ASSESSMENT OF THE RELIABILITY OF TECHNOLOGICAL MACHINES AND JUSTIFICATION OF THE REQUIREMENTS FOR THEM

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ANNOTATION

This article discusses the practical optimization problems associated with ensuring the trouble-free operation of technological machines operating on the lines during formation and operation, taking into account various ways to ensure their reliability.

The method for solving the problem is determined from the conditions of the need to take into account a large number of different factors: the operating conditions of the machines, the years of operation, the quality of the machines, the state of the repair and maintenance base, the organization of the preparation of equipment for technological work and the elimination of failures and other all mutually exclusive ways of occurrence of failures.

The results obtained indicate that in order to ensure the required pace of technological processes, it is necessary to substantiate the optimal interconnection of subsystems taking into account the main factors affecting the functioning of technological machines.

Key words: technological machines, probability of failure-free operation, exploitation, failure, restoration, complex system, system approach, information, machine downtime, efficiency, availability factor, optimal relationship.

Reliable operation of technological machines on the lines is one of the basic requirements for the implementation of the technological process.

Practical tasks associated with ensuring the failure-free operation of the system during the formation and operation is the technical solution of optimization problems, taking into account various ways to ensure their reliability.

The method for solving the problem is determined from the conditions of the need to take into account a large number of different factors: the operating conditions of the machines, the level of operation, the quality of the machines, the state of the repair and maintenance base, the organization of the preparation of equipment for technological work and the elimination of failures, and others. All these require consideration of issues from the standpoint of a systems approach. When analyzing complex systems, the modeling method is used [3]. The accuracy of the obtained decision results depends on the adequacy of the models and the accuracy of the initial information.

Reliability will be considered as a complex property that includes reliability, durability, maintainability and preservation, that is, a combination of these properties [2].

In most cases, machine elements after a failure are restored or replaced with new or backup ones, which allows them to restore their operability without a long loss of time. Recovery and preventive maintenance of machines does not exclude the possibility of failures, but significantly reduces their likelihood, that is, increases their reliability. [4].

When determining the reliability of technological machines in a system with recovery, we will consider it as a complex system consisting of many elements.

In the general case, the functioning of machines in the system can be represented in the form of two alternating time intervals $t_{i.j}$ and downtime $\tau_{i.j}$.

The functioning of a complex containing N technological machines and Nt vehicles will represent a set of states that change and alternate in time. In this case, the following options are possible: when all the machines are working in the system, the performance is maximum possible; the system operates with reduced efficiency or is completely inoperative.

We will determine the efficiency of the system by assessing the impact of failures of various technological machines on the degree of realizations of their productivity. The total number of failures of machines (their units) on the time interval [0, t] is

$$n(t)=\sum_{i=1}^{n} n_i(t)$$

where ni (t) -is the number of failures of the i-th element during time t

The total operating time of the machines will be:

$$t=T_p(t)+T_b(t) \qquad (1)$$

We represent the number of machines in the system as the sum of technically serviceable and remanufactured machines:

$$N=N_p(t)+N_b(t) \qquad (2)$$

If the system operates in a stationary mode, and the distribution of the periods of no-failure operation and recovery is described by an exponential function, we can assume that the values of the indicators of the probability of no-failure operation and the availability factor are equal [4]:

$$K_r=\left(1+\frac{T_b(t)}{T_p(t)}\right)^{-1}; \qquad K_r=\left(1+\frac{N_{bi}}{N_{pi}}\right)^{-1} \qquad (3)$$

The total downtime of machines TV i (t) due to the i-th unit in the time interval [0, t] is determined from the expression

$$T_b=\lim_{n\to\infty}\frac{T_{bi}(t)}{t}=K_r\sum_{i=1}^{N}\frac{\tau_{bi}}{t_i} \qquad (4)$$

The average number of failures per machine for each type of element will be

$$\lambda_i=\lim_{n\to\infty}\frac{n(t)}{t}=\frac{K_r}{t_{pi}} \qquad (5)$$

The average uptime of machines is

$$\bar{t}_p=\left[\sum_{i=1}^{N}\frac{1}{t_{pi}}\right]^{-1} \qquad (6)$$

Average machine downtime will be

$$\bar{\tau}_b=\bar{t}_p\sum_{i=1}^{N}\frac{\tau_{bi}}{t_{pi}} \qquad (7)$$

To determine the failure-free operation of technological machines, it is necessary to take into account all mutually exclusive ways of occurrence of failures.

The influence of the failure recovery time and the year of operation of technological machines, productivity and downtime ratio are presented in the graphs in Figure 1.

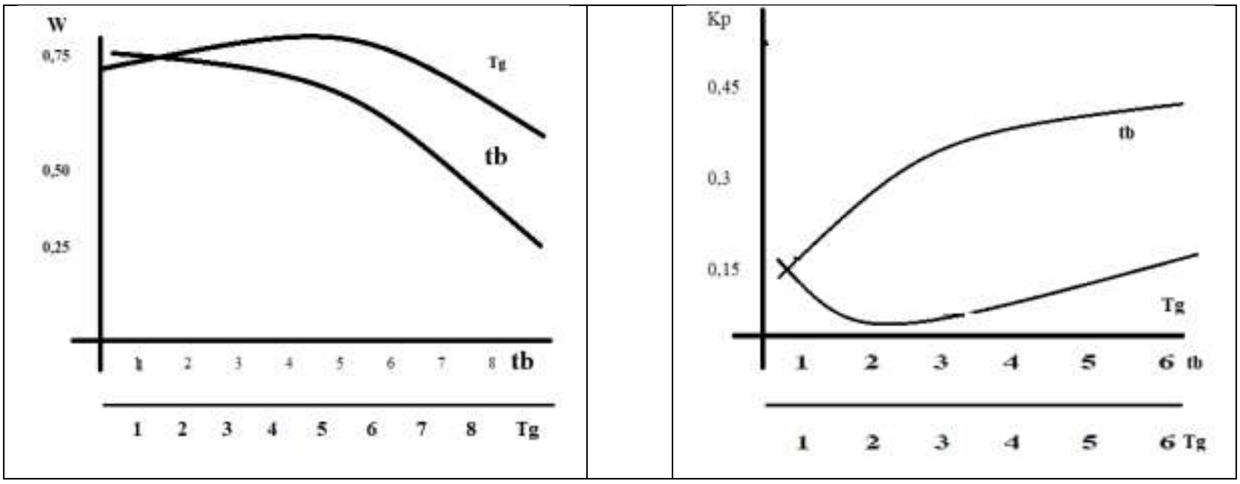

Figure 1. Influence of failure recovery time and year of operation of technological machines productivity and downtime ratio

It can be seen from the graphs that performance decreases with increasing recovery time, for example, 2 hours of downtime for recovery leads to a decrease in performance by 26%. Also, the nature of the change in productivity is influenced by the service life of the machines. At the same time, productivity does not change much for 2-4 years of machine operation 0.75-0.70, then it significantly decreases due to an increase in the downtime ratio for technical reasons.

The data obtained indicates that to ensure the required pace of the technological process, it is necessary to substantiate the optimal interconnection of subsystems, taking into account the main factors affecting the functioning of the whole system.

It should be noted that recovery without redundancy increases reliability only in the sense of availability, while the probability of failure-free operation does not change.

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