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A SYSTEMATIC APPROACH TO SOLVING THE OPTIMIZATION PROBLEMS OF MANAGEMENT OF TECHNOLOGICAL LINES

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The task of creating a technological line is generally reduced [1] to three stages: 1) development of the design of individual devices of the technological line; 2) selection of the inventory of line devices from the available range (most often by performance) and 3) connecting them into a single structure; operational management of the technological line.

Unfortunately, the above are often considered as separate tasks, which does not allow optimization of the technology creation process according to a global criterion [2].

Therefore, let's consider a simplified two-stage structure (Fig. 1), typical for a number of industries [3]: chemical, mining, food, etc.

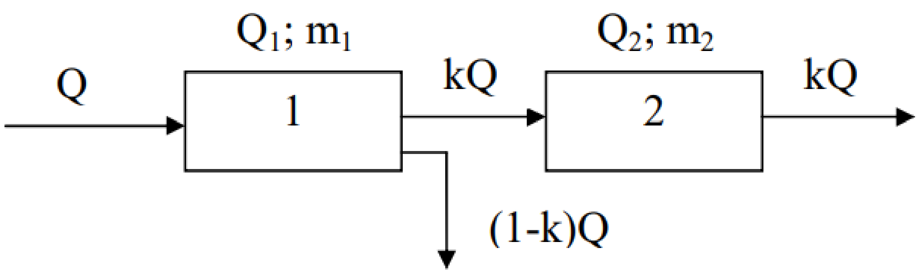

Figure 1 – Simplified two-stage structure of the technological line

At the entrance of the line comes a flow of material Q(t/h.), which requires certain processing according to a two-stage scheme. At the first stage (unit 1), in addition to the transformation of the quality characteristics of the flow, it is divided into two parts – kQ and $(1-k)Q$ according to a certain sign. The value of the separation coefficient $(0 < k < 1)$ depends on the indicators of the initial material flow.

Devices of the first and second stages are characterized by the maximum bandwidth Q_1 та Q_2 [t/h.] (usually this is a performance that does not cause unacceptable loss of quality), as well as operating costsи R_1 and R_2 [UAH/h.]. The higher the productivity of the device, the higher the operating costs. In a simplified way, we will assume a linear relationship between the parameters, i.e.:

$$R_1 = Q_1 m_1; R_2 = Q_2 m_2.$$

The coefficients of proportionality m_1 and m_2 [UAH/h.] have the meaning of specific operating costs at maximum productivity. The size of these coefficients determines the efficiency of the design of the corresponding devices.

In the simplified formulation of the problem, let the efficiency criterion be the total specific operating costs under the following limitations on the productivity of the devices of the first and second stages:

$$J = \frac{R_1}{Q} + \frac{R_2}{(kQ)} = \frac{Q_1 m_1}{Q} + \frac{Q_2 m_2}{(kQ)} \to min;$$
$$Q \le Q_1; \qquad (1)$$
$$kQ \le Q_2.$$

Despite its simple structure, problem (1) indicates the connection between the three stages of creating a technological line: the development of the design of the devices, the design of the line and its operational management. Optimising the design of devices consists in minimising m_1 and m_2; optimisation during design - in choosing the ratio between $Q_1$and Q_2 (or in choosing Q_2 when Q_1 is specified); optimization of operational management consists in determining Q.

The optimal ratio between Q_1 and Q_2 is determined at the line design stage and depends on the properties of the raw material - partition coefficient k, which is generally a random variable with a certain distribution law.

Conclusion. When creating two-stage processing technologies, a complex system approach is necessary [4]: the tasks of optimal operational management should be considered together with the tasks of designing a technological scheme and choosing equipment. At the same time, in accordance with the proposed methodology, it is necessary to take into account information about the specific operating costs for each stage of processing and qualitative indicators of the flow of processed raw materials.

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