Optimization of the operating mode of units with large Start-up power consumption

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Abstract

Optimization of operation modes of industrial enterprises' units is the way of rational use of electric power in this branch. It is known that high energy consumption in starting modes of these units leads to irrational use of types of energy. In the given article methods and methods of optimization of modes of these units are resulted. The mathematical apparatus is offered, defining the most optimal modes of equipment of units with big expenses of energy at starting modes. On the basis of parabolic and hyperbolic characteristics it is possible to present offered optimum modes.

***Keywords**: modes, units, optimization, energy-intensive, specific energy consumption.*

1. Introduction

In the finishing industry, the most energy-intensive are drying plants. When starting tentering machines, calendars and restorative miners, considerable time is required to bring the temperature in the core of the machines to the calculated value. At the same time, in these starting conditions, a significant amount of electric and thermal energy is consumed. In order to reduce these costs, it is proposed to determine the critical downtime $T_{кр}$, which allows you to choose the most advantageous mode during breaks in the operation of the units (in idle mode or when the machine is completely turned off) [1-4].

The most rational mode is selected by plotting the curves overexpenditure of electric W and thermal energy Q .

The study found that tentering and stabilization machines, for example of the Kyoto company, at breaks of less than 4,75 hours, it is advisable to leave in hot downtime, and turn off at large breaks.

The indicated method determines the optimal heat consumption regimes in calendars and regenerative miners. The annual savings from the implementation of the proposed rational regimes at the silk mill amounted to 210 thousand kWh of electric and 1300 Gcal of thermal energy per year [2-9].

2. Methods

Reducing the cost of raw materials, materials and semi-finished products for the production of finished products is an important direction in the work on the rational use of energy resources. At present, these costs in the electric power resources, as a rule, are not taken into account, although they are decisive in the power consumption at all the numerous technological stages of each production.

The level of energy consumption depends on the quality of raw materials and materials, on the technical perfection of technological equipment and process. To obtain 1 ton of finished goods, sometimes it is necessary to process tens of tons of raw materials, and where production organization is not perfect, there

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may be excessive losses and, accordingly, energy overruns. Given all this, it is possible to improve the work on standardization of electricity.

The essence of the proposed method is that the unit costs of raw materials are included directly in the calculation formulas for the specific power consumption of each production unit as a whole. In this case, the reserves of energy savings are identified as a result of optimization of a set of indicators of raw materials, materials and energy [10-12].

Consider the general case when the workshop of a particular enterprise, as a result of processing raw materials and semi-finished products, produces products that go in a certain technological sequence to manufacture products that are final for a given production Z.

To assess the impact of material consumption of the final product, i.e. specific consumption of raw materials and semi-finished products per unit of final product q, we find the value of this indicator to reduce the consumption of materials:

$$q_1 = \frac{\Pi}{Z} \tag{1}$$

and after:

$$q_2 = \frac{\Pi - \Delta\Pi}{Z} \tag{2}$$

accordingly, specific material savings will be:

$$\Delta q = q_1 - q_2 \tag{3}$$

and the change in the EEC per unit of workshop production according d to the normative characteristic $d = f(\Pi)$ (Fig.1) will be:

$$d \pm \Delta d \tag{4}$$

Where $\pm\Delta d$ is the deviation of the specific consumption. Here the "+" sign occurs with a falling normative characteristic in the working area of productivity (hyperbolic curve), and "-" - with an increasing dependence (parabolic curve) (Fig. 1).

If the share of this workshop in the specific energy consumption for the final products of the enterprise likewise is:

$$\alpha = dq \tag{5}$$

then a decrease in this fraction with a decrease in material consumption will be equal to:

$$\Delta\alpha = dq - (d \pm \Delta d)(q - \Delta q) \tag{6}$$

and the amount of energy savings:

$$\Delta W = \Delta\alpha Z \tag{7}$$

Typical regulatory characteristics of production facilities
or

$$\Delta W = [dq - (d \pm \Delta d)(q - \Delta q)] \cdot Z \tag{8}$$

If according to the normative characteristic the increment has a positive sign $(+\Delta d)$, then the amount of savings will be:

$$\Delta W = [\Delta q(d + \Delta d) - \Delta dq] \cdot Z \tag{9}$$

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With a negative sign:

$$\Delta W\left[\Delta q\left(d-\Delta d\right)+\Delta dq\right]\cdot Z \qquad (10)$$

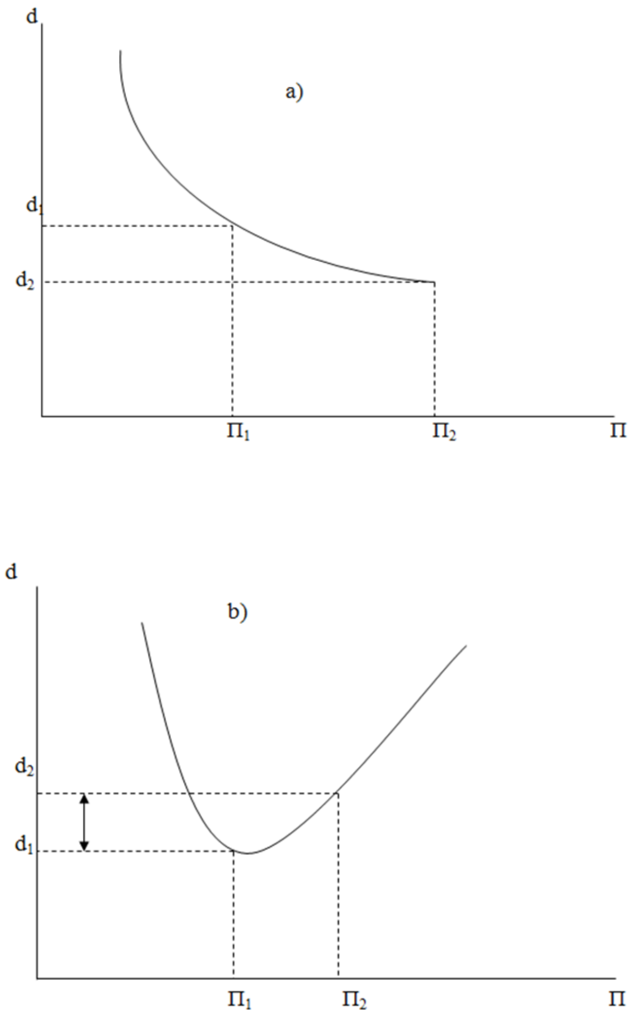

FIGURE 1: a) parabolic characteristic; b) hyperbolic characteristic

3. Results and Discussion

Thus, the first part of equations (9) and (10) represents the energy savings due to the reduction in material consumption, increased or decreased depending on the shape of the curve of the normative characteristic, the second part of these equations is a partial saving or over-expenditure of electricity due to a change in the volume of produced raw materials or semi-finished products [13-16].

Equations (9), (10) correspond to the most common cases when the electric intensity of the finished product decreases, and its output remains unchanged with a decrease in the production of raw materials or semi-finished products and a decrease in energy consumption, i.e. at:

$$q_2 < q_1; \quad Z = const; \quad \Pi - \text{var}; \quad W - \text{var} \qquad (11)$$

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The same equations may be true for such productions.such as weaving, where the power consumption remains constant at change in the volume of semi-finished products:

$$q_2 < q_1; \quad Z - \text{var}; \quad \Pi - \text{var}; \quad W = const \tag{12}$$

Completely different values are obtained when the release of finished products can be increased with a constant volume of manufactured semi-finished products and energy consumption, i.e.:

$$q_2 < q_1; \quad Z - \text{var}; \quad \Pi = const; \quad W = const \tag{13}$$

From formulas (9) and (7.16), $\Delta d = 0$ we obtain:

$$\Delta W = \Delta q d Z, \tag{14}$$

Here, energy savings are directly proportional to the reduced material consumption.

With a constant volume of finished products, a decrease in the number of manufactured semi-finished products, constancy and energy consumption, i.e. provided:

$$q_2 < q_1; \quad Z = const; \quad \Pi = \text{var}; \quad W = const \tag{15}$$

will have:

$$d_1 q_1 = d_2 q_2 \tag{16}$$

as energy consumption does not change with change, or

$$d_1 q = (d_1 \pm \Delta d)(q_1 - \Delta q) \tag{17}$$

Substituting this expression into equation (8), we obtain:

$$\Delta W = 0 \tag{18}$$

Thus, if the reduction in material consumption does not reduce the energy consumption and does not change the volume of the final product, then this measure will not lead to energy savings [17].
Energy savings for the enterprise as a whole will be:

$$W_э = Z \sum_{i=1}^{n} d_i - (d_i + \Delta d_i)(q_i - \Delta q_i) \tag{19}$$

or

$$W_i = \sum_{i=1}^{n} \Delta W_i = Z \sum_{i=1}^{n} \Delta \alpha_i \tag{20}$$

In the first case, with a decrease in the supply of raw materials and semi-finished products by $\Delta \Pi$. with a constant volume of finished goods output Z , the national economy of electricity is determined as follows [18-21].

We find the URE per unit of raw materials or semi-finished products coming into production:

$$d_a = \frac{eZ}{\Pi} = e\frac{1}{q} \tag{21}$$

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Where e is the energy intensity of raw materials and semi-finished products coming into production.

Full economic savings from electricity reduction Π $\Delta\Pi$ the magnitude is:

$$W_э = e\frac{\Delta\Pi}{q} + \sum_1^n \Delta W \quad (22)$$

or

$$W_э = d_a\Delta\Pi + \sum_1^n \Delta W_i \quad (23)$$

In the second case, with an increase in the output of the final product by an amount, the total energy savings will be the same:

$$W_э = e\Delta Z \quad (24)$$

When a company receives several types of raw materials and semi-finished products, energy savings are equal. If with a decrease in supply (SP) by the value of the volume of finished products remains unchanged, then:

$$W'_э = \sum_1^m e_i \frac{\Delta\Pi_i}{q_i} + \sum_1^n \Delta W'_i \text{ , (25)}$$

or

$$W'_э = \sum_1^m e_i \frac{\Delta\Pi_i}{q_i} + \sum_1^n \Delta W'_i \text{ , (26)}$$

The value for this case is determined in accordance with the formula:

$$\Delta W' = \Delta\alpha'_i \cdot Z \text{ , (27)}$$

Where $\Delta\alpha' = d_1 f - (d_1 \pm \Delta d)\left[(q_{A_1} - \Delta q_A) + (q_{Б_1} - \Delta q_Б) + (q_{m_1} - \Delta q_m) \right]$

or

$$\Delta\alpha' = d_1 f(d_1 \pm \Delta\alpha)\sum_1^m (q_{i_1} - \Delta q_i) \text{ , (28)}$$

Where:

$$f = q_A + q_Б + \ldots + q_m \text{ , (29)}$$

If the output of finished products increases by an amount with a constant joint venture, then:

$$W'_э = \Delta Z \sum_1^m e_i \text{ , (30)}$$

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4.Conclusion

The total energy savings in an industrial enterprise from the reduction of material consumption, taking into account the energy costs of producing raw materials and semi-finished products manufactured at other enterprises, can be determined by our method, which takes into account the presence of the following most typical situations:

a) a decrease in the volume of deliveries to the enterprise of raw materials and semi-finished (a) products with a constant amount of finished products produced by the enterprise;

b) an increase in finished goods output with a constant volume of supplies of raw materials and semi-finished products due to a decrease in their specific consumption.

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