Seminar No. 9

TOPIC Ferrous metals. Steel and cast iron. Marking.
Non-ferrous metals and their alloys. Precision alloys.
Methods for the production of medical products from metals.
The concept of the technological process.

The main questions to be discussed at the seminar:

1. Alloys of iron with carbon. General characteristics. Classification.
2. General characteristics and classification of steels. Carbon steels. Properties and application of carbon steels.
3. General characteristics and classification of alloyed steels. Steel marking.
4. Cast iron. General characteristics, types.
5. Non-ferrous metals.
6. Corrosion and protective and decorative coatings.
7. Steelmaking processes. Processes for obtaining copper, aluminum, magnesium.
8. Methods for the production of products from metallic materials. Types of production processes in relation to the product.
9. Basic production processes and methods for obtaining blanks from metallic materials. The technological process of manufacturing metal products.

The consumer properties of metal medical products are determined mainly by the chemical composition of the materials from which they are made. Therefore, most often, metallic materials are classified according to their chemical composition.

The classification of all metallic materials according to the chemical composition of the main elements implies their division into those made of ferrous and non-ferrous metals.

Metals (from the Greek metallon mine) are simple substances that under normal conditions have characteristic metallic properties, high electrical conductivity and thermal conductivity, brilliance and plasticity.

Metals include both metals themselves and their alloys.

Alloys are macroscopic homogeneous systems consisting of two or more metals (rarely metals and non-metals), with characteristic metallic properties.

The main raw material for obtaining metals and their alloys is ore. Ore is a natural mineral raw material with such a content of metals and useful minerals, which ensures the economic feasibility of their extraction.

In addition, in the production of metals and alloys, fluxes are used (to remove waste rock and various harmful impurities) and fuel (to provide the required melting temperature and reduce iron from its oxides). Alloys are named based on the name of the chemical element that is included in them in the largest amount (example: iron alloys, aluminum alloys, etc.). Elements introduced into alloys to improve their properties are called alloying, and the process itself is alloying.

- Alloys are divided into two groups:
- ferrous metals - alloys based on iron
- non-ferrous metals - all other alloys

A group of ferrous metals are iron or iron-carbon alloys (an alloy of iron with carbon in various proportions), which, depending on the carbon content, are called cast iron and steel. Iron-carbon alloys have different names and grades depending on the carbon content and alloying additives. Products made of ferrous metals have hardness, strength and heat resistance; while products made of non-ferrous metals are lighter, more ductile and, in some cases, resistant to moisture and oxygen in the air.

Alloys of iron with carbon:

- steels: alloys of iron with carbon containing up to 2.14% C, the crystallization of which ends with the formation of austenite, they have high ductility, are well deformed;

-cast iron: alloys of iron with carbon containing more than 2.14% C and the crystallization of which ends with the formation of eutectic (ledeburite). Cast irons are less ductile and have good casting properties.

According to the chemical composition, steels are classified into carbon and alloy steels.

Steels are classified according to their carbon content.

low-carbon, with a carbon content of up to 0.25%;

medium carbon, with a carbon content of 0.3 ... 0.6%;

high-carbon, with a carbon content above 0.7%.

Carbon steels are the main structural material, the properties of which depend on the amount of carbon, structure and impurity content.

As the carbon content increases, the structure changes, the amount of ferrite decreases, the amount of pearlite increases, and, accordingly, strength and hardness increase and plasticity decreases.

According to their purpose, steels are distinguished:

1. Structural (contains carbon up to 0.5%) - used for the manufacture of machine parts and mechanisms;

2. Tool (contains carbon from 0.7% and above) - used for the manufacture of various tools;

3. Special - steels with special properties: electrical, with special magnetic properties, etc. (stainless, corrosion-resistant, heat-resistant, heat-resistant, wear-resistant).

Cast iron is an alloy of iron and carbon, in which the carbon content is greater than 2.14%.

In addition to carbon and iron, the alloy contains impurities: silicon, manganese, phosphorus, sulfur, etc. These impurities have a significant impact on the formation of the alloy structure, and, consequently, on the mechanical, physical and other properties of cast iron.

Depending on the form in which carbon is present in alloys, there are:

- white
- gray
- malleable
- high-strength cast irons.

According to the chemical composition, cast iron is divided into:

carbonaceous

Alloy.

Alloyed cast iron contains, in addition to conventional elements, special additives to improve mechanical or special properties: wear resistance, heat resistance, corrosion resistance, etc.

All alloying elements change the graphitization process, and fine graphite and a more dispersed base are formed.

High-alloy cast irons have, as a rule, an austenitic structure.

They are non-magnetic, have high heat resistance, corrosion resistance in alkalis, sulfuric, formic, acetic acids, caustic soda, in sea water, are less stable in hydrochloric acid and are quickly destroyed in nitric acid.

Non-ferrous metals (copper and its alloys, aluminum and its alloys, titanium and its alloys)

Non-ferrous metals are more expensive and scarce than ferrous metals, but their scope in

medicine is constantly expanding. Of the 65 non-ferrous metals currently used in non-ferrous metallurgy, copper, aluminum, titanium, nickel, tin, zinc, noble metals and alloys based on them are most often used for the manufacture of medical products.

In the manufacture of medical instruments and equipment, copper alloys are most common (copper has high electrical and thermal conductivity, high corrosion resistance, and is well polished).

Copper Alloys: Brass is an alloy of copper and zinc. Most widely used in the medical industry (sterilizers, bougies, catheters, probes, etc.)

Bronzes: tin - if high corrosion resistance is required in combination with strength (sterilization-distillation equipment) and tin-free - have high mechanical, anti-corrosion and other properties.

Nickel silver is an alloy of copper with zinc, nickel and cobalt (high corrosion resistance - cannulas, eye spoons, Voyachek probes).

Aluminum and its alloys as a structural material, aluminum alloys are much more often used. They are characterized by high specific strength, ability to resist inertial and dynamic loads, and good manufacturability. Most have high corrosion resistance (with the exception of alloys with copper.)

Titanium and its alloys: contain aluminum, molybdenum or vanadium. Material for medical instruments (low specific gravity, high mechanical properties, corrosion resistance). There is a good germination of bone tissue in titanium implants, the instruments do not need to be coated.

Corrosion is understood as the destruction of a material due to exposure to the external environment.

Corrosion of metals and products from them has a chemical or electrochemical nature.

Corrosion of non-metallic materials (organic and synthetic) is caused by microorganisms and is called microbiological corrosion, or biocorrosion.

Three types of coatings are used to protect medical products and their metal parts from corrosion:

- metal
- non-metallic inorganic
- non-metallic coatings with paints and varnishes.

In modern production, the following main methods for obtaining blanks are used:

- casting method,
- metal forming method,
- welding method,
- method of powder metallurgy.

Metal shaping methods are:

- forging
- casting
- stamping.