

## **MATERIAL SELECTION PROBLEMS AND SOLUTIONS IN TECHNOLOGICAL MACHINES**

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**Abstract:** This scientific article scientifically analyzes the main problems encountered in the process of selecting materials for technological machines and their modern solutions. Selection criteria are considered based on the physical and mechanical properties of materials, economic efficiency, compliance with environmental requirements, corrosion and heat resistance. Alternative solutions are developed based on composite materials, artificial intelligence selection, surface reinforcement and recycled materials.

**Keywords:** material selection, technological machine, composite, surface reinforcement, AI algorithms, recycling, environmental compatibility, mechanical

The quality, reliability and service life of technological machines directly depend on the materials selected for their manufacture. Since any machine or mechanism has its own specific load, environment, temperature, operating conditions and service life, the selection of a suitable and optimal material for it is of great importance. However, in practice, this selection is fraught with many problems. This essay systematically analyzes the main problems in selecting materials for technological machines, the factors that cause them, and modern alternative solutions.

Parts used in technological machines must be resistant to various stresses, friction, thermal effects and chemical environments. Therefore, the material selection process is carried out on the basis of engineering calculations, laboratory tests, experimental bases and economic factors. However, the main problems encountered in this process are:

1. Insufficient determination of the physical and mechanical properties of materials. There are no complete technological specifications for many new or little-studied materials. This creates a risk in their use.
2. Issues of resistance to corrosion, heat and wear. The operating environment of machine parts is an important factor for their durability. An incorrectly selected material will lead to failure in a short time.
3. The imbalance between price and economic efficiency. Materials with high technical properties are often very expensive. This limits their use in all production sectors.
4. The level of availability of local resources. Sometimes the necessary materials are not available in the country or there are problems with their delivery.

5. Negative impact on the environment. Some materials harm nature during production or after use. This leads to environmental problems.

The system of solutions to these problems consists of the following:

- The use of composite materials. They consist of a combination of two or more material components and can have the desired properties. For example, carbon fiber plastic or metal matrix composites.
- Technologies for strengthening the surface of materials (hardening, nitrocarburization, plasma spraying). This allows you to give a cheap material a surface with high properties.
- The use of recycled materials. This method ensures environmental sustainability and in some cases is more economically profitable.
- Scientific research on material alternatives. New opportunities open up through the development and testing of alternative materials.
- Material selection based on artificial intelligence. AI algorithms integrated into CAD/CAM systems can automatically recommend optimal materials for the environment.

The most commonly used materials in the production of technological machines are steel, aluminum, copper alloys, polymers and ceramics. Each has its own advantages and disadvantages. Therefore, in a specific case, which of them is most effective is determined depending on the production conditions and purpose.

For example, for high-speed shafts or bearings, strong, wear-resistant and smooth-surfaced steels are selected. In high-temperature environments, heat-resistant nickel alloys or ceramic-based materials are used.

Also, the share of recyclable materials in global production is increasing. This, along with reducing environmental pressure, serves as an alternative solution in material selection. Digital technologies, in particular, allow for modeling based on simulation and creating virtual forms of material testing.

Material selection for technological machines is a complex process that includes not only mechanical properties, but also economic, environmental and operational criteria. Its success directly affects the service life, reliability and technical efficiency of the manufactured product. Modern solutions - composite materials, AI algorithms, environmental approaches and virtual testing - can overcome these problems. A strategic approach to material selection is essential to create competitive technological machines.

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