ADVANCED TECHNOLOGIES

IN MECHANICAL ENGINEERING

Textbook

Yuliia Levchenko, Nataliia Priliepo,
Stanislav Popov, Oleksandr Petrash

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Faculty of Engineering and Technology

Department of Mechanical and Electrical Engineering

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The textbook outlines the main provisions related to the introduction of advanced technologies in the mechanical engineering. The concepts of the production process and the quality of equipment are defined. The method of designing technological processes is presented. The technological features of the production of blanks and parts by casting and plastic deformation are noted.

For students majoring in Mechanical Engineering, Automobile transport, Agricultural Engineering, Vocational Education at higher education institutions, as well as professionals in manufacturing engineering for advanced training.

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INTRODUCTION

The implementation of technological processes based on the processing of materials by pressure and manufacturing by casting compared to other types of metalworking is steadily expanding. This is explained by the reduction of metal losses, the possibility of ensuring a high level of mechanization and automation of technological processes.

When materials are processed using pressure, it is possible to obtain products with a constant or periodically changing cross-section, as well as pieces of various shapes. These products can be similar in shape and size to finished parts, or they can have slight differences. Piece products are usually processed by cutting. The amount of metal removed during the process depends on how closely the shape and dimensions of the forging match those of the finished part. Sometimes, pressure processing produces products that do not require cutting, such as bolts, screws, and most sheet metal forging products.

Modern mechanical engineering is impossible without the use of cast blanks, which ensure the rational use of metal, as well as the effective reduction of the mass of products due to the rational design of the part, the use of cast alloys with higher technological, physic-mechanical and service properties. Casting is one of the most common molding methods. Compared to other methods of obtaining blanks in this way, it has a number of advantages: production with the largest values of characteristic coefficients; final castings can be of practically unlimited dimensions and weight; obtaining blanks from alloys that are not subject to plastic deformation and are difficult to process by cutting. The modern level of foundry production allows the production of many important machine parts and special purpose parts by casting.

The textbook consists of 6 chapters. In the first chapter, the concept of the technological process, as well as its components, is considered. The types of machine-building production, and their influence on the construction of the technological process are defined. The second section is dedicated to ensuring the quality of equipment. In particular, considerable attention is paid to the concept of surface roughness. The third section presents the methodology for designing technological processes of creating blanks and their further processing. The fourth chapter covers the issue of obtaining blanks by the casing method. The fifth and sixth chapters are devoted to the peculiarities of the formation of structural materials by methods of hot and cold deformation.

1 PRODUCTION PROCESS

1.1 The concept of technological process and its components

When setting up a product for serial production, it is necessary to perform an appropriate set of works of a design, technological and organizational nature. This stage is called production preparation. It starts from the moment of decision on serial production [1-6].

In order for the product manufacturing process to take place, it is necessary to organize the production process.

Production process – it is the totality of all processes carried out in order to transform materials and semi-finished products into a finished product.

The production process is carried out at the factory, which, regardless of the scale of the production of equipment, includes three groups of subdivisions:

- main production (procurement-processing and assembly-testing), the task of which is the manufacturing of products (units);
- auxiliary production (production of technological equipment), necessary for the operation of the main production;
- service production, necessary for the operation of the main and auxiliary production.

Technological process – it is part of the production process in which changes occur in the subject of production, or, in other words, the technological process is a set of physical and chemical processes and processes aimed at transforming materials and semi-finished products into a product.

When solving issues of designing technological processes of manufacturing products, it is necessary to take into account that the technology can be considered in three aspects:

1. Technology as science. This aspect involves a scientific and research approach when choosing the optimal variant of the technological process. The main attention is paid to two conflicting main factors - the complexity of manufacturing and the accuracy of the product.

2. Technology as a part of the production process. This aspect considers the optimal interaction of the selected variant of the technological process with specific production conditions, which also provide two main factors - labor intensity and precision (a higher level of precision at minimum costs).

3 Technology as a document. Any designed working variant of the technological process must be issued in the form of a document – a set of

documents of the technological process of manufacturing the product.

The procurement and processing technological process is a set of technological operations for shaping the part and giving it specified physical and mechanical properties.

Technological operation – this is the finished part of the technological process, which is performed at this workplace. Or, in other words, a technological operation is a finished part of a technological process that is performed continuously on one part or a group of them and is carried out at one or more workplaces of the same name by one or more workers.

A technological operation is the main unit of production planning and accounting, regulated by special documents - an operational map and a map of sketches. In the operation, the labor intensity of processing parts, the necessary equipment, devices, and tools are determined. The operation includes settings and positions.

Setting – is a part of the technological operation, which is performed with an unchanged position of the part relative to the processing tool, which is provided by a clamp.

Position – part of the technological operation, which is performed with an unchanged position of the processed surface relative to the processing tool, which is provided by a special device (positioner) during one fixation of the part.

Technological operations consist of technological and auxiliary transitions.

Technological transition is the finished part of the technological operation, in the process of which the processed surface, cutting tool, processing modes remain constant. For example, for a two-stage hollow shaft, the following transitions exist: machining three end surfaces, two outer cylindrical surfaces, and one inner surface. Each of these surfaces is characterized by its own geometric parameters, its own tool and its own cutting modes will be used for their processing.

Auxiliary transition – the finished part of a technological operation, which consists of human or equipment actions and is not accompanied by a change in shape, size, or roughness, but is necessary for the implementation of a technological transition (installation of the blank, feeding of the tool, etc.).

Transitions can be simple – each surface is processed sequentially, and complex – several surfaces are processed simultaneously.

A technological transition can consist of operational steps.

An operational move – the finished part of the technological transition,

which consists of a single movement of the processing tool relative to the blank, accompanied by a change in the shape, dimensions, surface roughness or properties of the blank. When cutting, the working stroke is a part of the transition when removing one layer of material.

An operational step is followed *auxiliary move* – returning the tool to its original position.

1.2 Types of mechanical engineering production

Analysis of existing and design of new technological processes should be carried out taking into account the type of production organization in which they are carried out. There are three main types of machine-building production: mass, serial and unit. Sometimes serial production is divided into large-, medium- and small-series [3].

The main factors that determine the type of organization of production in the shop, on the site, are the nomenclature of products, the production program and the labor intensity of the production of parts.

For an unambiguous assessment of the type of production, there is a standard technique, according to which the type of production is characterized by the coefficient of fixation of the operation:

$$K_{fo} = O / P, \qquad (1.1)$$

where O – the number of different operations in one month; P – the number of workplaces where various operations are performed.

When $K_{fo} = 1$ – it's mass production; $2 < K_{fo} < 10$ – large series production; $10 < K_{fo} < 20$ – medium series production; $20 < K_{fo} < 40$ – small series production; $K_{fo} > 40$ – unit production.

Characteristic features of the main production types are presented in Table 1.1.

In addition to those noted in the table, an important characteristic of the production type is parts' circulation at workplaces.

In mass production, blanks are moved from one place to another during processing, in a flow, without delay. Machine tools and other workplaces form the flow line.

Table 1.1

Types of production and their features

Production features	Characteristics of production features		
	mass	serial	unit
1	2	3	4
The nature of the products	Homogeneous products of a standard type	Products of an established type	Custom products
Product nomenclature	Limited, narrow	Significant	Wide and diverse
Release program for each product	Very large	Large, several batches produced per year	Each product is made in one instance or in a small number of them
Equipment category	Automatic lines of machines, assembly machines	Special machine tools of general purpose	General purpose, universal machine tools
Devices and tools	Special mechanized and automated	Special normalized, universal	Universal, standard, universally assembled
Site equipment arrangement	By technological process operations	According to the sequence of parts' processing stages	By machine tools' types
Workplace specialization	At each workplace, one operation is performed, which is constantly repeated	At the workplace, several operations are performed that are repeated regularly	Various operations are performed at the workplace

Thus, mass production is production flow. To carry out such a movement of parts, preliminary synchronization of operations is necessary: the selection of processing methods, equipment, tools, and processing modes ensures that the artificial execution time of each operation is equal to the output cycle or is a multiple of it.

Self-control questions

1. What is called a production process?
2. Define the term "technological process".
3. In what aspects is the technology considered?
4. What is a technological operation?
5. What do technological operations consist of?
6. What coefficient characterizes the type of production?
7. What are the features of workplace specialization in mass production?
8. What is the nomenclature of products in mass production?
9. What equipment is used during unit production?
10. How is the arrangement of the equipment at the site during serial production?

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