

EKONOMICZNE NAUKI

Matematyczne metody w gospodarce

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Research and development of methods to reduce energy consumption Closed Joint Stock Company "Erlan"

The work developed economic model selecting optimal heating of industrial facilities to reduce energy consumption.

To construct a mathematical model of optimization criteria have been established, the analysis of the most important characteristics of the components of the heating system, normalized variables of the object, the analysis of the criteria for the final model limitations.

Mathematical model

$$F_1 = \sum_{i=1}^n m_i C P_i M_i \rightarrow \max \quad (1)$$

$$F_2 = \sum_{i=1}^n (m_i C_i + a M_i C_e C P_i m_i) \rightarrow \min \quad (2)$$

$$\left\{ \begin{array}{l} m_i \geq 0, \quad i = \overline{1,8} \\ m_i \text{ - digital} \\ \sum_{i=1}^n m_i s_i = S \end{array} \right. \quad a = \frac{t' M_i}{t_{\max} M_i} \quad (3)$$

m_i , - each type of equipment through $i = [1;8]$; n – the number of types of equipment, $n = 8$, C_i – unit price of equipment i -th type, M_i –power equipment i -th

type, CP_i – coefficient of performance i -th type of equipment, C_e – electricity tariff, UAH. / Wt, a – utilization of power equipment

Application of criteria in the construction of a linear function

$$F = \frac{(F_2 - F_2^{opt})F_1^{opt} - F_2^{opt}(F_1 - F_1^{opt})}{F_1^{opt} F_2^{opt}} \rightarrow \max \quad (4)$$

$$\left\{ \begin{array}{l} \sum_{i=1}^n m_i s_i = S; m_i \geq 0, \quad i = \overline{1, 8}; \\ m_i - \text{digital}; \\ m_2 \leq 2; m_3 \leq 165; m_5 \leq 86; m_8 \leq 1. \end{array} \right. \quad (5)$$

F_i – i -th criterion problem; F_i^{opt} - the optimum criterion; F_i^n - normalized value criterion.

An analysis of the calculations this method optimal set of heaters is 86 pieces. heat fans TCC TV 01-30 and 2 pcs. industrial infrared heaters Frico IR45 total cost of 70200 USD.

Application of the guaranteed result $F_1^n = 0.001$, $F_2^n = -0.78$.

The results of calculations of the system by this method coincide with those obtained at maximizing the second criterion. That is, the heating system is composed of 166 pieces of equipment.

Application of normalized convolution of partial criteria

$$F(m_i) = \frac{\mu_1 F_2(m_i)}{\mu_2 F_1(m_i) + 1} \rightarrow \max \quad (6)$$

The results of calculation and the amount of equipment-type coincide with the results obtained using the method of guaranteed results:

In the calculations for different options coefficient significance criteria were also obtained similar results heating industrial premises.

Application of converting one of the criteria to limit

$$\left\{ \begin{array}{l} \sum_{i=1}^n m_i s_i = S; m_i \geq 0, i = \overline{1,8} \\ m_i - \text{digital} \\ m_2 \leq 2; m_3 \leq 165; m_5 \leq 86; m_8 \leq 1 \\ CP_i * m_i * M_i \leq 434783 \end{array} \right. \quad (7)$$

Calculations heating different values of the coefficient of power equipment

Method	$a = 0,63$			$a = 0,7$			$a = 0,78$		
	The cost of electricity for		Saving	The cost of electricity		Saving	The cost of electricity for		Saving
	W	UAH	%	W	UAH	%	W	UAH	%
Optimization F1	192240000	42292,8	38,59%	192240000	42292,8	38,59%	185040000	40708,8	40,89%
Optimization F2	716399999,8	157608	-128,85%	716400000	157608	-128,85%	716400000	157608	-128,85%
The construction of linear features	192240000,1	42292,8	38,59%	192240000	42292,8	38,59%	185040000	40708,8	40,89%
The method is normalized convolution	716399999,8	157608	-128,85%	716400000	157608	-128,85%	716400000	157608	-128,85%
Converting 2nd criterion limits	192240000	42292,8	38,59%	185040000	40708,8	40,89%	185040000	40708,8	40,89%

Determination of Pareto-optimal solutions

$$m_2 \in [0; 2], m_5 \in [83; 86], m_6 \in [0; 4], m_8 \in [0; 1]. \text{ Иными } m_i = 0.$$

Given the condition of the equipment in the system must be of the same type, the number of heaters define a model. Because of the solution $x_5 = 83, x_6 = 4$, it is acceptable for the company to purchase and install 88 units. Thermal models of industrial fans TCC TV 01-30.

Calculating economic impact the introduction of new heating industrial premises

Indicator heating facilities old heating facilities

Electricity consumption per month, W 264 000 434 783

The cost of electricity consumed, rub. / Month. 41 817.6 68 869.62

The cost of the new equipment is 70 400 UAH. taking into account savings from reduced power consumption of the equipment payback period is 3 months, ie one heating season.

Thus, the technique of saving in the next season will increase revenue by 27 thousand UAH.