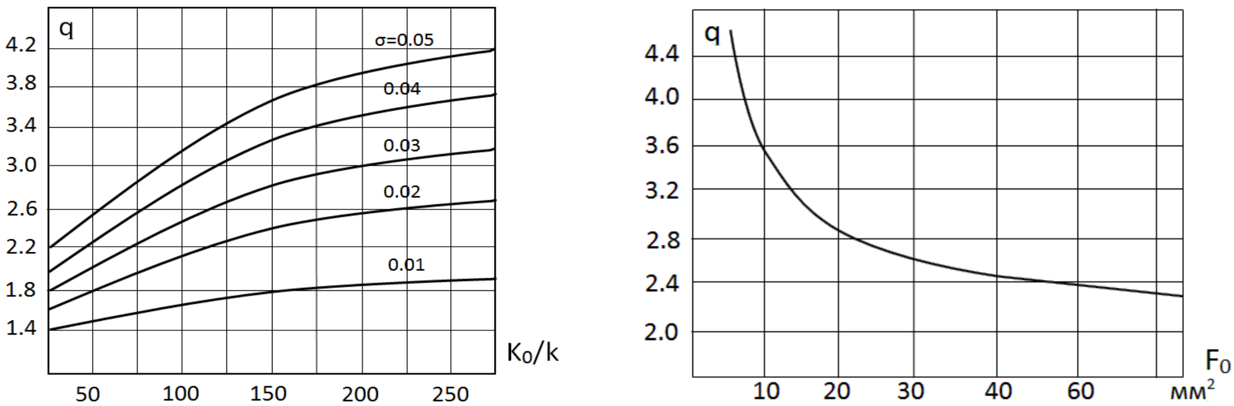
also on the initial section of the scale. The dependence of the increment of the scale F_0 on the change $\frac{K_0}{k}$ in the initial section of the scale and the ratio is shown graphically in Fig. 2. The curves in fig. 2a. plotted at $F_0 = 16$ mm², and in Fig. 2b - for $\delta = 0{,}05$ and $\frac{K_0}{k} = 112{,}27$.

In this case, the step size of the cable cross-section scale is 3.48; 2.97 and 2.63, respectively, for initial sections of 10.16 and 25 mm². In this case, instead of 8 standard sections, it is possible to use only three sections. In this case, after rounding off the scale of sections, they take the form: 10, 35, 120 mm²; 16, 50, 150 mm²; 25, 70, 150 mm² [22-25].

The calculation of the reduction of energy losses in cable lines due to the use of a limited number of standard cable cross-sections is carried out. The calculations were carried out for the regions of the SES of the Tashkent region. In this case, reducing the number of cable cross-sections used in electrical networks can significantly reduce power losses. At the same time, the reduction in specific electricity losses is 15 kWh per 1 kW of load on the buses of 10 / 0.38 kV transformer substations, which for one region is 427,500 kWh per year of electricity [26-27].



a) b)

Fig. 2. Dependence of the scale step on the change, $\frac{K_0}{k}$, $\boldsymbol{F_0}$, **and** $\boldsymbol{\delta}$

Thus, the existing scale of nominal cable cross-sections does not satisfy the conditions for optimal use of cable lines in rural areas and contains an overestimated number of cross-sections. Based on the analysis, the final cross-section of the cables was determined and the optimal value of the initial cross-section of the scale was established. In this case, the optimal number of cross-sections in the scale of nominal cross-sections of cables for agricultural cable lines is: 25; 50 ; 120 mm².

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