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METALLURGY TECHNOLOGIES FOR MATERIALS IN ENGLISH

*Утверждено Редакционно-издательским советом университета
в качестве учебного пособия*

**Учебное пособие по дисциплине
«Профессионально-ориентированный перевод»
(для аспирантов направлений 22.06.01 Технология материалов /
Металлургия чёрных, цветных и редких металлов /
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Учебное пособие предназначено для подготовки по направлениям 22.06.01 Технология материалов / Металлургия чёрных, цветных и редких металлов / Обработка материалов давлением для развития переводческих компетенций на основе анализа языковых средств, определения коммуникативно-грамматического стиля технических текстов, характера и понимания прагматической установки в соответствии с требованиями языка перевода (адекватная передача содержании символов, схем, графиков, формул). Состоит из нескольких практических разделов: терминологическая и общетехническая лексика, коммуникативно-грамматический раздел, тексты на английском языке разной профильной направленности с целевыми заданиями, направленными на общее и точное понимание содержания текстов.

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PREFACE

This textbook is intended for students attending a non-vocational higher education institution in the field of metallurgy. The volume of this textbook generally corresponds to the number of teaching hours provided for the second vocationally-oriented stage of English language teaching in VET institutions (5-7 academic hours per author's sheet).

The main goal of the manual is to develop both universal and professional competences in mastering the knowledge and skills of mature reading of scientific discourse in the field of metallurgy. Including didactic material for practice in reading, comprehension and discussion, the textbook thus fulfills the general requirements for the levels of implementation of the FSES-3 HET educational standard and is aimed at achieving the Common European competence threshold level B1 (understanding of the main ideas of messages, ability to communicate in professional situations, making a coherent message) and advanced threshold level B2 (understanding the general content of highly specialized texts, expressing your views in the professional sphere).

The textbook is divided into two parts.

Part 1 is designed to develop reading comprehension, which is seen as both an aim and a means of learning. The different types of reading can be mastered by the learners with different tasks, which is why there are four types of texts in each lesson of the first part. Text A, the learning text, is to be worked through in the classroom under the guidance of the teacher. Texts B, C and D provide background information on the topic of the lesson, with B and C aimed at developing fast reading skills (sight-reading or introductory) and D for extracurricular independent reading.

Pre-textual tasks are designed to systematise the knowledge of vocabulary, grammar and word formation acquired at school and during the first stage of higher education. A great role is given to pre-textual tasks for the introduction of terminology about metals, exercises are given that stimulate word-formation analysis, as derivatives and composites constitute in English a large part of the lexical units of the language of science. As regards grammar, special attention is paid to the recitation and subsequent consolidation of those grammatical phenomena, the knowledge of which contributes to the development of reading and translation skills of scientific texts.

Post-text exercises aim at controlling reading comprehension and systematising the information acquired. They are designed to develop logical thinking and the ability to convey the content of the text in English in monologue and dialogue.

Part 2 aims to work on texts in greater depth: not only extracting scientific and technical information, but also making sense of what has been read, identifying the main content, analysing and synthesising the material being worked on and identifying its value characteristics. In this context, Part 2 contains a description of text compression processes through annotation and abstracting, as well as sample annotation and abstract examples, speech clichés, authentic texts for annotation and abstracting and tasks to facilitate their implementation.

The structure of the manual can be considered as block-modular, i.e. one that allows the teacher to vary the sequence of work on the lessons depending on the professional needs of future professionals and the level of the students' preparation.

PART I

UNIT I
Topic: WHAT ARE METALS

ACTIVE VOCABULARY

1. the condition	условие
2. the lead	свинец (химический знак Pb)
3. the property	свойство
4. the iron	железо (химический знак Fe)
5. the gold	золото (химический знак Au)
6. the body	*физ*. тело
7. the copper	медь (химический знак Cu)
8. the conductor	*техн.* проводник
9. the conductivity	*техн.* проводимость, проводящая способность
10. oxygen	кислород (химический знак O)
11. the silver	серебро (химический знак Ag)
12. behaviour	1) поведение; 2) отношение
13. heat	тепло, теплота
14. the tin	олово (химический знак Sn)
15. decrease (decreased, decreased)	уменьшаться
16. determine	1)определять; 2)предназначать
17. amount (amounted, amounted)	составлять
18. heat	нагревать

19. conduct	*техн.* проводить (ток, тепло)
20. melt (melted, melted)	плавить(ся)
21. rise (steigen, rose)	подниматься, повышаться
22. connect (verband, connected)	связывать, соединять
23. count	считать, причислять; считаться
24. basic	основной
25. solid	твердый, прочный, крепкий
26. liquid	жидкий
27. hammerable	ковкий
28. brittle	хрупкий
29. warm	теплый
30. first	только, лишь

TASKS

I. Read the following names of the metals. Remember that they are all neutrals. Look up the names of the metals you do not know in the dictionary.

antimony, lead, iron, gallium, Englishium, gold, copper, mercury, caesium, tin.

II. Translate the following words related to word formation (Appendix 1, §1, "Word formation").

a) conduct - the conductor - conductive - the conductivity;

b) the beginning - begin, the shine - shine, distinguish -the difference;

c) form - the formation, connect - the connection, condition - the condition, determine - the determination;

d) elastic - the elasticity, great - the greatness, warm - the warmth - to heat;

e) flow - fluid, hammer - to hammer;

f) transparent - opaque

III Read the compound nouns, noting the main and secondary stresses. Derive their meanings from the meanings of their components (Appendix 1, §1 'Word formation').

the ′mountain'construction, the ′ground'location, the ′space'tempera'ture, the ′sour'substance, the ′melting'tempera'ture, the 'year′century

IV. Each time, choose the word that corresponds to the meaning of the sentence. Translate the sentences.*

1. (The oxygen, the gold, the body) are counted among the metals. 2. Metals are under normal conditions (solid, liquid, warm). 3. Metals are (compounds, gases, conductors). 4. When heated (decreases, increases, melts) the conductivity of metals. 5. Iron is (liquid, solid, transparent) under normal conditions. 6. At room temperature (silver, copper, mercury) is liquid.

V. Find the word in each row that has a generalised meaning for that row of* *words.*

1) the property, elasticity, conductivity, lustre;

2) the lead, the antimony, the caesium, the metal;

3) heat, melt, work, hammer;

4) tin, gallium, oxygen, the element

VI When translating the following sentences, pay special attention to the verb acquiesce, which has the meanings of possibility and passivity (Appendix 1, § 4, "Word Formation").

1. The science of metals can be characterised as a young science. 2. Metals can be hammered and melted. 3. Mercury and antimony cannot be hammered in their normal state. 4. Metals can be joined in groups. 5. The elasticity of metals means that they can be worked.

VII Translate the sentences, noting the different functions of the word zu. It can occur as:

а) a preposition with the meanings к, на, по, в, для;

б) a particle before the infinitive (is not translated);

в) an intensifying particle before adjectives and adverbs with the meaning слишком.

1. Antimony is not hammerable, it is too brittle. 2. Six metals were known in Lomonosov's time. 3. According to Lomonosov's determination, mercury does not belong to the metals. 4. Tungsten begins to melt at the temperature of 3450°C. 5. The difference between some metals is too great. 6. It is not easy to answer the question of the properties of metals.

VIII. Translate the following word compounds.*

a) four times greater, six times better, a hundred times less, a thousand times warmer, fifty times stronger;

b) those qualities, that metal, that oxygen, that condition, those differences, those elements;

c) two centuries ago, in his time, according to Lomonosov's determination, under normal conditions, with increasing temperature.

IX. Determine the functions of the verb become. Translate the sentences.

The verb become can occur:

(a) in its independent meaning - стать, становиться;

b) as an auxiliary verb in the future tense;

c) as an auxiliary verb in the passive voice.

1. Other metallic properties were mentioned later. 2. Mercury becomes solid only at the temperature of -38.5°c. 3. Science will determine the properties of metals more precisely. 4. Iron becomes elastic when heated. 5. The metals can be joined in groups because they have common properties.

X. Read text A and say what you have learned about the metals in it.

TEXT A
WHAT ARE METALS

It is not easy to answer the question of what metals are, because the science of metals is young. Two centuries ago, the great Russian scholar M. V. Lomonosov wrote in his work "Fundamentals of Metallurgy and the Art of Mining": "Metals are shiny bodies that can be hammered". That was brief and correct in its time. At that time, six metals were known: Gold, silver, copper, iron, lead and tin. According to Lomonosov's definition, mercury and antimony do not belong to the metals, because mercury is liquid under normal conditions and antimony cannot be hammered, it is too brittle.

Later, other "metallic properties" were mentioned. The Meyerschen Konversationslexikon[1] of 1897 states: Metals are "those elements which are good conductors of heat and electricity,... possess a strong luster..., are non-transparent and form mostly basic compounds with oxygen". Today it is added that the electrical and thermal conductivity decreases with increasing temperature.

There are about 80 elements that are counted among the metals. Each metal is peculiar. Some metals have common properties, they can be connected in groups.

But more interesting are the differences between the metals. For example, their melting temperatures differ. Mercury is molten at room temperature, it only becomes solid at -38.5°C. Gallium melts when you hold it in your hand, its melting temperature is +29.5°C. Tungsten, however, has to be heated to 3450°C before it starts to melt.

It is said that metals are good conductors of electricity. Good conductors are silver and iron. But silver conducts electricity about six times better than iron. The metal Englishium has the electrical conductivity some thousand times less than the iron.

Let's take another property of metals like elasticity. A characteristic value for this property is the modulus of elasticity. It is thirteen times greater for iron than for caesium.

XI.Read text B and say what you have learned about the properties of metals.

TEXT B
PROPERTIES OF THE METALS

Metals in compact form have a characteristic sheen - metallic luster. They are silvery white to grey with exception[1] of gold (yellow) and copper (red). The metals have good electrical conductivity and high thermal conductivity. Silver, copper or aluminium, for example, are used as electrical conductors. All metals are solid at normal temperature, except mercury, which is liquid. Many metals form alloys with each other, which have particularly good physical and chemical properties. Various steel alloys, e.g. with cobalt, nickel, vanadium, titanium or molybdenum, are very solid. Steels with chromium, nickel, silicon, carbon and manganese are particularly chemically resistant[2].

A distinction is made between precious metals and base metals according to their chemical behaviour against oxygen and acids³. Precious metals do not oxidise in air. They include silver, gold and the platinum metals ruthenium, rhodium, palladium, osmium, iridium and platinum. The precious metals occur in nature as pure metals5 , while the base metals occur as sulphides or oxides. In technology, metals are divided into light and heavy metals or into technical iron with many types and alloys and non-ferrous metals. Metals are also grouped according to their melting point, alloyability, thermal and electrical conductivity and mechanical properties.

XII. Discuss text C in dialogue.

TEXT C
MIKHAIL VASILYEVICH LOMONOSOV

M. V. Lomonosov was born in 1711 in a small village in the Archan-gelsk region, the son of a fisherman. After a solid education in Moscow, he went to Englishy. From 1736 to 1742, Lomonosov perfected his education at the

education at the University of Marburg and at the Freiberg Mining Academy. In 1745 he was appointed professor of chemistry at the Academy of Sciences in Petersburg. Lomonosov is one of the greatest scientists of the 18th century. He led extensive scientific and educational activities. He is rightly considered the founder of scientific metallurgy, geology, meteorology and, above all, chemistry in Russia. He is the author of the work "Fundamentals of Metallurgy and the Art of Mining", which was published in Petersburg in 1765. Achievements in many fields of science made him a universal scientist. He died in Petersburg in 1765. The largest university in Russia is named after him today.

XIII. Read text D. To understand the content as fully as possible, look up the unknown words in the dictionary.

TEXT D
THE METAL WEALTH OF THE EARTH

Metals have been used by humans for thousands of years. Modern technology is inconceivable without metals, especially iron and steel. But the question must always be asked whether they are inexhaustible. One is mistaken if one believes this.

The earth's metal supply has often been estimated, and it was found that the earth's metal content is relatively low. 76% are non-metals, about 18% light metals and only about 6% heavy metals. The elements oxygen and silicon are the most common. Almost three quarters of the Earth's crust consists of oxygen and silicon. Of the metals, aluminium, iron, magnesium and titanium are abundant.

One must also consider the question of whether the metals present in the earth are extractable. Some metals, e.g. gold, platinum, palladium, iridium, osmium, partly silver, copper, mercury, bismuth are found in the earth in pure form. Other metals only occur in the form of chemical compounds as sulphides, arsenides, oxides, silicates, carbonates, hydrates, sulphates, etc., i.e. as ores.

Minerals are counted as ores if they contain one or more metals in such a form and concentration that metals can be extracted from them industrially and with economic success, either directly or after physical processing. However, it must be taken into account that only a part of the metals occur in deposits with such concentrations that the extraction of the metals is technically and economically feasible. Therefore, the question of extracting the metals from poorer ores that are difficult to process is becoming topical today. Mining methods are constantly being perfected, ore mining processes improved and metallurgical processes further developed.

When it comes to the consumption of metals, one must always remember that the demand for metals throughout the world is growing faster than its production. Although new deposits are constantly being discovered, they are no longer sufficient to cover the demand for metals. The metals copper, nickel, tin, zinc and lead, for example, are becoming scarce. They should be used sparingly and only where they cannot be replaced by other metallic and non-metallic materials due to their special properties. The other way to meet the growing demand for metals is to reuse metal scrap. We should also try to extend the life of the metal inventory as much as possible.

XIV. Read Text D again and answer the following questions.

1. Since when has man used metals?
2. Are the earth's reserves of metals inexhaustible?
3. Which metals are abundant in the earth?
4. Which metals are found in abundance in the earth?
5. Which minerals are counted as ores?
6. Are all metals easy to extract?
7. Which metals are in short supplies?

8) what are the ways to meet the growing demand for metals?

XV. Give the main content of text D in writing (10 - 15 sentences).

XVI. Say what you think about the problem of uneconomic consumption of metals.

UNIT II
Topic: METALS ARE CHEMICAL ELEMENTS
ACTIVE VOCABULARY

1. the orbit	орбита, траектория
2. the density	плотность, объемный вес
3. the colour	цвет, краска
4. the regularity	закономерность
5. the weight	вес
6. the cast iron	чугун
7. the shell	оболочка
8. the core	ядро
9. the carbon	углерод (химический знак С)
10. the charge	заряд
11. the alloy	легируемость, способность сплавляться
12. the alloy	сплав
13. the order	последовательность
14. the nitrogen	азот (химический знак N)
15. set up	составлять, разрабатывать
16. consider	рассматривать
17. contain (enthalten, contained)	содержать
18. correspond (corresponded, corresponded)	соответствовать
19. determine	утверждать, констатировать, устанавливать
20. load (lud, laden)	заряжать
21. order	упорядочивать, систематизировать
22. encircle	окружать, кружить
23. lose (lost, lost)	терять
24. use	применять
25. depend	зависимый
26. distinct	отчетливый
27. total	весь, целый, общий
28. equal	равный, одинаковый
29. pure	чистый
30. almost	почти

TASKS

I. Read and translate the following names of the chemical elements. Determine their grammatical gender.

Boron, Fluorine, Helen, Potassium, Carbon, Lithium, Sodium, Neon, Oxygen, Nitrogen.

II. Translate the following words related to word formation (Appendix 1, §1 "Word Formation").

a) dense - the density, warm - the heat, cold - the cold, large - the size;

b) charge - the charge, alloy - the alloy, order - the order, tell - the telling, retell - the retelling;

c) dependent - independent, distinct - indistinct, equal - unequal, pure - impure, solid - unsolid.

III Read the compound nouns, noting the main and secondary stresses. Derive their meanings from the meanings of their components (Appendix 1, § 1 "Word formation").

the A′tom'construction, the A′tom'weight, the A′tom'mass, the ′cast'iron, the ′nonme'tall, the ′order'principle, the ′place'number.

IV. Name the pairs of words that have opposite meanings.*

a) transparent, outside, above, left, dependent;

(b) bottom, opaque, right, independent, inner.

V. Each time, choose the word that corresponds to the meaning of the sentence. Translate the sentences orally.*

1. Steel is considered as (pure metal, non-metal, metal alloy). 2. Chemical elements are (cast iron, carbon, bronze). 3. In the periodic table, chemical elements are classified according to (colour, meaning, and nuclear charge). 4. The nucleus is orbited on certain paths (electrons, protons, neutrons). 5. The atomic nucleus carries a (positive, negative, relative) charge. 6. The metallic properties (decrease, increase, exist) in the periodic table from left to right.

VI. Find the word in each row that has a generalised meaning for that row of words.*

1) the cast iron, the alloy, the steel, the bronze;

2) non-metal, carbon, nitrogen, neon;

3) the density, the colour, the atomic mass, the property;

4) the orbit, the nucleus, the shell, the atom.

VII Translate the sentences in writing, noting the infinitive usages (Appendix 1, § 6 "Infinitive").

1. To use metals, you almost always alloy them. 2. To determine the properties of metals, you have to order them. 3. To determine the order in the system of chemical elements, one must know their relative atomic masses. In order to recognise the inner laws of the periodic table, one has to look at the atomic structure of the elements. 5. 5. To use metals, study their properties.

VIII. Put together sentences that make sense. Remember: nothing else but... - ничто иное как...

Carbon and fluorine			chemical elements
Metals	are		an alloy
Bronze		nothing else than	non-metals
the legibility	is		a metallic property
the periodic system			the order of the chemical elements

IX. Read text A and answer the question why the system of chemical elements has great importance.

TEXT A
METALS ARE CHEMICAL ELEMENTS

But if only chemical elements were counted as metals, then steel, cast iron, bronze, in short all alloys, would not be metals. This is not the case, of course. Most metals are not used purely, but in the form of alloys. Alloyability is nothing other than one of the metallic properties. We first consider only the pure metals.

The metals show a common behaviour, but in order to determine this, we have to order them. Which ordering principle should be taken? Ordering the metals according to their colour or according to their melting temperature or according to their density does not lead to a satisfactory result. It is better to order the metals according to the periodic table of the chemical elements.

In the periodic table, the elements are arranged in the order of the nuclear charge of their atoms. The periodic table of the chemical elements was drawn up independently by Lothar Meyer and Dmitri Ivanovich Mendeleev. No one knew the exact model of the atomic structure at that time. The order in the periodic table was determined by the relative atomic mass.

In order to recognise the inner law of the periodic table, one has to look at the atomic structure. The atom consists of a nucleus and a shell in which electrons orbit the nucleus. The atomic nucleus contains almost the entire mass of the atom and carries a positive electrical charge whose magnitude is equal to the atomic number of the atom. It corresponds to the place number in the periodic table. In the shell, as many electrons, i.e. negative charges, are arranged in orbits as the nucleus contains positive charges. This makes the atom electrically neutral to the outside.

In the periodic table, the chemical elements are arranged in such a way that the metallic properties decrease from left to right. The elements lithium, sodium, potassium on the left are the most active metals that lose their electrons easily. On the right are the non-metals helene, boron, carbon, nitrogen, oxygen, fluorine, neon. From top to bottom, the metal character is clearer. The periodic table of the elements and the laws of the dependence of the properties of the chemical elements on their atomic structure are of great importance for the science of metals.

X. Find answers to the following questions in the text A.

1. Are steel, cast iron and bronze metals?

2. What is the alloyability of metals?

3. What is the main principle of ordering metals?

4. How are the elements ordered in the periodic table?

5. What does an atomic nucleus consist of?

XI. Choose the statement that expresses the main idea of the text. Memorise the word association: The text is about ...- В тексте говорится о...

a) The text is about the alloyability of metals.

b) The text is about D. I. Mendeleev.

c) The text is about the arrangement of chemical elements in the periodic table.

XII. Divide text A into more or less self-contained parts. Say what each part is about.

XIII. read text B and state what makes the discovery of the "Periodic Table of Elements" by D. I. Mendeleev particularly valuable.

TEXT B
DMITRY IVANOVICH MENDELEEV

When on 2 February 1907 the great Russian scholar D. I. Mendeleev died, his life's work, the "Periodic Table of the Elements", was known throughout the scientific world. He was rightly called a Copernicus of the microcosm of atoms, because his system gave the principle and the basis for the grouping of the chemical elements.

Mendeleev was born in Tobolsk in 1834. When he became a professor in

Petersburg, he was 22 years old. He worked a lot on the technological development of Russia's mineral resources. His special achievement, however, is the compilation of the periodic table of the elements. At the same time and independently of him, Lothar Meyer also developed this system. However, Mendeleev also predicted the properties of elements that had not yet been discovered. When he drew up the periodic table, only 63 elements were known. Among other things, he was able to determine the properties of gallium and Englishium from their position in the periodic table. His predictions are consistent with the elements discovered later.

XIV Discuss text B in dialogue.

XV. Read text C. Say what is reported in it by John Dalton.

TEXT C
JOHN DALTON

John Dalton is as well known and famous in England as M. V. Lomonosov is in Russia. He was born in 1766 as the son of a weaver[1]. John Dalton was an autodidact, i.e. he did not go to school, nor did he study at any university. He learned on his own and through independent study he became a scholar of world renown[2]. At the age of 12 he began to teach the village children. From that time onwards, he worked as a private teacher for many years.

As a scholar, scientific theories occupied[3] him, especially the atomic theory. He worked a lot on the problems of the structure of the chemical elements. The result of his work was the atomic theory he developed around 1800, which is still considered correct on the whole today and has exerted a great influence on chemical science4. It is said of John Dalton that he founded scientific atomic theory and was the first to assign an atomic weight to each chemical element. The atomic structure of the chemical elements became generally accepted through Dalton's work5.

Text explanations

1. the weaver - ткач
2. the scholar of world renown - ученый с мировым именем.
3. employ - занимать
4. exert an influence - оказывать влияние
5. recognise - признавать

XVI. Speak in English about the great English scholar John Dalton.

XVII. Read text D carefully. To understand the text as fully as possible, look up the unknown words in the dictionary.

TEXT D
BINDING TYPES OF METALS AND NON-METALS

The internal cohesion of a substance is the result of interaction forces between its particles. These particles attract and repel each other. If the distance between them is very large, the forces of attraction and repulsion are practically zero; if they are brought closer together, the interactions increase. At a certain distance, the attraction and repulsion are equal, i.e. the particles are in a state of equilibrium.

The maximum of the attraction force is also called atomic cohesive strength. The development of the interaction forces between the particles forming a compound is related to the type of bond. A distinction is made between four basic types of bond:

1) Ionic bond, also called electrostatic or heteropolar bond;
2) Valence bond, also called homeopolar bond;
3) metallic bond;
4) intermolecular bond.

The ionic bond occurs between elements in which the outer shell of the atoms contains only a few electrons and between those in which the shell is almost full. The metals contain few, easily detachable electrons in the outer shell. The non-metallic elements with heavily occupied outer shells strive to fill them up by accepting electrons. If, for example, the metallic element magnesium and the non-metal oxygen come together, magnesium will give up the two electrons of its outer shell to the oxygen, whose outer shell is occupied with six electrons and which is completely saturated by the two that are added. The resulting magnesium oxide is composed of positively charged magnesium ions and negatively charged oxygen ions. The cohesion of a substance whose building blocks are differently charged ions is brought about by electrostatic interaction forces.

The valence bond is formed when neighbouring atoms continuously exchange electrons with each other in order to obtain filled outer shells. In the case of selenium, for example, there are only six electrons in the outer shell, i.e. es are missing two more electrons for full saturation. There is a constant exchange of electrons of each atom with the two nearest atoms. This leads to the formation of positive and negative ions in constant alternation and to the occurrence of

electrostatic alternating forces.
Antimony has five electrons in its outer shell. The individual atoms can only form eight-shells by exchanging one electron each with the three nearest neighbouring atoms. This is how disc molecules are formed, which are connected to each other by relatively weak intermolecular forces. The leafy slate structure of the antimony results from these bonding ratios.
The valence bond is only possible if at least four electrons are present. If there are less than four - as is typical for metals - all the electrons within the compound become freely mobile between the atomic trunks as electron gas, and no assignment of a free electron to an atom or atom pair is possible. This metallic bond is given by interactions between the negatively charged electron gas and the atomic trunks, which are positively charged ions.
For the intermolecular bond, forces are assumed which are also called van der Waals forces and whose nature has not yet been clearly clarified.

XVIII. Read text D again and answer the following questions.
1. Чем объясняется внутреннее сцепление любого физического вещества?
2. Когда частицы вещества находятся в состоянии равновесия?
3. Что называют прочностью на сцепление атомов?
4. Какие основные виды связей различаются в атомной теории?
5. Какова краткая характеристика: а) ионной связи; б) валентной связи; в) металлической связи?
6. Что сказано в тексте о межмолекулярной связи?

XIX Give the content of the text in English (10-15 sentences).

UNIT III
Topic: MELTING AND ALLOYING THE METAL

ACTIVE VOCABULARY

1. the solidification point	точка затвердевания
2. the mixture	смесь
3. the lattice	решетка
4. the space lattice	пространственная решетка
5. the melt	1) плавка; 2) расплав
6. the substance	материал
7. the process	процесс
8. the state	состояние
9. cool down	охлаждать
10. change (itself)	изменять(ся)
11. arrange	располагать (в определенном порядке), расставлять
12. observe	наблюдать
13. need	нуждаться
14. divide	подразделять
15. come into being (arose, originated)	возникать
16. achieve	достигать
17. congeal	затвердевать, застывать
18. belong	принадлежать
19. pass over (went over, passed over)	переходить, превращаться
20. destroy	разрушать
21. increase (increased, increased)	увеличиваться
22. simultaneously adj	одновременный
23. high-melting part adj	тугоплавкий
24. highest-melting part adj	наиболее тугоплавкий
25. low-melting part adj	легкоплавкий
26. constantly adj	постоянный
27. additionally adj	дополнительный
28. many pron	некоторый
29. already adv	уже
30. being present	быть, иметься в наличии

TASKS

I. Keep the following verbs in three basic forms.

stayed-stayed - оставаться
happened-happened - происходить
cast-cast-cast - лить
measure-measured-measured - измерять
sink-sank-sunk - опускаться, снижаться
grow-grew-grown - расти

II. Write the initial form of the verbs in bold. Translate the sentences orally.*
1. Mercury melts at room temperature. 2. Metals are poured into moulds. 3. The demand for metals is constantly growing. 4. Many thousands of years ago, man began to use metals. 5. What happens during melting? 6. The temperature remained constant. 7. The temperature decreased. 8. The temperature is measured with a thermometer. 9. Electrical conductivity decreases with increasing temperature. 10. The importance of steel increased with time.

III. Name the initial form of the following verbs.
a) passes over, increases, divides, builds up, establishes, arranges, cools down;
(b) melted, poured, maβ, contained, corresponded, lost, amounted, warmed, arose, destroyed;
(c) rose, melted, charged, cooled, divided, increased, built up, observed, considered, connected.

IV. Translate the nouns formed by the corresponding verbs (Appendix 1, § 1 "Word Formation").
a) the solidification, the heating, the cooling, the melting, the pouring, the happening, the measuring, the growing, the sinking, the alloying;
b) the destruction, the observation, the contemplation, the classification, the arrangement, the formation, the connection, the determination, the use, the solidification.

V. Translate the following words related to word formation (Appendix 1, § 1 "Word Formation").
warm - the warmth - warm up; cool - the coolness - cool down; high - the height - increase; dense - the density - condense; clear - the distinctness - clarify; equal - the sameness - compare; rigid - the rigidity - solidify.

VI Read the compound words, noting the main and secondary stresses. Derive their meanings from the meanings of their components.
the ′lead'energy, the ′solidification'point, the ′melt'point, the ′space'grid, the ′heat'energy, the ′lead'mixture, the ′melt'heat, the ′solidification'heat, the Me′tall'body, the Me′tall'substance.

VII. Each time, choose the word that corresponds to the meaning of the sentence. Translate the sentences orally.*
1. Lead is a (low-melting, high-melting, highest-melting) metal. 2. When the metal is heated, the space lattice is (solidified, bonded, destroyed). 3. In the case of high-melting metals (the modulus of elasticity, the solidification point, the melting point) is between 1000 and 2000°C. 4. When cooling down, the metal changes into (solid, liquid, gaseous) state. 5. After the melting temperature, all metals are divided into 3 groups (built up, transitioned). 6. (Likewise, as soon as, as long as) the melting temperature is reached, the lead begins to melt.

VIII. Name the antonym of the first word in the series.*
a) to rise: to remain, to increase, to decrease, to increase;
b) increase: decrease, destroy, arise, take;
c) cool: build up, divide, pass over, heat;
d) pure: constant, additional, impure, equal;
e) to melt: to solidify, to order, to pour, to heat.

IX. Translate the following groups of nouns with the extended attribute (Appendix 1, § 7 "Participles").*
the long-known property of metallic substances; mercury, which is liquid under normal conditions; elements which combine easily with oxygen; metals heated to 1000°C; metals used in the form of alloys; chemical elements ordered according to the nuclear charge of the atoms; the atom consisting of a nucleus and a shell; the periodic table of chemical elements developed by Mendeleev; the order present in the solid state; many crystals growing simultaneously.

X. Find sentence structures in the first paragraph of text A, determine the type of subordinate clauses (Appendix 1, § 9 "Sentence structures"). Translate the sentences orally.

XI. Read Text A and find the answer to the question what happens in metals when they melt and solidify.

TEXT A
MELTING AND SOLIDIFICATION OF METALS

Melting is one of the properties of metallic substances that have been known for a long time. Lead casting is an example of this. Lead is a metal with a low melting point. Heated to 327°C, it passes from the solid to the liquid state. Let's measure the temperature of the lead constantly from the beginning of the process. As long as it remains solid, the temperature rises. As soon as the melting temperature is reached, the lead begins to melt. The temperature of the solid and already melted lead mixture does not change any more. Only when the lead has melted does the temperature increase again. If we let the lead cool, we observe that the temperature drops to the solidification point. But then it remains the same with the formation of the first lead crystals in the melt. When all the lead is solid, the temperature drops further.

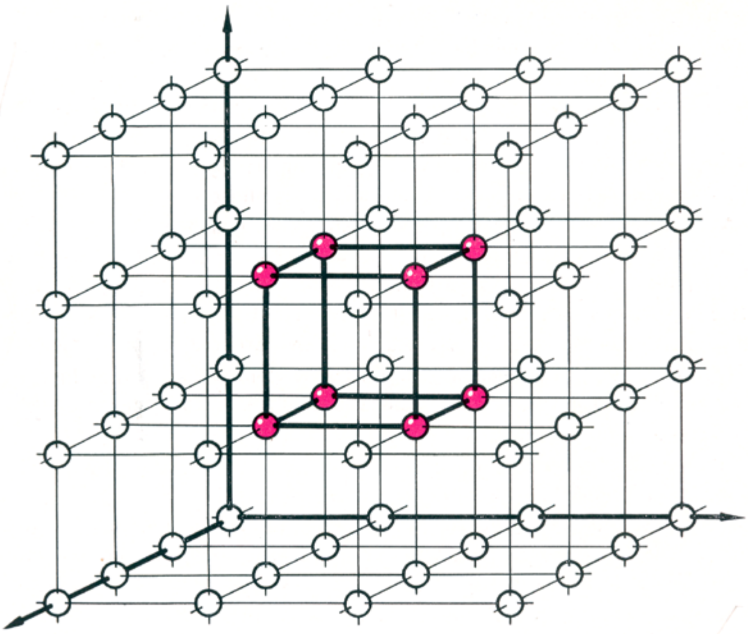

Figure 1.1. Schematic representation of the spatial lattice and the unit cell of the cubic-primitive lattice. The arrangement of the atoms is completely the three spatial directions.

All pure metals and some alloys behave in the same way as lead. According to the level of their melting and solidification temperature, the metals can be divided into low-melting, high-melting and ultra-high-melting. Low-melting metals with a melting point below 1000°C are lead, tin, zinc and aluminium. High-melting metals have a melting point between 1000 and 2000°C. These include iron, nickel, titanium, etc. High-melting metals with a melting point above 2000°C are molybdenum, tantalum and tungsten.

What actually happens during melting? During heating, the order that exists in the solid state, the space lattice, is destroyed. The destruction of the space lattice requires additional heat energy without increasing the temperature. This latent heat of fusion is released again during solidification as solidification heat. When a metal solidifies, the atoms rearrange themselves into a lattice. Many crystals are formed and grow simultaneously, from which a metal body is built up.

XII. Answer the following questions about the text.

1. What is melting?
2. What happens when metals are heated?
3. Into which three groups can metals be divided?

4 What happens to the space lattice during melting?

5 What happens when the metals solidify?

XIII. Group the metals according to their melting temperature

.

Low-melting Metals	Refractory Metals	Ultra-high melting point Metals

Molibdenum, Iron, Tin, Lead, Nickel, Tungsten, Tantalum, Zinc, Titanium

XIV Choose the assertion that expresses the main idea of the text, using the phrase it is about - речь идет о....

1. This text is about the solidification heat of metals.
2. This text is about the melting point of metals;
3. This text is about lead;
4. This text is about the melting and solidification of metals.

XV. Divide text A into more or less self-contained parts. Tell what each part is about.

XVI. report what happens when the metals melt. Use the following words and word combinations.

a) destroy, need, set free, arrange, come into being, grow, build up;

b) the long known property, the space lattice present in the solid state, the latent heat of fusion.

XVII. look at figure 1.1, describe the space lattice and the unit cell of the cubic primitive lattice.

XVIII. Read text B and establish the objective of alloying.

TEXT B
ALLOYING THE METALS

Most metallic substances are not pure metals, but alloys. Alloying is the process of combining a metal with one or more metals and also non-metals. Alloying allows the properties of the metal to be changed. Thus, soft copper alloyed with tin gives the harder bronze. Iron becomes steel or cast iron by alloying with carbon. Alloyed steels contain other alloying elements, e.g. manganese, nickel, chromium.

The aim of alloying is to improve the properties of the metallic substances. In an alloy, the compounds of substances are the same as the chemical compounds. For example, in steel there is a compound of iron and carbon - the iron carbide with the formula Fe_3C; or the aluminium-copper alloy is a compound of the two metals - Al_2Cu. In some alloys, the metals form only mechanical compounds. For example, in an iron-lead alloy, iron and lead crystals are found next to each other. But it is also possible that the two metals unite to form a new crystal. Such crystals are called solid solutions. An alloy can therefore be a chemical compound or contain a chemical compound.

XIX. Describe the process of alloying the metals in English (5-8 sentences).

XX. Read text C and learn about some interesting alloys.

TEXT C
ABOUT THE MELTING POINTS OF SOME ALLOYS

Almost always, the melting points of metals are far above[1] normal room temperature. It is different with some alloys. These alloys have a fixed melting point like the pure metals, but it is below[2] the melting temperatures of the metals forming the alloy. For example, a bismuth-lead alloy melts at 125°C already. An even lower melting point can be achieved by alloying. A bismuth-lead-tin-cadmium alloy melts at 60°C. But the record is held by mercury alloys. The mercury-thallium alloy, for example, only becomes solid at -60°C. Such low-melting alloys are also used to solve various technical problems.

Text explanations

1. above - выше
2. below - ниже

XXI Discuss text C in dialogue. Change roles.

XXII. Read text D carefully. To understand the text as fully as possible, look up the unknown words in the dictionary.

TEXT D
NICKEL-CHROMIUM ALLOYS AS MATERIALS IN THE THIN-FILM TECHNOLOGY

Binary Ni/Cr alloys have been produced for electrical engineering since the turn of the century. Initially, the focus was on the use as heating conductors. Further areas of application are the production of thermocouples and resistance materials for wire resistors.
Numerous investigations have been carried out in these fields of application in order to improve the scaling resistance of the heating conductor material, to increase the thermoelectric voltage and to stabilise the resistance value of the resistance material and to lower its temperature coefficient. As a result of this work, special alloy compositions were developed that contain specific additives of other metals on the basis of nickel/chromium that are assigned to the application purpose. In addition to the additives and the technically induced impurities of the starting materials, additives for deoxidation are also necessary for the smelting metallurgical alloy production.

The composition of the vapour deposition layer must be 40% to 50% nickel and correspondingly 60% to 50% chromium for the production of the resistance components.
The alloys that have been technically produced so far include NiCr10[1], NiCr20[1] and the alloy NiCr30[1], which has been developed for some years. All these alloys

are used as heating material.
The alloy NiCr10 has a high sublimation voltage[2], but provides layers with too low a chromium content, which means that the temperature coefficients and stability of the components do not meet the requirements.
The sublimation range of the alloy NiCr20 is small and therefore difficult to maintain in terms of production technology. However, this alloy is particularly suitable for obtaining high-quality chromium-rich layers for low-resistance resistors by sublimation or evaporation from the melt. Work on alloying and evaporation technology would be necessary for this material so that it es advantageous for thin-film technology in terms of production technology.
For years, evaporation of 2 mm diameter NiCr30 heating wire has proven successful. At a current of 38 to 40A, 1050 to 1150°C are reached and thus a sublimation intensity sufficient for the production of components.
The following requirements are placed on the alloy NiCr30 for the production of thin-film components by sublimation:
- the wire surface must be free of impurities and oxide deposits;
- the wire surface should be as smooth, bright and metallically shiny as possible;
- Wires with a brightly pickled surface should be pickled again before use;
- the wire should have a fine-grained structure to ensure high grain boundary diffusion for post-diffusion of the chromium;
- the alloy must have a very low gas content so that there is no deterioration of the vacuum;
- in particular, the alloy must not contain additions of the metals manganese, aluminium and silicon.

Text explanations

1. NiCr10, NiCr20, NiCr30 - марки сплавов
2. Sublimatios voltage - упругость сублимации (возгонки).

XXIII Interview your interlocutor. Answer the following questions about Text D.

1. Where are binary Ni/Cr alloys used?
2. For what purpose are numerous studies of the above alloys carried out?
3. Which Ni/Cr alloys are technically used today?
4. What are the disadvantages of the alloys nicr10 and nicr20?
5. What demands are made on the alloy nicr30?

XXIV Give the content of text D in writing. Use the answers from task XXIII.

XXV. Do you know of any original alloys? Tell how they are produced and used.

UNIT IV
Subject: ELASTICITY, PLASTICITY AND STRENGTH OF METALS

ACTIVE VOCABULARY

1. the stress	напряжение, нагрузка, усилие
2. the wire	проволока
3. the strength	прочность, сопротивление
4. half	половина
5. the force	сила
6. the position	положение
7. the load	нагрузка, груз
8. the source	источник
9. the piece	кусок
10. the consolidation	упрочнение
11. the dislocation	дислокация, перестановка
12. claim	подвергнуть нагрузке
13. burden	нагружать
14. eliminate	устранять
15. influence	воздействовать
16. relieve	снимать нагрузку, напряжение
17. explain	объяснять
18. soften	размягчать
19. deform	деформировать, изменять форму
20. assemble	собирать(ся)
21. wander	мигрировать, перемешаться
22. change	меняться, чередоваться
23. return	возвращаться
24. thin adj	тонкий
25. required adj	требуемый, необходимый
26. so-called adj	так называемый
27. originally adj	первоначальный
28. finally adv	наконец
29. the more, the...	чем .., тем …
30. either... or	или … или …

TASKS

I. Read and remember the following strong verbs in three basic forms.

bend-bent-bent - гнуть, сгибать
break-broke-broken - ломать/ся/
tear-teared - рвать, разрывать
overcome-overcome- преодолевать
interrupt-interrupted- прерывать
avoid-avoided-avoided - избегать

shift-shifted-shifted - сдвигать, передвигать
accept-accepted-accepted - принимать
deviate- deviated-from - отклоняться
enter-entered-entered - вступать, наступать

II. Write the initial form of the verbs in bold. Translate the sentences orally.*
1. The wire snapped because the strain was too great. 2. The plastic object is easily bent. 3. No one knew at first why the steel parts broke without reaching the critical stress possibility. 4. When heated, the attractive force of the atoms is overcome, the atoms are shifted against each other in the space lattice. 5. The ship deviated from the given course. 6. After bending, an elastic object takes on its original shape. 7. Winter came unexpectedly quickly. 8. His studies were interrupted by illness. 9. In the solid solution the arrangement of the atoms deviates from the ideal structure of the space lattice. 10. If the properties of the metal are well known, the mistakes in its use can be easily avoided. 11. When heated, the steel is brought into a liquid state.

III. Name the initial form of the following verbs.
a) knew, brought, deformed, interrupted, avoided, acted in, returned, entered, deviated, wandered out;
b) deformed, bent, removed, relieved, shifted, formed, returned, deviated, entered, assumed;
c) acting in, deviating, breaking, tearing, interrupting, softening, returning, breaking off.

IV. Translate the nouns formed by the corresponding verbs (Appendix 1, § 1 "Word Formation").
a) deforming, removing, wandering, warming, softening, bending, tearing, knowing, changing;
b) the solidification, the dislocation, the explanation, the stress, the strain, the removal, the impact, the relief, the interruption, the overcoming, the deformation.

V. Translate the following words related to word formation (Appendix 1, § 1 "Word Formation").
a) firm - the firmness, half - the half, elastic - the elasticity, plastic - the plasticity;
b) close - finally, so call - so-called, the origin - originally.

VI Read the compound nouns. Derive their meanings from the meanings of their components (Appendix 1, § 1 "Word formation").
the decade, the initial form, the copper wire, the atomic arrangement, the space lattice, the solid solution, the dislocation source, the deformation process, the new formation, the metal strength

VII. In each row, find the word whose meaning is given at the beginning of the row.*

1) напряжение: the strength, the elasticity, the load, the stress;
2) сила: the position, the load, the force, the source;
3) упрочнение: the dislocation, the consolidation, the elimination, the deformation;
4) снимать нагрузку: to relieve, soften, deform, assemble;
5) меняться: deviate, wander, act in, change, know;
6) первоначальный: finally, originally, so-called, thin;
7) или ... или ...: the more... the more ..., both... and ..., either... or ..., not only... but also ...

VIII. Choose the correct translation of the words in bold.*
1. People have been shaping metals for 6000 years.
а) обрабатывают, б) размягчают, в) собирают, г) деформируют.
2. an elastic object takes its initial shape after bending.
а) разрыв, б) прогиб, в) искривление, г) исходная форма.
3. during plastic stress, the spatial lattice of metals is destroyed.
а) предмет, б) положение, в) образование, г) напряжение.
4. the arrangements deviating from the ideal structure of the space lattice are called dislocations.
а) скопления, б) смещения, в) размягчения, г) упрочнения.
5. to prevent the metal from breaking, it must be softened by heating.
а) избежать, б) размягчить, в) разгрузить, г) устранить.
If the forces acting on the metal are greater than the forces connecting it, it breaks or cracks.
а) воздействующие, б) прерывающие, в) устраняющие, г) смягчающие.
IX. Transform the conditional sentences without conjunctions into the sentences with conjunctions and vice versa. Translate the sentences orally. (Appendix 1, § 9 "The sentence structure").
Pattern A: If you heat a metal, it becomes liquid. - If you heat a metal, it becomes liquid.
Pattern B: If the elastic metal is deformed several times, it breaks. - If the elastic metal is deformed several times, it breaks.
1. If a copper wire is bent, it remains deformed. 2. If a plastic object is deformed, many dislocations form in its spatial lattice. 3) If an elastic object is relieved, it takes on its original shape. 4. If the processes occurring in metals are explained correctly, many catastrophes can be avoided. 5. If copper is alloyed with tin, a new metal is formed - bronze. 6. If there are many dislocations in the space lattice of the metal, solidification occurs. 7. If the machine parts are dynamically stressed, they may break. 8. If lead is worked in a nuclear reactor, it becomes more elastic. 9) If one considers the properties of metals, one must first of all mention their alloyability. 10. If you want to know the laws of the periodic table, you must look at the atomic structure of the chemical elements.

X. Find in the text A sentence structures with the conjunctions although, whether, ever ..., the more ... and translate them (Appendix 1, § 9 "The sentence *structure").*

XI. Read text A and find the answers to the questions what goes on in an elastic and a plastic metal.

TEXT A
ELASTICITY, PLASTICITY AND STRENGTH OF METALS

Until a few decades ago, people did not know what happens inside a metal when it is deformed, even though people have been bending metals for 6000 years.

A thin piece of steel, e.g. a razor blade[1], can be bent. When released[2] it returns to its original shape. This piece of metal is said to be elastic. A copper wire behaves differently. If it is bent, it remains deformed even after the applied force is removed. It behaves plastically. Whether the material reacts elastically or plastically can be explained by the following.

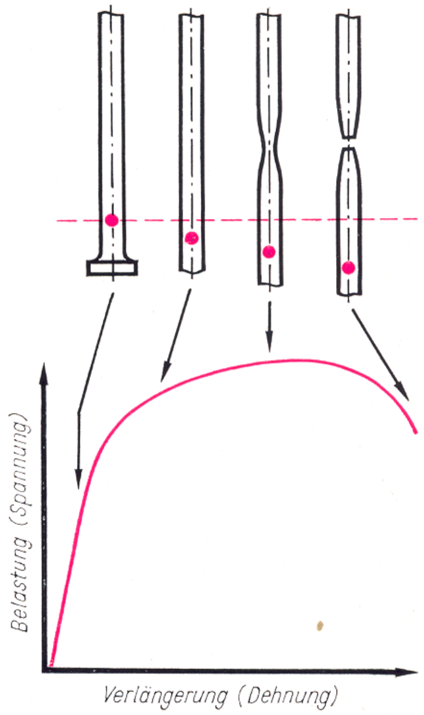

Figure 1.2: The tensile test makes it possible to determine the strength of a metallic material for a static tensile load.

During elastic stress, the atomic arrangement in the space lattice changes. If the load is relieved, the atoms return to their original position (see Figure 1.2). Plastic deformation means that half of the atoms are displaced. This can be explained by the fact that in the crystal there are arrangements that deviate from the ideal structure - the so-called dislocations. If chromium is added, they either move out of the crystal or remain in the crystalline metal body. The dislocation sources constantly produce new dislocations. The further the deformation, the more dislocations are formed. The remaining dislocations, however, make it more difficult for the other dislocations to migrate. Solidification occurs. It finally becomes so great that the forces necessary for deformation become greater than the forces overcoming the metallic bond. The metal breaks or cracks.

To avoid such catastrophe, one must interrupt the deformation process and soften the metal by heating it. This eliminates the consequences of plastic deformation - i.e. the gathered dislocations. A new core formation occurs. The metal is again in a state that makes further deformation possible.

Text explanations

1. the razor blade - бритвенное лезвие
2. let go - отпущенный

XII. Divide the sentences containing the data on the elasticity and plasticity of metals into two groups: Group A - about elasticity, Group B - about plasticity.

1. A thin piece of metal can be bent, but then it returns to its initial shape. 2. A piece of metal remains deformed even after the applied force is removed. 3. When the load is removed from a metal body, the atoms return to their original position. 4. During deformation, the dislocation sources produce new dislocations, solidification occurs, the metal breaks.

XIII. Read text A again and find in it the answer to the question:

What should be done to avoid the breaking or cracking of plastic metals?

XIV Choose the assertion that expresses the main idea of the text.

1. This text is about the deformation conditions of metals.
2. This text is about elasticity and plasticity as metallic properties.
3 This text is about the bending and cracking of metals.
4. This text is about how to change the space lattice of metals.

XV Characterise the elasticity and plasticity of metals. Use the following words and word combinations.

take the initial form, remain deformed, behave plastically, react elastically, return to the original position, form dislocations, avoid fracturing, soften the metal, eliminate the dislocations, be able to deform the metal again.

XVI. Read text B and determine what fatigue fracture means.

TEXT B
ABOUT THE PERMANENT FRACTURES[1]

In the middle of the last century, the engineer August Wöhler investigated the behaviour of iron and steel under constantly changing stress. This was necessary because many machine parts and entire constructions are subjected to dynamic stress, i.e. the type and magnitude of the stress is constantly changing. Under such conditions, it can happen that the steel breaks. This is called fatigue fracture.

Fatigue fractures are dangerous because they do not occur through plastic deformation, but because they occur at stresses that are far below the tensile, compressive or flexural strength[2] of the metal.
For two decades, August Wöhler investigated the relationship between the magnitude of the load and the number of load cycles[3] and summarised the Wöhler curve4 , which is named after him today. The Wöhler curve is still used by engineers and designers in their work today.
The great importance of investigating the metal strength of dynamically stressed constructions becomes clear when one knows that 90% of all fractures of machine parts are fatigue fractures.

Text explanations
1. Fatigue fracture - усталостный излом, разрушение от усталости.
2. Tensile, compressive or flexural strength - предел прочности на разрыв, на сжатие или на изгиб.
3. The number of load cycles - число циклов нагружения.
4. The wöhler curve - кривая велера.

XVII. Say in what the danger of fatigue failure in the exploitation of metal products consists.

XVIII. Read text C and say what its heading can mean.

TEXT C
LEAD IS ALLOYED WITH LEAD

Lead is a plastic and not an elastic metal. This is explained by the fact that there are free dislocations in the space lattice of this metal. They are constantly made to migrate. In order to reduce the plasticity of the lead and thus increase its elasticity, the dislocations must be firmly anchored[1]. To achieve this, the lead is placed in a nuclear reactor. When bombarded with neutrons[2], the atoms of the metal wander in the space lattice until they come to a dislocation. There, the atoms and the dislocations become mutually anchored. After a permanent neutron bombardment[2], only a few free dislocations remain. This makes the lead more elastic.

Text explanations

1. anchor - скреплять, укреплять, закреплять.
2. the bombardment with neutrons = the neutron bombardment - бомбардировка нейтронами.

XIX Discuss in dialogue which method of increasing the elasticity of lead is referred to in this text.

XX. Read text D carefully. To understand the text as fully as possible, look up the unknown words in the dictionary.

TEXT D
HARDENING AND ANNEALING OF METALS

Quenching red-hot steel in water and hardening it in this way is a treatment that has been known for a long time. Not all steel is hardenable. We know that the carbon content is decisive. If the steel contains very little carbon, up to 0.2% by mass, then the achievable increase in hardness is not great. What actually happens during hardening has not been known for very long. The rules, passed down from generation to generation, were treated as an arcanum[1], i.e. a secret remedy. It is said that in the last century a ship transported water from Sheffield, the famous centre of the steel industry in England, to America. The reason: the American experts believed that the quality of Sheffield steel depended on the water used for hardening. Incidentally, this assumption is not entirely wrong. Although it is primarily the composition of the steel, especially its carbon content, that is decisive, the quenchant also has an influence, although not the decisive one expected by the American entrepreneurs who wanted to compete with the Sheffield steel industry.

One of the special properties of iron is that the cu-bisch space-centred α-iron[2] transforms into face-centred γ-iron[3] when heated. The transformation temperature is 911°C for pure iron. If carbon is added, then the iron-carbon alloy starts to transform into γ-iron at 723°C already. Depending on the carbon content, a certain line in the iron-carbon diagram indicates the end of the transformation.

What characterises hardening? While α-iron is able to dissolve a maximum of 0.02 mass percent of carbon, γ-iron can dissolve up to about 2 mass percent. If a steel is heated to such a high temperature that its structure consists only of γ-crystals, the carbon is completely dissolved. If cooled slowly, the carbon can escape from the solid solution and form cementite with some of the iron. However, if cooling is very fast, e.g. quenched in water, the time is not sufficient for the carbon to escape and it must remain in the solid solution. There are significant differences between the quenched and the slowly cooled steel. A new structural component has taken the place of the ferrite-cementite mixture. According to the scientist A. Martens, this hardness structure is called martensite.

However, with increasing hardness comes a disadvantage. The steel behaves very brittle, in the worst case similar to glass, it cannot be plastically formed and breaks under stress. To reduce this loss of toughness, tempering is carried out after quenching. During tempering, the hardened steel is heated to a temperature of about 600°C. The hardened steel is then tempered. The combination of hardening and tempering is called quenching and tempering. For each steel, the conditions, which include the hardening and tempering temperatures, the heating and cooling rates and the holding times, must be very carefully observed and adhered to. Otherwise the desired properties will not be achieved.

Hardening and tempering are the most important heat treatment processes. However, there are also other treatment processes. Some have been in use for a long time, others have only been introduced in the last few decades. Thermo-dynamic treatments are a new development. This term covers all processes in which a steel is plastically deformed and simultaneously or subsequently subjected to a temperature cycle in order to achieve favourable properties. It sounds complicated and it is, but these new heat treatment processes do much to meet the increased demands of technology on steels.

From the first obscure references to the hardening of swords4 in legendary lore5 to modern, scientifically based heat treatment technologies is a long journey of discovery, and we have by no means reached the end of it. Scientists and engineers are working together to make better and better use of the possibilities for the favourable treatment condition of a steel for a specific use and thus to improve the material economy.

Text explanations

1. the arcanum - тайное (чудодейственное) средство.
2. The cubic space-centred α-iron - объемно-центрированное α-железо.
3. the face-centred γ-iron - плоско-центрированное γ-железо
4. the sword - меч
5. the legendary traditions - сказочные предания, традиции.

XXI. Read text D again and answer the following questions.

1. What is hardening?
2. What is hardening characterised by?
3. What are the disadvantages of hardened steel?
4. How is the brittleness of hardened steel reduced?
5. What is the aim of heat treatment processes?

XXII. Give the main content of text D in writing.

UNIT V
Topic: METAL CORROSION AND CORROSION PROTECTION

ACTIVE VOCABULARY

1. the coating	окраска, покрытие
2. the vapour deposition	напыление, нанесение покрытий разложением газовой фазы
3. the treatment	обработка
4. the ore	руда
5. the danger	опасность
6. the air	воздух
7. the environment	среда
8. the means	средство
9. the surface	поверхность
10. the layer	слой
11. the protection	защита
12. the spraying	опрыскивание, нанесение (краски, металла) распылением
13. the dipping	погружение, опускание в жидкость
14. the process	метод, способ
15. the loss	потеря
16. the material	материал
17. liberate	освобождать
18. insert	применять, внедрять
19. take place	происходить
20. loosen	растворять
21. protect	защищать
22. cause	служить причиной, вызывать
23. prevent	предупреждать, предотвращать
24. act	действовать
25. gradually	постепенный
26. steadily	устойчивый, стойкий
27. dry	сухой
28. perfect	совершенный совершенно
29. immediately	тотчас
30. to a great extent	в большой мере

TASKS

I. Keep the following strong verbs in three basic forms.

attack-attack-attacked - корродировать, разъедать.
offer-bid-bid - предоставлять
invade-invade-invaded - проникать
received-obtained - получать
surrounded-surrounded - окружать

occur-occurred-occurred - встречаться
forcing-forced - принуждать

II Put the verbs in the brackets in the correct forms. Read and translate the sentences orally.

1. The science of metals ... Various processes to deform them (offer). 2. The surface of metals is ... (attack) by water. 3. Pure metals ... Very rare in nature (occur). 4. Aluminium ... (maintain) a protective layer in the air. 5. The risk of corrosion ... (force) a treatment that protects metals. 6. The losses caused by corrosion ... (amount to) large sums. 7. The bauxite ... (contain) the aluminium in the form of alumina. 8. The corrosion protection ... Also today an important task of the science as well as of the practice (remain). 9. Corrosion losses are often ... (avoid) by painting.

III Translate the sentences. In each case, choose the appropriate meaning of the verb bestehen (to exist).

exist (acc.) - выдержать, преодолеть (что-либо).
exist (since dat.) - существовать (с какого-либо времени)
insist (on dat.) - настаивать (на чем-либо)
consist (of dat.) - состоять (из чего-либо)
consist (in dat.) - заключаться (в чем-либо)
pass (before dat.) - устоять (перед чем-либо).

1. He passed the exam with "good". 2. There are great differences between different metals. 3. Atoms consist of nuclei and neutrons. 4. The Institute of Mining and Metallurgy has existed since 1934. 5. Most iron ores are made of iron oxide. 6. The task of science is to find new methods of protecting metals against corrosion. 7. When a metal or alloy resists corrosion, it is called corrosion resistant. 8. Steel consists not only of iron and carbon, it may also contain other alloying elements. 9. M.V. Lomonosov had the right to insist on his assertion that metals are shiny hammerable bodies. 10. Galvanised objects last much longer before corrosion.

IV. Read the following internationalisms. Say their Russian meanings.

the bauxite, electroplating, corrosion, oxide, plating; corrode; resist corrosion.

V. Translate the following nouns (Appendix 1, § 1 "Word formation").

a) the solution, the environment, the action, the compound, the condition, the destruction, the treatment, the deliverance, the prevention, the effect;

b) the strength, the resistance, the possibility, the importance, the freedom, the corrosion resistance, the conductivity, the dependence, the equality, the purity.

VI. Translate the following word compounds.*

the water - the aqueous solution
number - the numerous processes

surface - the superficial treatment
the danger - the dangerous effect
nature - the natural protection against corrosion
consist (устоять) - the resistant metals.

VII Read the compound nouns. Derive their meanings from the meanings of their components (Appendix 1, § 1 "Word formation").

a) the metal oxide, the iron ore, the iron oxide, the aluminium oxide, the material, the corrosion loss, the corrosion risk, the surface, the metal vapour;

(b) the aluminium oxide layer, the surface treatment , the ferrous metal object, the steel part treatment.

VIII. Find the word in each row that has a generalised meaning for that row of words.*

a) corrosion resistance, b) colour, c) alloyability, d) property, e) strength
a) the year, b) the decade , c) the century, d) the time, e) the hour
a) the environment, b) the air, c) the water, d) the gas, e) the solution
a) protection, b) corrosion, c) exposure, d) deformation, e) destruction
a) electroplating, b) protection, c) vapour deposition, d) plating, e) coating
a) acting, b) loosening, c) penetrating, d) intervening, e) protecting

IX. Choose the correct translation of the words in bold.*

1. metal oxides are more stable than pure metals.

а) металлические руды, б) металлические предметы, в) металлические окислы, г) металлические соединения.

2. most metals occur as metal compounds.

а) встречаются, б) происходят, в) освобождаются, г) действуют.

3. bauxite contains aluminium as aluminium oxide.

а) получает, б) содержит, в) сохраняет, г) соединяет.

4. during corrosion, metals are destroyed by the surrounding environment.

а) воздействие, б) опасность, в) поверхность, г) среда.

Corrosion causes great losses.

а) потери, б) средства, в) методы защиты, г) слои

6. corrosion gradually penetrates the metals.

а) прочно, б) медленно, в) постоянно, г) постепенно.

7. there are no perfectly corrosion-resistant steels.

а) совершенно, б) сразу, в) насухо, г) почти.

8. in chemical corrosion, dry gases have a destructive effect.

а) разрушают, б) разрушающе, в) разрушаются, г) разрушены.

9. the simplest protection is achieved by painting.

а) простой, б) проще, в) простейший, г) более простой.

10. electroplating offers great possibilities of metal protection.

а) трудности, б) опасности, в) возможности, г) потери.

X. Write out the word compounds "subject + predicate" from the following sentences. Determine what these main clause links are expressed with (Appendix

1, § 2 "General").

1 The most important iron ores consist of iron oxide. 2. Metallurgical processes free the metals from chemical compounds. 3. The risk of corrosion can be prevented. 4. A distinction is made between chemical and electrochemical corrosion. 5. There are many means of protecting metals against corrosion. 6. Water has a destructive effect. 7. An oxide layer forms on the surface of the aluminium when exposed to air. 8. Some metals are destroyed very quickly, the others are more resistant. 9. Copper wire is plastic.

XI. Find adjectives and adverbs in the comparative and superlative in the text A and translate them (Appendix 1, § 3 "The degrees of intensification of adjectives and adverbs").

Sample A: Steel is stronger than iron. Firmer - тверже.

Pattern B: The most commonly used metal alloy is steel. Most - больше всего.

XII. Read text A and determine what corrosion is and what procedures are worked out to eliminate it.

TEXT A
CORROSION AND CORROSION PROTECTION OF METALS

Many chemical compounds, e.g. the metal oxides, are more stable than the metals under normal conditions. That is why most metals do not occur as pure metals, but as chemical compounds. The most important iron ores consist of ironoxide, bauxite contains aluminium, etc. Metallurgical processes free the metals from the chemical compounds. But the results of human work are largely undone by corrosion[1].

Corrosion is the destruction of metallic materials by the action of the surrounding environment. Corrosion causes great losses. For example, the corrosion losses of steel in the world are estimated at €50 million per year[2].

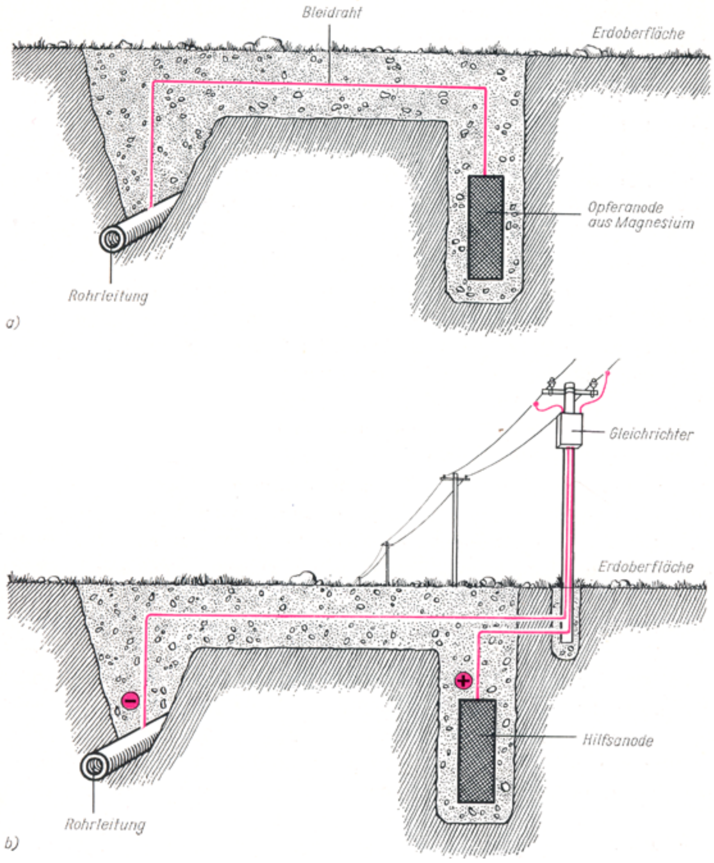

Figure 1.3. Cathodic corrosion protection
a) with sacrificial anode made of magnesium
b) with auxiliary anode and external current

The risk of corrosion also forces the use of significant means of preventive protection.

Corrosion has many faces, but it always starts on the surface of the metals and gradually penetrates them. Different metals do not corrode in the same way, some are destroyed very quickly, others are more resistant. However, there is no metal that is completely resistant to corrosion.

A distinction is made between chemical and electrochemical corrosion. If the metallic material is only attacked by dry gases, then it is chemical corrosion. In the case of electrochemical corrosion, the aqueous solutions have a destructive effect.

With some metals, natural corrosion protection takes place. Aluminium very quickly forms a thin aluminium oxide layer on its surface when exposed to air. If it is destroyed, it immediately forms anew at this point. But this rarely happens. Usually, a lot of force is used for corrosion protection.

The simplest protection is achieved by painting. They protect the surface of the metal objects from the environment. Apart from paint coats, there are many other surface treatments. For example, steel parts are given a zinc coating by dipping them in molten zinc. Other options include plating, metal spraying and vapour deposition of metals on surfaces, electroplating and other protective methods.

Text explanations

1. undo - отменять, аннулировать.
2. estimate on (a number) - оценивать в (какое-либо число).

XIII Express your agreement or disagreement with the following assertions. In doing so, begin with yes or no.

Sample A: Six metals were known in Lomonosov's time. - Yes, six metals were known in Lomonosov's time.

Pattern B: Today, six metals are known. - No, not six but 80 metals are known today.

1. Metal compounds are more stable than metals. 2. Most metals occur pure in nature. 3. The most important iron ores contain iron oxides. 4. Bauxite contains mercury oxide. 5. The Коrrosion does not cause metal loss. 6. Significant agents are used for corrosion protection. 7. The different metals do not corrode in the same way. 8. All metals are destroyed very quickly. 9. A distinction is made between chemical and electrochemical corrosion. 10. Natural corrosion protection usually occurs with all metals.

XIV. Read text A again and find the answer to the following question: What is corrosion?

XV. Divide text A into more or less self-contained parts. Say what each part is talking about.

XVI. Look at Figure 1.3 and say what processes are shown on it.

XVII. Read text B and find the answer how and for what a metal is sacrificed.

TEXT B
A METAL IS SACRIFICED[1]

Sir Humphry Davy[2] was one of the most important chemists of the 19th century and president of the oldest English Academy of Sciences. He found that copper can be protected vor corrosion in salt water if there is iron or zinc there. The salt water destroys iron or zinc, copper is spared[3], as long as there is still some of one or the other metal. Davy asked himself what practical significance this could have. In 1824 he recommended to the British Admiralty his method of protecting the copper plating4 of ships which was below the waterline. But something happened that Davy had not foreseen. If iron was there, so no copper ions formed to protect the ship from being overgrown with marine organisms. This led to a significant reduction in the speed of the ships. Davy's method was rejected because of this. Much later, when man ships began to be built of steel, people returned to Davy's idea. Admiral ships were given zinc plates as sacrificial anodes to protect the steel from corrosion. This made the risk of corrosion of the ship's propeller, which was made of Bronze, much smaller.

Text explanations

1. sacrifice - жертвовать
2. sir humphry davy - сэр Хэмфри Дейви
3. spare - щадить
4. the copper fitting - медная обшивка (корабля).

XVIII. Report in English what discovery is referred to in text B.

XIX. Read text C and state what is the novelty of the method of corrosion protection of metals described in it.

TEXT C
NEW CORROSION PROTECTION METHOD

A new method for protecting the metal has been developed by scientists at the Institute of Inorganic Chemistry in Novosibirsk. It consists of microplasma discharges[1] occurring between the metal surface covered with a thin anode layer and the electrolyte under certain conditions. Under theirer influence, a protective shell is created over the metal. At the same time, this process makes it possible to combine the protective layer with oxygen compounds and thus change its physico-chemical properties.

Text explanation

1. Microplasma discharge - микроплазменный разряд.

XX. In the dialogue, discuss where the anti-corrosion method described in Text C was devised and how it works.

XXI. Read text D. To understand the text as fully as possible, look up the unknown words in the dictionary.

TEXT D
PRODUCTION AND DEVELOPMENT
CORROSION RESISTANT STEELS AND ALLOYS

In black metallurgy, there are various ways to protect metals from corrosion. Thus, metallic or non-metallic protective coatings can be applied to sheet metal, pipes and other products. In addition, corrosion-resistant steels can be produced. The share of corrosion-resistant steels in total production is relatively small, amounting to about 1%. Nevertheless, the production of corrosion-resistant steels consumes the large amount of alloying elements, such as chromium, nickel, molybdenum, niobium, titanium, etc., which are not always readily available.

The constantly increasing demands on corrosion-resistant steels, the transition to higher temperatures and pressures, accelerated process sequences, greater mechanical loads and the use of aggressive media required the improvement of the service properties of the

steels and alloys used.

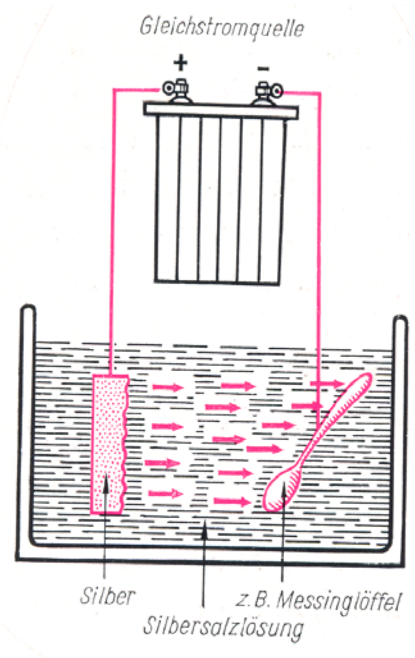

Figure 1.4: Schematic representation of galvanic silver plating.

As a rule, the demands for improved properties are met by an additional alloying effort. The increased consumption of alloying elements and considerable technological difficulties make one look for new or further developed technologies. Particular attention is paid to technologies that make it possible to produce steels with improved corrosion resistance.

The necessary solution of many tasks in this direction is closely connected with the technologies, which themselves determine the assortment. Obviously, the technology must be developed in three directions simultaneously:

- Perfection of metallurgy with the character of mass production for the production of corrosion resistant steels of uncomplicated chemical composition. For this production, the equipment of secondary metallurgy and modern processes must be used.
- Improvement of known and development of new metallurgical processes for the production of complex alloyed corrosion-resistant steels and alloys and those of significantly higher purity.
- Creation of fundamentally new technologies for the production of highly corrosion-resistant alloys for use in extreme conditions on the basis of such processes as powder metallurgy, production of amorphous materials, etc. Such technology should be directed mainly towards the production of materials with complicated chemical composition, which cannot be produced by classical technologies.

XXII. Read text D again and say which assertions correspond to its content.

1. In black metallurgy there are different corrosion protection processes.
2. Protective coatings are applied to metallic products.

3. Corrosion-resistant steels are produced.
4. Almost 100% of steels are corrosion resistant.
5. The most commonly used alloying elements are chromium, nickel, niobium and titanium.
6. The demands for improved properties of the metal cannot be met.
7. The constantly increasing demands on metallic materials make it necessary to look for new technologies and develop the old ones.
8. The technologies for the production of steels with improved corrosion resistance cannot be further developed.
9) The technologies for the production of steels with improved corrosion resistance can be developed at least in three directions.
10. Mass production of corrosion resistant steels of uncomplicated composition should be improved.
11. Not to pay attention to mass production of corrosion resistant steels of uncomplicated composition.
12) Use secondary metallurgy equipment and modern processes.
13) One of the directions is to develop only the processes for the production of steels and alloys of the highest purity.
14) One of the directions is to further improve the processes that can be used for the production of complex alloyed steels.
15) New technologies for the production of corrosion-resistant steels and alloys should also be created in principle.
16. New materials with complicated chemical composition can also be produced by classical technologies.

XXIII Give the content of the text D in English. Use the assertions from task XXII that correspond to its content.

XXIV Look at Figure 1.4 above and describe the process of galvanic silver plating. Work in pairs.

UNIT VI
Topic: IRON AND CARBON

ACTIVE VOCABULARY

1. the requirement	потребность
2. the ingredient	составная часть
3. the eutectic	металлургия черных металлов
4. the eutectic	эвтектика
5. the progress	прогресс
6. the structure	строение, кристаллическая структура
7. the content	содержание, вместимость
8. the grain	зерно
9. the mass percent	весовой (объемный) процент
10. the quantity	количество
11. the mixture	смесь
12. the pig iron	чугун
13. the distribution	распределение
14. the tool steel	инструментальная литая сталь
15. the toughness	вязкость
16. the addition	добавка, присадка
17. designate	обозначать, называть
18. harden	закаливать, подвергать закалке
19. to hit (hit, hit)	встречать
20. assign	добавлять легирующий элемент
21. low	малый, незначительный
22. hard	твёрдый, крепкий, жесткий
23. highly wear-resistant	в высокой степени износостойкий
24. primary	первичный
25. hypereutectic	заэвтентический
26. direct	непосредственный
27. wear-resistant	износостойкий
28. tough	вязкий
29. primarily	в первую очередь
30. in honour	в честь

TASKS

I. Name the basic forms of the following verbs.

to meet, to grow, to be, to arise, to alloy, to increase, to rise, to harden, to become, to reach, to contain, to denote, to connect, to be called, to ascertain, to name.

II. Write the initial forms of the following verbs.

a) is, grows, rises, occurs, becomes, meets, exists, is called, melts, happens;

b) alloyed, hardened, reached, designated, connected, bound, called, formed, hit, attacked, forced;

c) determining, alloying, increasing, significant, preventing, liberating, penetrating, proceeding.

III. Determine the syntactic function of the verb forms in bold.*

1. Carbon **occurs** in cast iron in the form of graphite. 2. Iron becomes steel when carbon **is added**. 3. As the carbon content increases, the strength of the iron increases. 4. The amount of alloying additions **determines** the properties of the steel. 5. Iron carbide, **formed** from molten iron and therefore called primary cementite, **is contained** in pig iron. 6. Pure iron is a silver-grey, shiny metal. 7. Cast iron **contains** more carbon than steel. 8. Significant agents **are used** for the preventive protection of metals. 9. Metallurgical processes release the metal from chemical compounds. 10. In electrochemical corrosion, the aqueous solutions have a destructive effect.

IV. Read the following internationalisms and name their Russian equivalents.

the steel (pl the steels), line, mass percent, limit, element, form, carbide, ferrite, perlite, cementite, ledeburite, eutectic, professor (pl the professors), metallographer; produce , corrode, alloy; chemical, eutectic, hypereutectic, special, metallic, elemental.

V. Translate the following words related to word formation (Appendix 1, § 1 "Word Formation").

a) denote - the designation, distribute - the distribution, mix - the mixture, alloy - the alloying, change - the change, treat - the treatment;

b) durable - the resistance, solid - the strength, tough - the toughness, dependent - the dependence, mutable - the mutability, cast - the castability, wear-resistant - the wear-resistance;

c) hard - the hardness - hardening;

d) alloyed - unalloyed, indirect - direct, stable - unstable, definite - indefinite, dependent - independent, bound - unbound;

e) add - the addition, require - the need.

VI Read the compound nouns. Derive their meanings from the meanings of their components (Appendix 1, § 1 "Word Formation").

(a) the non-metal, carbon content, tool steel, percentage by mass, alloying addition, carbon steel, iron carbide, carbon atom, iron carbide grain, pig iron, structural component, primary cementite, alloy content, treatment condition, material, iron alloy, transformability, cast iron;

(b) alloying and treatment techniques, wear and corrosion resistance.

VII. Find an adjective or adverb in the comparative in each series.*

a) immediate, b) slight, c) harder, d) soft;

a) dependent, b) firmer, c) primary, d) hard;

a) less, b) resistant, c) thin, d) thick;
a) silver-grey, b) inverted, c) elementary, d) more

VIII. In each row, find the word whose meaning is given at the beginning of the row.*

потребность: a) the ingredient, b) the addition, c) the treatment, d) the need.
структура: a) the mixture, b) the mixture, c) the structure, d) the distribution.
содержание: a) the agent, b) the environment, c) the toughness, d) the content.
количество: a) the quantity, b) the grain, c) the mass percentage, d) the progress
закаливать: a) meet, b) harden, c) grow, d) alloy.
обозначать: a) to form, b) to heiβen, c) to denote, d) to hold on to
износостойкий: a) wear-resistant, b) corrosion-resistant, c) hypereutectic, d) immediate.
первичный: a) hard, b) low, c) tough, d) primary.

IX. Choose the correct translation of the words in bold.*

1. It is only when iron is alloyed that es becomes harder and stronger.
а) первый, б) вначале, в) только, г) однажды.
2. The stronger the steel becomes, the less tough it is.
а) как..., так и..., б) не только..., но и..., в) чем..., тем..., г) или... или....
3. Carbon in highly wear-resistant steels increases by up to 2% by mass.
а) к, б) при, в) с, г) до
4. Therefore, the structure of a carbon steel consists of iron and iron carbide.
а) поэтому, б) так как, в) этим самым, г) тогда.
5. The reference here is to a eutectic.
а) в этом, б) тогда, в) у этого, г) при этом.
6. Iron alloys are mainly allem steels used in engineering nennen.
а) до всего, б) при всем, в) прежде всего, г) у всего.
7. Iron melts at 1541°C and thus belongs to the high-melting me-tals.
а) вместе с этим, б) с этим, в) тем самым, г) с тем.
8. 2 to 4 masses of carbon are contained in the iron.
а) около, б) что-то, в) чем-то, г) больше.

X. Say what the predicate is expressed by in the following sentences. Translate the sentences in writing (Appendix 1, § 6 "Infinitive").

1. Carbon is to be alloyed with pure iron. 2. To increase the strength of the steels, it is to be hardened. 3. In addition to the perlite and cementite, another structural constituent, the ledeburite, can be found in the pig iron. 4. Primary cementite can be observed in hypereutectic pig iron in addition to ledeburite. 5. Various space lattices are observed during heating and cooling in iron, titanium and some other metals. 6. Different iron products can be distinguished, depending on the type and amount of alloying addition. 7. Some properties of iron important for engineering should be mentioned. 8. Corrosion is to be considered as the destruction of the metal by the action of the surrounding environment. 9. A

distinction should be made between chemical and electrochemical corrosion. 10. Die protective layer is to be combined with oxygen compounds and thereby the physical properties of the materials are to be changed.

XI. In the text, find A sentence structures (Appendix 1, § 9 "The sentence structure"), determine the type of subordinate clauses. Translate the sentences.

XII. Read text A and determine the importance of carbon in black metallurgy.

TEXT A
IRON + CARBON

Scientific and technological progress would be impossible without iron and steel. We encounter this metal everywhere. Mankind's need for iron and steel is growing ever faster.

Pure iron is soft, its strength is low. Only when iron is alloyed does it become harder and stronger. Iron becomes steel when carbon is added. This non-metal works wonders. As the carbon content increases, the strength increases and the steel can be hardened, but the stronger it becomes, the less tough it is. Tool steels, where hardness is primarily important, contain 0.4 to 1.5 mass percent carbon and more. The carbon in highly wear-resistant steels increases up to 2 mass percent. However, this is the upper limit for the carbon content of steels.

If the steel does not contain any elements other than carbon as alloying additions, then it es an unalloyed steel. Sometimes it is also called carbon steel.

The carbon forms a chemical compound with the iron. It is the iron carbide Fe3C, in which three iron atoms and one carbon atom are bonded. Therefore, the structure of an unalloyed steel consists aus of a mixture of iron and iron carbide grains. The amount and form of the iron carbide and its distribution in the structure determine the strength, hardness and toughness of the steel. The metallographer calls the iron grains ferrite and iron carbide cementite. A special order of ferrite and cementite is called perlite. In addition to perlite and cementite, another structural component, ledeburite, can be found in pig iron. Es is a eutectic, which is named in honour of the Freiberg professor of iron metallurgy Alfred Ledebur. In the hypereutectic pig iron, besides ledeburite, iron carbide formed directly from the melt and therefore called primary cementite can be observed.

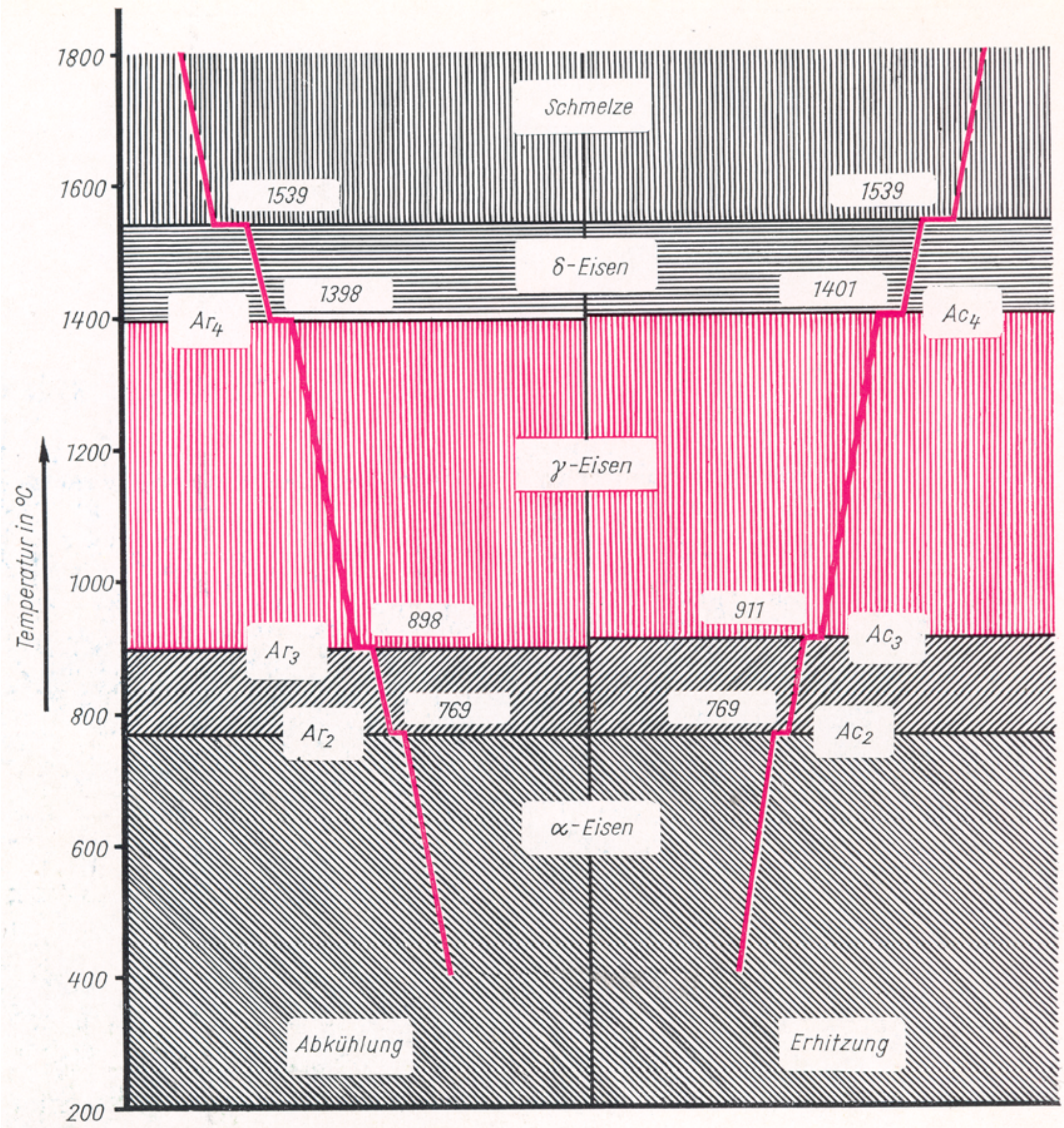

Figure 1.5. Heating and cooling curves of iron

XIII Express your agreement or disagreement with the following assertions. Start with yes, this is true or no, this is not true.

1. Pure iron is hard. 2. Iron becomes hard only when alloyed. 3. Tool steels contain 4 to 15 mass percent carbon and more. 4. An unalloyed steel is also called a carbon steel. 5. The carbon forms a chemical compound with the iron. 6. Iron carbide consists of iron, carbon and alloying additions. 7. The metallographer calls the iron grains cementite and iron carbide ferrite. 8. In pig iron there is another component, ledeburite.

XIV. Read text A again and answer the following question:

What constituents can steel contain?

XV. Formulate the main idea of text A. Start with the cliché: This text reports about ...

XVI. Report in English about the interaction of iron and carbon. Use the word combinations given below.

To be soft, to alloy iron with carbon, to become harder, to be less tough, to form mild steel, to consist of iron and iron carbide grains, to be determinant of strength, hardness and toughness, to be called ferrite and cimentite.

XVII. Using the diagram (Figure 1.5) describe the processes of heating and cooling of iron shown.

XVIII. Read text B and determine what the mutability of iron consists of.

TEXT B
IRON AND ITS SPECIAL PROPERTIES

No metal is more transformable[1] by alloying and by special treatments than iron. Depending von the type and amount of alloy content and the state of treatment, metallic materials with completely different properties are produced. There are mehr than 1200 iron alloys. These are mainly steels used in engineering.

The mutability[2] of iron is explained by its special properties. Pure iron is silver-grey, shiny metal with a density of 7.87g/cm3. It melts at 1541°C and thus belongs to the high-melting metals. When we heat iron, something strange happens[3]. At a temperature of 911°C, the space lattice changes. The second change in the space lattice occurs at 1401°C. This twofold transformation proceeds in reverse when cooling from the melting temperature. The different forms of iron are called α-, γ- and δ-iron.

Apart from iron, there are other metals, e.g. titanium, in which different space lattices can be observed depending on the temperature, but in no metal are they as important for alloying and treatment techniques as in iron.

Text explanations

1. mutability - подверженный превращениям.
2. mutability - способность к превращениям.
3. something strange - нечто удивительное, поразительное.

XIX. Report in Russian about the special properties of iron.

XX. Read text C and say what is the main difference between cast iron and steel.

TEXT C
WHAT IS THE DIFFERENCE BETWEEN CAST IRON AND STEEL?

Cast iron is auch a product of iron treatment. But it is very different from steel. Cast iron contains more carbon, between 2 and 4% by mass. It is ten times more than in mild steel. Whereas in steel the carbon is chemically bonded to the iron as iron carbide or, as the metallurgist calls it, cementite, in cast iron it occurs in its elemental form as graphite. The structure of cast iron therefore consists of iron grains (ferrite) and graphite lamellae[1]. The presence of graphite lamellae means that cast iron has a lower tensile strength than steel. However, its compressive strength is correspondingly higher.

The advantages of cast iron include its relatively low melting temperature, which is several hundred degrees lower than that of steel, its excellent castability, and its better resistance to wear and corrosion than unalloyed steel.

Text explanations

1. graphite lamella - пластинка графита
2. accordingly - соответственно
3. the advantage - преимущество.

XXI. Discuss the structure of cast iron in dialogue.

XXII. Read text D. To understand the text as fully as possible, look up the unknown words in the dictionary.

TEXT D
STEEL

The most commonly used ferrous material is steel. Its production from pig iron and scrap requires more metallurgical effort than the other ferrous materials. It is difficult to establish a precise distinction between steel and other ferrous materials. Very often the carbon content als the distinguishing feature, according to which all iron alloys below 2.0% carbon als steel and cast steel and those with 2.0 to 4.55% are called cast iron. But using the example of ledeburitic chromium steel with 2.1% carbon, it can be seen that this distinction is insufficient. It is also not possible to distinguish steels from other ferrous materials by means of their properties. Meltability or hardenability are often mentioned as characteristic properties of steels. But grey cast iron, a variety of cast iron, is also formable. It is probably most appropriate to include under the term steel all ferrous materials that are not pig iron, cast iron or pure iron. Cast iron includes grey cast iron, chilled cast iron, chilled cast iron and malleable cast iron. Cast steel, which is similar in its properties to forged or rolled steel, does not fall into this group.

There are various classification principles for the immense variety of steels. In the literature, a distinction is often made between flux-cast steel and welded steel, depending on whether the iron alloy was produced above or below its melting point. Since processes for the production of flux-cored steel are currently no longer technically used, this distinction has only historical significance.

However, the differentiation of steels according to their production process is significant. The most important raw materials for steel production, pig iron and scrap, are available in different proportions, in different compositions, in different forms, e.g. liquid or solid in the case of pig iron, depending on local conditions. For these reasons, various metallurgical processes have proven to be economically expedient. There are two basic types of production equipment: hearth furnaces heated by flames or electric current, which are mainly used when the metallic charge is predominantly solid, and converters without auβen heating, which are used when the charge is liquid. Accordingly, a distinction is made between SM steel and electrical steel on the one hand and Thomas, Bessemer and oxygen steel on the other. The differences between the mentioned types of steels are of great importance for a material expert. For example, Thomas steels are characterised by an increased nitrogen and phosphorus content. In general, converter steels have very low hydrogen contents.

Further designations or distinctions of the individual steels refer to their intended use (structural steels and tool steels), their further processing (heat-treatable steels, nitriding steels, case-hardening steels), their design form (wide flat steel, bar steel, tube steel) and to characteristic alloying elements (carbon steel, nickel steel, chrome-nickel steel). A distinction is made between unalloyed, alloyed and low-alloyed steels according to the alloying element content. There is also a division into bulk steels, quality steels and stainless steels. Stainless steels are steels with consistent suitability for heat treatment and/or physico-chemical properties. If alloy steels are not heat treated, they belong to Massen and quality steels. This applies, for example, to silicon alloy transformer steel.

It is customary not to include technically pure iron among the steels. However, it is becoming increasingly important as a material and is produced both by melting processes and by electrolysis or powder metallurgy processes.

XXIII. Read text D again and say which assertions correspond to its content.

1. Сталь - это чаще всего применяемый, железный производственный материал.
2. Трудно установить границу между сталью и другими производственными материалами из железа.
3. Все сплавы железа с содержанием углерода до 2% называются сталью или стальным литьем.
4. Все сплавы железа с содержанием углерода свыше 2% не относятся к стали.
5. В качестве отличительных признаков стали называют ковкость и закаливаемость.
6. Серый чугун не поддается ковке.
7. К литому чугуну относятся серый чугун, отбеленный чугун, чугун с отбеленной поверхностью и ковкий чугун.
8. Стальное литье не относится к стали.
9. В литературе господствует разделение стали на литую и сварочную.
10. Различие литой и сварочной стали имеет теперь только для истории.
11. Различие между литой и сварочной сталью базируется на температурных условиях их производства.
12. Очень важным является различие сталей по способу их производства.
13. Сталь производится только из чугуна.
14. Важнейшим сырьем для производства стали являются чугун и скрап.

15. Прежде всего следует назвать два принципиально различных металлургических процесса: мартеновский и конверторный.

16. В мартеновском производстве сталь выплавляется в подовых печах без подогрева.

17. В. конверторах сталь дополнительно нагревается в процессе плавки.

18. Различие между мартеновской сталью, с одной стороны, и томасовской, бессемеровской и кислородно-конверторной – с другой, имеют большое значение для специалиста-металловеда.

19. Наиболее важной является классификация сталей по сфере их применения.

20. Наиболее важной является классификация сталей по способу их дальнейшей переработки.

21.Существуют различные классификации сталей: по способу производства, по сфере применения, по методу обработки, по форме выполнения, по составу легирующих элементов и т.д.

22. Чистое железо, которое, как правило, не относится к сталям, находит все большее применение.

XXIV Reproduce Text D in Russian. Use the statements from Task XXIII that correspond to its content.

UNIT VII
Topic: NON-IRON METALS

ACTIVE VOCABULARY

1. the area	область, сфера
2. the sheet	листовой металл, жесть
3. the non-ferrous metal	цветной металл
4. the earth crust	земная кора
5. vehicle construction	автомобилестроение
6. aircraft construction	самолетостроение
7. the commonality	общность, общая черта
8. the raw material	сырье
9. the jewellery	украшение
10. the representative	представитель
11. the advantage	преимущество
12. the value	ценность, цена, стоимость
13. discover	открывать
14. enable	делать возможным
15. use	употреблять, применять
16. win (won, won)	добывать, получать
17. produce	изготовлять
18. process	обрабатывать, перерабатывать
19. displace	вытеснять
20. represent	представлять
21. tin	лудить
22. excellent	отличный
23. workable	обрабатываемый, поддающийся обработке
24. noble	благородный, драгоценный
25. frequent	частый
26. excellent	выдающийся
27. essential	существенный
28. against	напротив, зато
29. first	вначале
30. opposite to	в противоположность чему-л.

TASKS

I. Name the basic forms of the following verbs.

gain, process, use, become, use, make, find, get, represent, displace, employ, enable, count, occur, achieve, discover.

II. Write the initial form of the verbs in bold.*

1. Gold was the first metal to be extracted and processed. 2. Aluminium

represents the group of light metals. 3. Titanium **was discovered** three times. 4. Copper **is displacing** silver in electronics and electrical engineering. 5. Tin **is used** for the production of tinplate. 6. Aluminium is the most common metal. 7. Pure metals **are produced** by metallurgical processes. 8. The properties **obtained** by alloying enable the use of this metal in aircraft construction. 9. Aluminium **melts** at the temperature of 660ºc. 10. Titanium **behaves** as a metallic chameleon.

III. Read the following internationalisms and name their Russian equivalents.

career, photography, electronics, electrical engineering, production, canning, competition, chocolate, staniol, foil, container, stage; analyse; practical, electrical, interesting, reactive.

IV. Translate the following words related to word formation (Appendix 1, § 1 "Word Formation").

a) dense - the density, common - the commonality, liquid - the liquid, represent - the representative, weigh - the weight, discover - the discovery;

b) cover - discover, put - make, work - process, urge - displace, find - invent, put - use, step - represent;

c) excel - excellent, signify - significant, distinguish - excellent, work - workable, forge - forgeable, cast - castable, use - useable.

V. Read the compound words. Derive their meanings from the meanings of their components (Appendix 1, § 1 "Word formation").

a) non-ferrous metal, earth bark, means of payment, basis, semiconductor technology, precious metal, jewellery, heavy metal, elecrtotechnology, tin plate, light metal, scope, tin foil, usable metal, metal extraction, metal application;

b) for days, for months, for years, for centuries, for millennia, silver-white, silver-shiny.

VI Form the comparative and superlative of the following adjectives. Translate them (Appendix 1, § 3 "The gradations of adjectives and adverbs").

Pattern: pure - purer - the purest, purest

late, important, significant, frequent, great, good, easy, low, young, different, high, small.

VII. Find the word in each row that is related in meaning to the first word in the row.*

the earth's crust: a) the earth's crust, b) the earth, c) the earth's ball, d) the earth's satellite

use: a) process, b) belong to, c) represent, d) employ

produce: a) originate, b) establish, c) determine, d) produce

process: a) harden, b) treat, c) achieve, d) use

denote: a) get, b) name, c) meet, d) increase

frequent: a) slight, b) excellent, c) often, d) dependent

essential: a) significant, b) excellent, c) distinct, d) additional minor: a) primary, b) tough, c) noble, d) small

VIII. In each row, find the word whose meaning is given at the beginning of the row.*

преимущество: a) the sheet, b) the advantage, c) the density, d) the colour.
ценность: a) the range, b) the commonality, c) the advantage, d) the value
сырье: a) the non-ferrous metal, b) the application, c) the raw material, d) the need
открывать: (a) discover, (b) develop, (c) use, (d) denote.
добывать: a) contain, b) gain, c) belong, d) consider
лудить: a) displace, b) process, c) transform, d) tin
обрабатываемый: a) workable, b) noble, c) total, d) refractory.
вначале: a) immediately, b) against, c) first, d) almost.

IX. Put the nouns given below the line in the correct sense and grammatically. Translate the sentences orally.*

1. Metals are used in all ... Of human life. 2. ... Is rich in non-ferrous metals. 3. 3. As ... For the production of aluminium is bauxite. 4. Gold was first used only as .... 5. Light metals are displacing ferrous materials from the ... 6. Non-ferrous metals have many ... Compared to ferrous materials. 7. Non-ferrous metals have many ... 8. Copper is to be mentioned as the most important ... Of the heavy metals. 9. Silver is the best electrical ... 10. Tin is used to make ...

the range, the earth's crust, the conductor, the canning sheet, the representative, the aircraft construction, the raw material, the advantage, the jewellery, the totality

X. Put together as many sentences as possible.

			the light metals
			the heavy metals
			the precious metals
			in electronics
Aluminium			in aircraft construction
Silver	belongs to	the chemical symbol	as an electrical conductor
Copper	is used	by man	as jewellery
Tin	belongs to	the group	in rocket construction
Titan			Au
Gold			Cu
			Sn
			Ti
			Ag

XI. Say what the attributes in the following sentences are expressed by. Translate the sentences.

1. Gold is the first metal to be extracted and processed. 2. The excellent properties of titanium were discovered recently. 3. Aluminium is one of the metals with the lowest density. 4. The durable metals form an excellent basis for aircraft and rocket construction. 5. Non-ferrous metals have significant advantages over ferrous materials. 6. The constantly increasing production of the non-ferrous metals is characteristic for the whole world. 7. Aluminium is the most common metal. 8. Copper is a metal that conducts electricity well. 9. Aluminium, which is easy to machine, can be formed into very thin sheets. 10. Titanium is the ninth most abundant element in the earth's crust.

XII. Find sentence structures in text A (Appendix 1, § 9 "The sentence structure"), note their translation.

XIII. Read text A and name the main representatives in different groups of non-ferrous metals.

TEXT A
NON-FERROUS METALS

In the earth's crust of our planet, many non-ferrous metals can be found, which were discovered by humans at different times. The non-ferrous metals are still called non-ferrous metals. They have many advantages over the ferrous materials.

The noble metals. Gold, the first metal to be extracted and processed by humans, made its career several times. Easily worked, it was used as jewellery. Later it became a means of payment and the basis of currencies. Today, gold has become an important material whose outstanding properties are needed above all in modern semiconductor technology.

Of the other precious metals, silver is practically the most important. For thousands of years, only jewellery was made of silver, until photography began to use it. Today, electrical engineering also uses large quantities of this metal more and more often.

The heavy metals. Among the heavy metals, copper is the most important today. It owes its role to electrical engineering and electronics, because after silver it is the best electrical conductor.

The heavy metals tin, zinc, nickel and lead also have special applications. Their extraction is constantly increasing all over the world. Tin is particularly interesting, as it is used in the production of tin-plated tinplate and in electronics.

The light metals. The light metals - the metals with the lowest density - are among the youngest metals. They gained their importance in the 20th century. Their most important representative, aluminium, is already competing with many other non-ferrous metals, even steel, in some areas of technology thanks to its excellent properties. Aluminium has replaced copper in some areas of application and when chocolate is wrapped in "tin foil" today[2], it is not tin foil but aluminium.

In vehicle and container construction, the lower weight of aluminium alloys is particularly advantageous.

The resistant metals. The reactive metals titanium, tungsten, niobium and tantalum have also not been used in technology for very long. In the meantime, they have become the basis for modern aircraft and rocket construction.

The pure metals. Semiconductor elements and the purest metals, such as silicon, selenium, galium and iodium, are known to enable the most significant progress in electronics and electrical engineering. Although they do not all chemically belong to the metals, they are counted among the raw material base of non-ferrous metallurgy.

Despite this diversity of non-ferrous metals, there are also commonalities. The non-ferrous metals - in contrast to the ferrous materials - are produced and used in smaller quantities. The value of non-ferrous metals, on the other hand, is much higher than that of ferrous materials.

Text explanations

1. owe (to someone) - быть обязанным (кому-либо чем-либо)
2. wrap up - заворачивать (в обертку).

XIV Express your agreement or disagreement with the following assertions. Start with in my opinion ... (по моему мнению ...).

1. Gold is only made into jewellery.
2. Gold has become an important material.
3. A distinction is made between non-ferrous metals and non-ferrous metals.
4. Non-ferrous metals are still called non-ferrous metals.
5. Copper is a better conductor of electricity than silver.
6. Copper is the best electrical conductor after silver.
7. The most important representative of the light metals is aluminium.
8. The silver-white sheen of aluminium is particularly advantageous in vehicle and container construction.

9) In vehicle and container construction, the lowest weight of aluminium is particularly important.

10. Resistant metals are not yet used in technology.
11. The resistant metals have become the basis for aircraft and rocket construction.

XV. Characterise each group of non-ferrous metals according to the following schedule:

1. Which metals belong to the group?
2. How long have these metals been known?
3. Where are they used?
4. What are the special features of the metals in each group?

XVI. Read text B; make an effort to understand its content as fully as possible.

TEXT B
ALUMINIUM AND ITS ALLOYS

Aluminium is one of the most important non-ferrous metals. Represented in the earth's crust at 7.5 per cent by mass, it is the most abundant metal. It is extracted from bauxite, half of which consists of aluminium oxide.
Aluminium is a shiny silver metal that conducts heat and electricity well, with a density of 2.7 gr/cm3 and a melting point of 660°C.
The special properties of aluminium are achieved by alloying it with various alloying elements. The most important alloying additions are silicon, copper, magnesium, zinc and manganese.
Seven properties are important for the technical application of aluminium and its alloys.

1. Aluminium is light; its mass is one third of that of steel.
2. Aluminium is resistant to the atmosphere and to many gases and liquids.
3. Aluminium has a high reflectivity[1] and its shine makes it look like jewellery.
4. Aluminium alloys reach and exceed[2] the strength of normal structural steels.
5. Aluminium has high elasticity and is not brittle even at low temperatures.
6. Aluminium and its alloys are easy to work, they can be shaped. Aluminium can be formed into foils of 1/100 millimetre thickness and less.
7. Aluminium is the best conductor of electric current and heat of the metals in use after copper.

The fields of application of aluminium are construction and architecture. Aluminium is also used in aircraft and vehicle construction. The production and use of aluminium is increasing.

Text explanations

1. reflectivity - способность отражаться
2. excel - превосходить.

XVII. Ask your interlocutor what aluminium items people use in their family household and what for.

XVIII. Look at the diagram given below and describe the way of bauxite to aluminium. You can use the following words and phrases.

On the diagram we see ... ; one obtains ...; the bauxite first succeeds ...; then comes the ore ...; there the mixture is ...; one gets ...; mix; dilute; refine; dehydrate; melt; submit to electrolysis

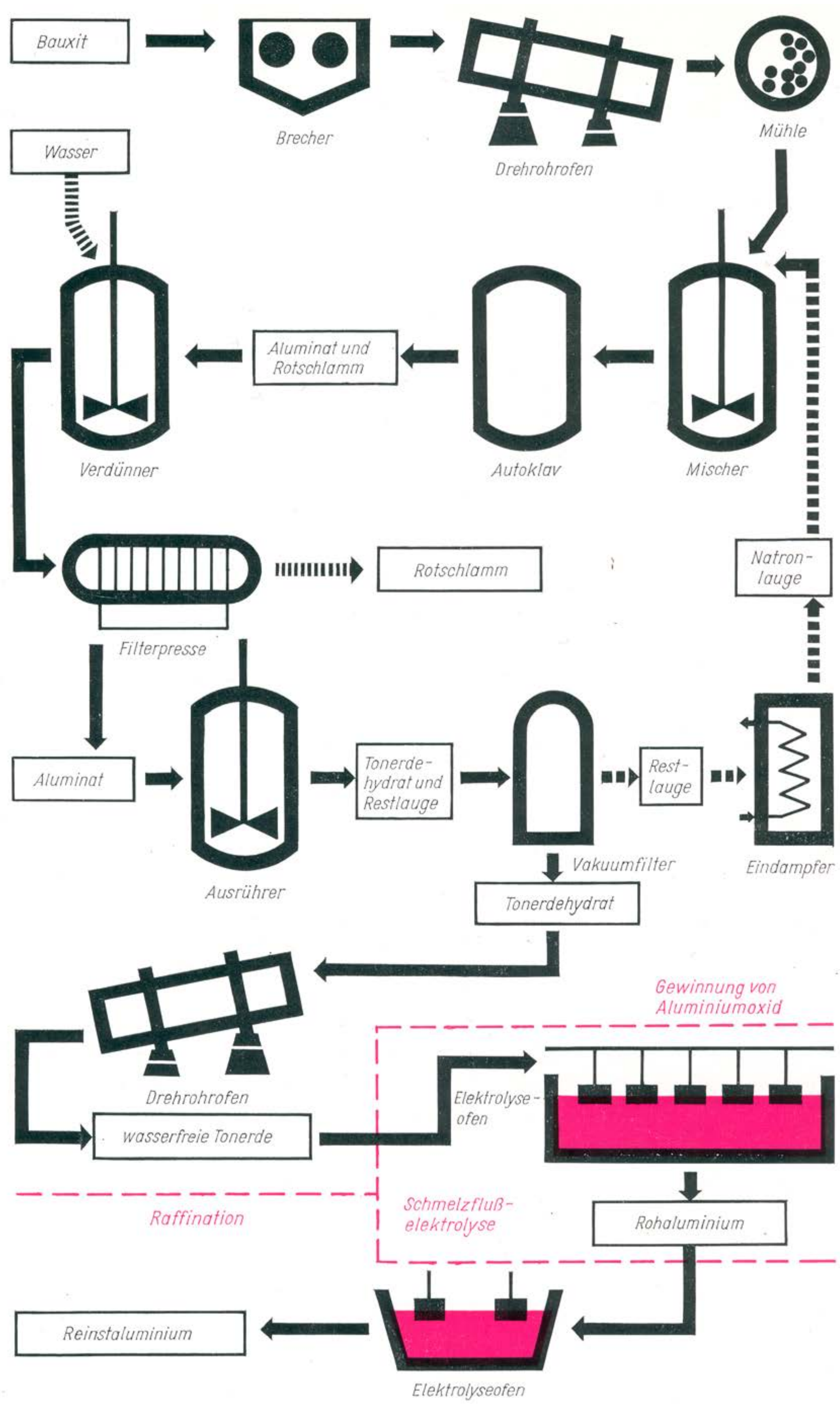

Figure 1.6. Path of aluminium from bauxite to metal

XIX Read text C and find the answers to the following questions in it.

1. Why is titanium called crystal chemical chameleon?
2. How was titanium discovered?
3. What are the properties of titanium?
4. Where is titanium used?

TEXT C
TITANIUM - A TITAN AMONG METALS

Titanium is the ninth most abundant element in the earth's crust, after oxygen, silicon, aluminium, iron, magnesium, calcium, sodium and potassium. Its total amount is about 1/20 that of aluminium and 1/10 that of iron. However, there are only some titanium ores with high titanium content. So it behaves as a crystal chemical chameleon.

Only 40 years ago, titanium was a rarity[1]. Today it is already produced in the amount of 100000 tons per year. It combines a relatively low density with excellent properties and corrosion resistance.

The discovery of titanium took place in three stages. As early as 1791, an English chemist, W. Greger, had found a blackish mineral containing the oxide of an unknown element. He called it "manaccanite". In 1875, Martin Heinrich Klaproth analysed several minerals, including ilmenite and titanite, and found that they contained an unknown metal identical to manaccanite. He named it "titanium". In 1910, M. A. Hunter obtained the free metal by reducing the oxide with sodium:

$$TiO_2 + Na = Ti + 2Na_2O$$

Titanium is a silver-white malleable metal that melts at 1670°C. Most of the titanium ores - rutile and ilmenite - are processed into titanium oxide, which is used as a white pigment in the paper, paint and plastics industries[2]. The small part is used as metal in aircraft construction and in the construction of machines and apparatus.

For both purposes, different properties are required: in aircraft construction - high strength with high temperature resistance, in machine and apparatus construction - high corrosion resistance with good strength. Such different properties can be achieved by alloying.

Text explanations

1. rarity - редкость
2. the plastic industry - промышленность искусственных материалов.

XX. Discuss the content of the text in dialogue.

XXI. Read text D. To understand the text as fully as possible, look up the unknown words in the dictionary.

TEXT D
SPECIAL METALS

Zirconium, hafnium, tantalum, niobium, tungsten and molybdenum form a special group in the periodic table of the elements. As different as their properties and their technical applications are, they have in common that they only came into the focus of technical interest a few decades ago.

The lightest of them is zirconium. Although it was discovered as early as 1789 by M. Klaproth, it was not until the 20th century that it was possible to produce pure zirconium. Like titanium, zirconium is also produced via chloride. Very pure metal is obtained when zirconium iodide is decomposed on a highly heated zirconium wire.

Zirconium is resistant to hydrochloric, nitric, sulphuric and phosphoric acids. In this respect, it surpasses titanium as well as the high-alloy steels and looks similar to steel. Its density is 6.49 g/cm^3, and its melting temperature is 1852°C. Its strength corresponds to that of higher-strength steels. With these properties already, zirconium can find a wide range of applications. But there is something more special. Zirconium is well suited as a material for nuclear reactors. It is used to make the shells of the fuel elements in reactors. The cladding material usually encloses the fuel as a thin tube and separates it from the coolant. In pressurised water reactors, the tube is surrounded by water at 200 to 300°C at high pressure. At these temperatures, the cladding material must be resistant to corrosion by pressurised water. It must also satisfy nuclear-physical conditions and must not disturb the neutron balance; it must not contain any atoms that strongly absorb neutrons. Zirconium and some zirconium alloys best fulfil these complex requirements for a design material for nuclear reactors. Very important is a high purity of the zirconium and its alloys. Above all, it must not contain any hafnium. This metal always occurs together with zirconium in nature and must be removed in complex purification processes.

Zirconium is also a very effective alloying element for steels and light metals. In steel, it improves brittleness at low temperatures, zirconium-alloyed steels are tough. In aluminium and magnesium alloys, zirconium increases strength and, to some extent, corrosion resistance.

Hafnium, the constant companion of zirconium, is chemically very similar to it and therefore also difficult to separate. Its existence was predicted by D. I. Mendeleev, and the Danish physicist Niels Bohr determined some of the properties of the as yet undiscovered element. Two of his colleagues, the Hungarian physicist G. von Hevesy and the Dutch physicist D. Goster, succeeded in discovering hafnium in 1923 with the help of X-ray spectral analysis. The element is named in honour of the Danish capital Copenhagen, whose Latin name is Hafniae.

Hafnium is a high-melting metal, its melting temperature is 1975°C. The technical use of hafnium is still in its infancy. It is strange that the metals zirconium and hafnium, which are similar in so many properties, are used in nuclear reactors for completely different purposes. But they differ in one important disposition. While zirconium is permeable to neutrons, hafnium forms an insurmountable obstacle for them. Therefore, hafnium serves as a brake substance for fast neutrons and as a neutron absorber.

The two metals tantalum and niobium are mainly used as alloying additions for special steels. They also have a high melting point, the melting temperature of tantalum is about

3000°C and of niobium - about 2415°C. Both metals are very strong and exceptionally resistant to chemical attack. Although tantalum and niobium are unknown to most of us, they have been used as special materials for many decades.
Two other refractory metals, tungsten and molybdenum, are mainly used as alloying elements for steels and nickel and copper alloys (80-90%), but they are also used as pure metals for some technical purposes because of their special properties.
At 3410°C, tungsten has the highest melting point of all metals. Its strength reaches and exceeds that of super strong steels. Tungsten is mainly used as filament wire in incandescent lamps and electron tubes, for heating elements and non-melting electrodes for inert gas welding.
Molybdenum has more modest properties than tungsten. Its melting temperature is significantly lower, at 2620°C. Its strength values are also lower. Its strength values are also lower. Molybdenum is used for some special purposes, e.g. for the accumulation of anodes and cathodes in electron tubes and for heating coils.

XXII Read text D again and say which assertions given below correspond to its content.
1. Zirconium, hafnium, tantalum, niobium, tungsten and molybdenum form a special group of the periodic table of elements.
Zirconium was discovered by m. Klaproth in 1789.
3. Pure zirconium is obtained by decomposing zirconium iodide on a highly heated zirconium wire.
4. No metal other than zirconium is obtained from chloride.
5. Zirconium and its alloys surpass titanium and high alloy steels in properties.
6. Zirconium is not used in the manufacture of nuclear reactors.
7. Zirconium as a nuclear reactor cladding material is corrosion resistant to pressurised water at high temperatures.
8. Zirconium as a nuclear reactor cladding material may contain another metal - hafnium.
9. Hafnium always occurs with zirconium in nature.
10. Zirconium is also an alloying element for steels and light metals.
11. Zirconium lowers the strength and corrosion resistance of alumi-nium and magnesium alloys.
12. Hafnium was predicted by d. I. Mendeleev.
13. Hafnium is a low-melting metal.
14. Hafnium is also used in nuclear reactors like zirconium.
15. Hafnium serves as a brake substance for fast neutrons and zirconium - as a neutron absorber.
16. Tantalum and niobium are alloying additions for special steels.
17. These metals (tantalum and niobium) are very well known to all.
18. Tungsten has the highest melting point of all metals.
19. Molybdenum is even stronger than tungsten.
20. Tungsten and molybdenum are mainly used as alloying elements and give excellent materials.

XXIII Give the content of the text in English (12-16 sentences). Use the assertions from task XXII that correspond to its content.

UNIT VIII
Topic: PRODUCTION OF RAW AND CAST IRON

ACTIVE VOCABULARY

1. the tap hole	выпусное отверстие, летка
2. the feed	шихта, колоша, садка, загружаемый материал
3. the fuel ash	зола горючих материалов
4. the cowper	каупер, воздухонагреватель
5. the nozzle	сопло, фурма
6. the ore	руда
7. the conveyor belt	транспортер
8. the blast	воздух, подаваемый воздуходувкой
9. the framework	каркас, остов
10. the rack	горн металлоприемника (доменной печи)
11. the gout	1) колошник (шахтной печи); 2) шихта, садка
12. the gout stage	колошниковая площадка
13. the gout hall	литейный цех (двор)
14. the heat	жара, тепло
15. the Hochofen	доменная печь
16. the limestone	известняк
17. the coal sack	распар (доменной печи)
18. the masonry	каменная (кирпичная) кладка
19. the rest	заплечики
20. the shaft furnace	шахтная печь
21. the inclined lift	скиповой подъемник
22. the combustion air	воздух для горения
23. the closing	затвор
24. the utilisation	применение, использование
25. the weight	удельный (объемный) вес
26. the wind heater	воздухонагреватель, каупер
27. the surcharges	присадки, добавки, флюсы
28. escape	улетучиваться, уходить, утекать
29. heat	топить, отапливать, нагревать, обогревать
30. alternate part	переменный, попеременно
31. refractory	огнеупорный
32. chalky	известковый
33. siliceous	кремнистый
34. layered	слоями
35. subsequently	дополнительно, в последующем

TASKS

I. Explain the meaning of the following compound words. Use the dictionary if necessary.
pig iron, blast furnace, shaft furnace, blast furnace gas, charge, taphole, auxiliary plant, casting hall, slag utilisation, blast furnace gas purification, coal, hot blast stove, blast furnace plant, combustion air, blast wind, brickwork, inclined lift, conveyor belt, blast furnace platform, component, fuel ash, limestone; hold together; refractory, conical, lattice, water-cooled, layered

II. Translate the following derivatives, relying on words from which they are derived (Appendix 1, § 1 "Word Formation").
the production, the filling, the switching, the opening, the measurement, the mixture, the meaning, the connection, the desulphurisation, the diameter, the height, the heat, the transition, the addition, the coking; to cool, to build up, to take in, to blow in, to take out, to heat, to transfer; again, liquid, separate, fusible, steely

III. In each row, find the word (compound) whose meaning is given at the beginning of the line.*
башня: a) the cowper, b) the part, c) the tower, d) the rest.
обладать: a) possess, b) build up, c) escape, d) follow
примыкать: a) to expand, b) to constrict, c) to join, d) to accumulate
вдувать: a) to heat, b) to cool, c) to fill, d) to blow in
подходящий: a) suitable, b) again, c) necessary, d) retrospective
внутренний: a) short, b) inner, c) upper, d) low
из-за: a) afterwards, b) together, c) because of, d) with that
время от времени: a) at the time, b) from time to time, c) in time, d) in time.

IV. Read text A. Name the main elements of a blast furnace.

TEXT A
PRODUCTION OF PIG IRON IN THE BLAST FURNACE

The blast furnace is a shaft furnace 20 to 30 m high and 4 to 10 m in internal diameter. It is built of refractory bricks held together by a steel framework. The upper opening of the shaft, the gout, has a cone-shaped closure to prevent the gasses from escaping into the open air. The gout is followed by the shaft, which widens downwards to provide space for the filling as it expands in the heat. Then follows a short cylindrical section, the coal sack to form the transition to another narrowing section. In the rest the charge comes to melt, and the molten iron, together with the slag floating on it because of its light weight, accumulates in the rack to be taken out separately from time to time through the tapping holes.

The blast furnace has a number of ancillary facilities, such as the casting hall, slag recycling, blast furnace gas purification and coking plant for producing the coke from hard coal needed to fill the blast furnace. Then there are the Cowpers (hot blast stoves). These are round towers of roughly the same dimensions as the blast furnace. Each blast furnace usually has three Cowpers. They work alternately. First, the cowper is heated by the purified hot blast furnace gases. Then the combustion air (blast wind) intended for the blast furnace is passed through the Cowper. It heats up and the hot lattice-like masonry is cooled down. This makes it necessary to switch back to blast furnace gas. The hot blast is blown into the blast furnace through water-cooled nozzles in the upper part of the frame.

The blast furnace is filled with ore and coke in layers, with the material being brought up to the height of the blast furnace platform by means of an inclined lift or, in the latest designs, by a conveyor belt. The correct selection of the aggregates to be mixed with the ores is important for the production of pig iron that is as pure as possible. In the blast furnace process, the siliceous and calcareous components of the ores and fuel ashes are to be converted into more easily fusible compounds, the slags, by suitable mixing with limestone. The slags should also absorb the sulphur, or the desulphurisation of the pig iron is carried out subsequently by adding soda ash.

V. List the English nouns (See pp. 88-89) with the help of which you can describe:

(a) a blast furnace;

b) the raw materials used in the blast furnace process;

c) auxiliary equipment of the blast furnace process.

VI Using picture 1.7, tell your partner everything you know about blast furnaces.

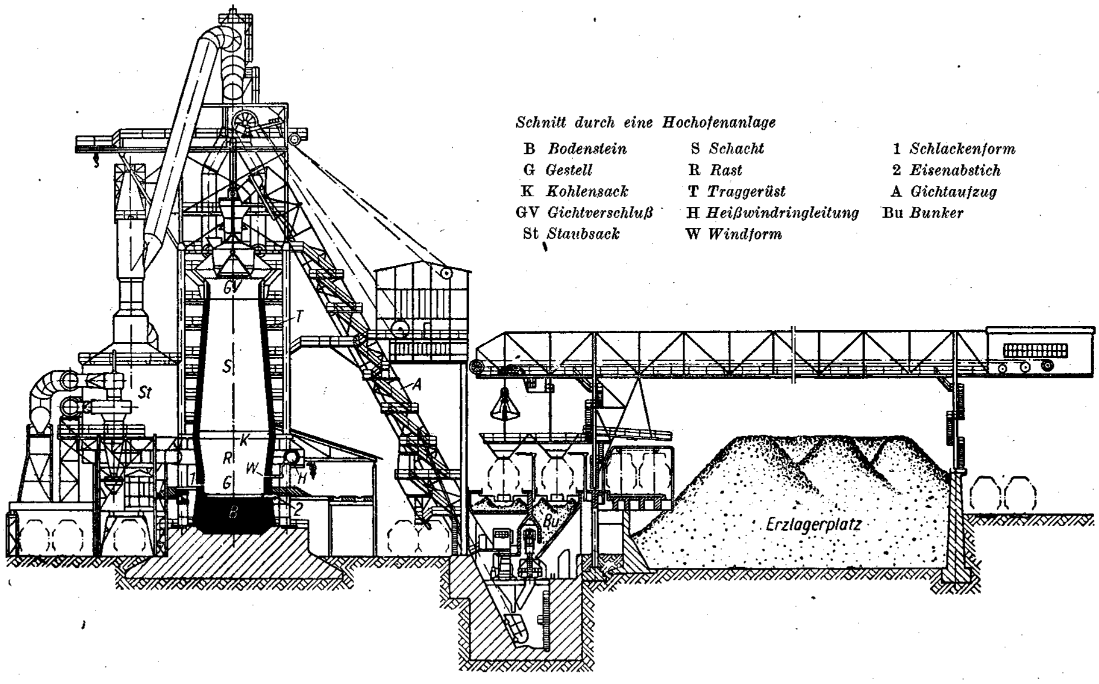

Figure 1.7. Section through a blast furnace plant

VII. Read text A again and say whether it is correctly divided into the sections - paragraphs - that make sense. How would you title them?

VIII. Graphically represent the content of text A. Write the English explanations for the diagram you have drawn.

IX. Read text B, make an effort to write down the most important processes in the blast furnace.

TEXT B
PROCESSES IN THE BLAST FURNACE

From a purely chemical point of view, the task of the blast furnace is to break down the iron ores, the chemical compounds of iron with oxygen, into their basic components. The preconditions for this reduction process are not only high temperatures, but also the presence of a substance that seeks to bind the oxygen to itself with greater force than the iron is able to hold. Such a substance is carbon.

In the upper part of the shaft, the charging masses are first heated and dried by the exhausting[1] blast furnace gases. When the temperature exceeds about 900°C, the reduction begins. Here the ores begin to give up their oxygen to the carbon oxide contained in the blast furnace gas, which burns to form carbonic acid according to the equation $FeO + CO = Fe + CO_2$ (indirect reduction). Metallic iron is deposited in a sponge-like[2] manner. It takes up carbon and comes to melt at about 1200°C. Some of the ore, however, has remained unchanged and is now directly reduced at 1400-1600°C in the rest. The reduction of silicon, manganese and phosphorus, whose oxides are contained in the iron ores in varying quantities, also takes place here in the rest, and the slag is also formed here. Iron and slag accumulate in a hot liquid state in the hearth.

The pig iron taken from the blast furnace is only an intermediate product. It is either taken to a collecting vessel4 or a mixer from where it is converted into steel. It can also be solidified in casting plants (moulds) into ingots, which are used by the foundries as a raw material for cast iron. The composition of pig iron varies widely depending on the ores and the furnace cycle 5. Pig iron is characterised by a high content of carbon, silicon and manganese.

There are various uses for the solidified slag: depending on how it is processed, it is used as paving stones, railway ballast, concrete aggregate, slag cement, slag wool, etc.

Text explanations

1. peeling - отходящий
2. spongy - в виде губки (губчатое железо).
3. liquid - в расплавленном виде.
4. the collecting vessel - копильник
5. the furnace passage - ход печи (процесс плавки).

X. Report on the production processes in a blast furnace. Use your notes and the text to do this.

XI. Read text C and find the answers to the following questions in it:
1. Where is the gigantic blast furnace described in the text located?
2. What is the annual output of the giant in cherepovets?
3. What are the advantages of the computer system?
4. What are the investments in the magnitogorsk and novolipetsk combines used for?

TEXT C
COMPUTER CONTROLS THE PROCESSES IN THE BLAST FURNACE

The blast furnace of the metallurgical combine in Cherepovets devours the load of 400 railway wagons with ore and coal every day. 20,000 tonnes of pig iron at full capacity is the daily norm for this world's largest furnace of its kind. 160,000 tonnes of steel structures had to be processed on the 100-metre-high giants and 15 kilometres of conveyor belts had to be laid for charging.

With a projected annual output of 4.5 million tonnes - initially it will be one million less - it alone achieves almost as much as the two blast furnaces currently operating in Cherepovets put together. The advantages are obvious[2]: less material is needed for construction, labour is saved during operation. These advantages are increased by the computer system, which ensures that the raw materials are processed with the highest possible efficiency.

The same is true for the reconstruction of the capacities of the Magnitogorsk Iron and Steel Works, where more than half of the investment funds are available for the introduction of effective technologies.

Text explanations

1. devour - проглатывать, поглощать.
2. something is obvious - что-то очевидно.

XII. Discuss the content of the text in a dialogue.

XIII. Read text D. To understand the text as fully as possible, look up the unknown words in the dictionary.

TEXT D
CAST IRON, MALLEABLE CAST IRON, CAST STEEL

Cast iron is made from pig iron by remelting. In this process, the chemical composition changes only slightly. However, the cast structure becomes denser, finer-grained and more uniform.

The shaft furnace consists of a circular shaft lined with refractory brickwork. A coke fire is first lit at the bottom of the shaft, and then layers of coke and iron, consisting of an appropriate mixture of pig iron, steel scrap and cast iron scrap, are thrown onto the embers. An aggregate of 7 to 12 per cent limestone is also added. Now the blower air is blown in through the air jacket and the nozzles, and the combustion of the coke creates such high temperatures in the shaft that the iron becomes liquid and runs down. It accumulates in the bottom of the shaft or in the forehearth and is blown off from there from time to time through the taphole to be taken in ladles to the sand moulds where it solidifies.

The quality of the pig iron can be considerably increased by reducing the carbon and silicon content. However, special precautions must be taken to ensure that the fracture surface of the parts does not turn white but grey, e.g. by preheating the moulds to delay cooling or by adding ferrosilicon, calcium silicide etc. to form crystal nuclei. Furthermore, superheating the cast iron up to 1500°C, instead of casting it at about 1350°C as is usually the case, helps to improve the fine grain and uniformity. These or similar measures result in the high-quality pearlite cast iron. Today, a double melting treatment (duplex process) is often used for its production. First, a cast iron of the usual type is melted in a shaft furnace and then superheated in an electric furnace and brought to the desired composition by adding steel scrap. The most commonly used electric furnace is the induction furnace.

Recently, it has been possible to melt spherulitic cast iron, which contains graphite in spherical form. It is produced from a low-sulphur cast iron melt by adding small amounts of cerium or magnesium in the ladle.

Malleable cast iron is the link between cast iron and cast steel. It combines the good castability of cast iron with steel-like properties. According to the colour of the fracture surface, a distinction is made between white and black malleable cast iron. The share of malleable cast iron in the total of cast iron materials is not very large - about 4%. It is important for automotive and precision engineering. The wall thickness should not exceed 20 mm for white malleable cast iron and 30 mm for black malleable cast iron.

Melting of the malleable cast iron is similar to that of cast iron. A suitable charge is melted in foundry shaft furnaces, flame furnaces or electric furnaces. Here, a relatively low content of alloying components (e.g. chromium) must be aimed for. The result is that the castings do not solidify as grey cast iron, but as chilled cast iron with a white fracture surface.

The castings are then packed into annealing pots and surrounded on all sides with annealing agents. The pots should be completely tight and closed with a lid so that the fire gases do not come into contact with the castings during annealing. The pots are then placed in an annealing furnace and subjected to heat treatment.

Large annealing plants also have tunnel furnaces where annealing is carried out in a continuous process (without interruption). Annealing transforms the carbon form of the castings so that they become almost as tough as steel. In the case of white malleable cast iron, superficial decarburisation also takes place. This is caused by the use of an oxygen-releasing annealing agent such as red ironstone, hammer blow and rolled sinter. For black malleable cast iron, on the other hand, a neutral annealing agent such as quartz sand is used.

Steel castings do not differ from steel in composition, but only in the way they are cast. Steel is cast into blocks for further processing, whereas cast steel is cast into finished mouldings. This was only possible after a sufficiently heat-resistant moulding material of fat sand, clay, unfired clay and sawdust had been found for the moulds, because cast steel has melting and casting temperatures that are 100 to 300° higher than cast iron and malleable cast iron.

The production of cast steel largely corresponds to that of steel. Depending on the special conditions and quality requirements, Siemens-Martin furnaces, electric furnaces and induction furnaces are used as melting equipment, but smaller furnace units are used than for ingot casting.

XIV. Carry out a lexical analysis of the text D. Write out technical terms that you do not know and that characterise the casting process and its products. Learn these terms.

XV. Read text D again and say which assertions correspond to its content.

1. При выплавке литого чугуна его состав сильно изменяется.
2. Структура литья становится плотнее, равномернее и имеет более мелкую зернистость.
3. Работа в вагранке начинается с загрузки кокса и железа.
4. Вначале в вагранке разжигается кокс; на возникший жар насыпаются слоями кокс и железо.
5. Присадки в виде известняка составляют 7-12%.
6. Дутье подается только через кольцевой воздухопровод.
7. Жидкий чугун собирается на дне шахты или в копильнике и выпускается оттуда через летку.
8. Жидкий чугун застывает в ковшах.
9. В ковшах жидкий чугун подается в песчаные формы и застывает там.
10. Уменьшение содержания углерода и кремния значительно повышает качество литого чугуна.
11. Поверхность излома такого чугуна становится не белой, а серой без принятия каких-либо особых мер.
12. Улучшению мелкозернистости и равномерности способствует также процесс перегрева чугуна до 1500°С вместо обычного до 1350°С.
13. Для получения литейного чугуна с перлитной структурой используют дуплекс-процесс.
14. При дуплекс-процессе чугун только перегревается, не получая никаких добавок.
15. Сферолитный чугун содержит шаровидный графит.
16. Сферолитный чугун получается, когда в расплаве много серы, и подаются большие присадки церия и магния.
17. Ковкий чугун – это связующее звено между литейным чугуном и стальным литьем.
18. Различают белый и серый ковкие чугуны.
19. Доля ковкого чугуна в общем количестве литых железных материалов более 40%.
20. Ковкий чугун применятеся в автомобилестроении и точном

приборостроении.

21. Выплавка ковкого чугуна происходит так же, как и литейного чугуна, в вагранках, пламенных или электропечах.

22. Ковкий чугун после выплавки не подвергается дополнительной термической обработке.

23. В туннельных печах отжиг производится непрерывно.

24. После отжига литье становится почти таким же вязким, как сталь.

25. Стальное литье отличается от стали по составу.

26. Стальное литье в отличие от стали отливается в готовые формы.

27. Для стального литья нужна более теплостойкая формовочная масса.

XVI Reproduce the content of the text in Russian using the assertions from Task XX.

XVII. Say whether you have observed a blast furnace process. If so, describe your impressions.

UNIT IX
Theme: PROFIT OF STEEL

ACTIVE VOCABULARY

1. the exhaust gas	отработанный газ
2. the lining	кладка, облицовка, футеровка
3. the band	лента, полоса
4. the admixture	примесь, добавление
5. the sheet	листовой металл, жесть, стальной лист
6. the block	чушка, болванка, слиток
7. the deoxidation	раскисление, удаление кислорода, восстановление
8. the wire	проволока
9. the insert	шихта, загрузка, завалка, садка
10. case-hardening steel	цементируемая сталь
11. the freshening	фришевание, получение стали путем окислительной плавки чугуна, рафинирование, окисление, передел
12. chamber	камера, отделение, генератор (мартеновской печи)
13. the mould	кокиль, изложница
14. the regenerative firing	регенеративное отопление
15. the tube	труба
16. the melting hearth	под плавильной печи
17. the scoop test	ковшовая (ложечная) проба
18. the scrap	скрап, лом
19. the steel waste	стальной скрап
20. the bar	пруток, стержень, брус
21. transformation	превращение, преобразование
22. tempering steel	улучшенная (термообработанная) сталь
23. to cut off	выпускать (металл, шлак) из печи
24. to expose	выкладывать, производить кладку
25. feed	загружать, засыпать, подавать шихту, производить завалку (вагранки)
26. grasp	вмещать
27. switch over	переключать, изменять (направление)
28. preheat	предварительно нагревать, подогревать
29. self	1) *pron* сам, 2) даже
30. be suitable	быть пригодным, подходящим, удобным

TASKS

I. Explain the meaning of the following compounds (Annex 1, § 1 "Word formation").
the oxygen converter, the combustion products, the gas form, the fresh process, the flame furnace, the heating gas, the combustion air, the heat emission, the heating air, the charging opening, the steel waste, the fresh process, the alloying constituents; gas-fired, evenly, for the most part.

II. Combine the words from groups A and B into word formation pairs (Appendix 1, § 1 "Word Formation").
Pattern: the gaining - win
A: the extraction, the comparison, the admixture, the transformation, the oxidation, the melting, the preheating, the switching, the charging, the possibility, the execution, the addition, the combustion; remove, supply, accept, heat, deliver, heat up, utilise, run off, solidify, process; cooled, predetermined, alloyed, liquid
B: to remove, to cool, to process, to utilise, to solidify, to liquid, to alloy, to dispense, to heat, to feed, to drain, to heat, to accept, to predetermine; to extract, to add, to oxidise, to burn, to compare, to switch, to preheat, to add, to charge, to transform, to melt, to carry out; possible

III. Find the word in each row that has a generalised meaning.*
a) freshening, b) smelting, c) pre-heating, d) tapping
a) the iron ore, b) the steel waste, c) the pig iron, d) the starting material
a) the case hardening steel, b) the quenched and tempered steel, c) the steel grade, d) the stainless steel
a) the metal product, b) the strip, c) the sheet, d) the wire

IV. Choose the correct word. Translate the sentences.*
1. The steel solidifies into (tubes, strips, ingots) in the ingot moulds. 2. The furnace can have a basic or acidic (charge, lining, firing). 3. Minor admixtures are in the (steel, pig iron, iron ore). 4. Heating gas and combustion air are (tapped, preheated, switched) by exhaust gases. 5. At present (the Siemens-Martin process, the electric process, the converter process) is the most widespread. 6. The SM steel has been well (alternate, resistant, suitable) in mechanical engineering. 7. The steel is obtained in the oxygen converter in (liquid, gaseous, hard) state. 8. The chambers where the heating gas and the combustion air are preheated are exposed with refractory (sheets, stones, bars).

V. Translate the sentences containing the subjunctive (Appendix 1, § 10 "Konjunktiv in der deutschen wissenschaftlich-technischen Literatur"). Determine whether they express real or unreal meaning.
1. Emphasise that the temperature of the metal mixture is constantly increasing. 2. 10% carbon is added to make the steel harder. 3. Let it be said that the cast iron is superheated up to 1500°C. 4. It is said that cast steel has higher melting and pouring temperatures than cast iron and malleable cast iron. 5. Steel is cast into ingots for

further processing. 6. Underline in the lecture that it is essential that iron and slag accumulate in a rack.

VI. Read text A and identify the main features of the production of steel from pig iron.

TEXT A
EXTRACTION OF STEEL FROM PIG IRON

Compared to pig iron, steel has fewer impurities. When the pig iron is converted into steel, most of the impurities have to be removed. This is done by combustion (ozydation). The products of combustion either escape in the form of gas or pass into the slag. This process is called refining.

Of the refining processes, the most common was recently the Siemens-Martin process. Today it is the oxygen converter process and the electric steel process. In all these processes, so much heat is added to the melt by burning the admixtures that the steel is obtained in a liquid state.

The most widespread steelmaking process for a long time was the Siemens-Martin process. The SM furnace is a gas-fired furnace whose heating gas and combustion air are preheated to achieve the high temperatures necessary for steel melting by regenerative firing. Two chambers latticed with refractory bricks are used for this purpose. Let us assume that the left chamber is heated first and is ready to give off heat. Above the melting hearth, the heating gas and hot air combine and burn. The hot exhaust gases are passed through the right-hand chamber and give off their heat there. After some time, a switchover takes place and now the preheating of air takes place in the right-hand chamber, while the cooled left-hand chamber is heated up again by the exhaust gases.

Through the charging openings, the hearth is charged with iron ore and liquid pig iron (pig iron ore process) or with liquid pig iron and steel scrap (scrap pig iron process). It is precisely the possibility of melting the scrap that accumulates everywhere in large quantities, which could hardly be utilised otherwise, that contributes significantly to the importance of the Siemens-Martin process. The refining process proceeds slowly under the oxidising effect of the flame after deoxidation has been carried out and, if necessary, after the addition of alloying constituents, the liquid steel is tapped off to solidify into ingots in moulds. The hearth can be provided with a basic or acid lining.

The Siemens-Martin furnaces hold 50 to 9000 tonnes of charge. The solidification process takes 4-10 hours. The processes are therefore very slow, so that they can be controlled as desired by means of scoop tests. The product is therefore pure and uniform and corresponds exactly to a predetermined composition. SM steels are perfectly suitable for the components of our modern machines, including cars. They are not only processed into bars, tubes and wires, but also into sheets and strips. Even alloyed case-hardening and heat-treatable steels are partly melted in SM furnaces.

VII. Read text A again and divide it into more or less self-contained sections. Title each section.

VIII. Characterise the Siemens-Martin process of steel production. Use the material from Text A and your own knowledge.

IX. Read text B, familiarise yourself with steel production in a converter.

TEXT B
STEEL PRODUCTION IN THE CONVERTER

The conversion of pig iron into steel in the converter is economically very important. The converter is a tiltable[1] pear-shaped steel vessel whose inner wall is lined with refractory material. The converter is surrounded by a support ring[2] on which there are two bearing journals[3]. These journals rest on the converter stands. It allows the converter to be tilted into the required position.

The converter is operated from the converter platform. The waste gases produced during the refining process are collected by the chimney, which is double-walled for water cooling, and discharged via cooling and dust removal systems. Aggregates and auxiliary material are transported from the hoppers via conveyor belts to the storage bunkers and from there via chutes4 directly into the blowing converter. In the transport ladle, the molten pig iron is brought to the converter by overhead travelling crane5. For scrap, crane systems or a charging machine are used. The liquid steel is transported to the casting hall by means of the casting car.

The most widespread process is the oxygen blowing process. The oxygen is supplied by a nozzle that is lowered into the converter through the converter neck. There are also converters in which the oxygen is blown through special nozzles located at the bottom of the converter, so-called bottom-blowing converters.

After the addition of lime and coolant, the converter is tilted to the horizontal position and the molten pig iron is poured from the ladle into the converter. The converter is then erected and the oxygen is blown in. The converter is filled to about one third with pig iron. The permissible charge temperature is exceeded, which leads to increased wear of the refractory lining of the converter and to casting errors. Scrap or iron ore is therefore used to cool the charge.

The sequence and rate of conversion of the accompanying elements in the iron melt as well as the degree of completeness of the conversions are determined by the following factors:

1) by the oxygen affinity of the individual elements at the respective temperature;

2) by the concentration of the elements and oxides in the iron melt or in the slag;

3) the reactivity and solubility of the slag.

The oxidation of the accompanying elements takes place via FeO, which initially forms when the oxygen enters the melt at the nozzles and also passes into the melt according to Nernst's distribution law6 : [FeO] ↔ (FeO).

As far as the higher oxides Fe2O3 and Fe3O 4 are formed in addition to FeO during blowing, they are reduced to FeO on contact with metallic iron. The following Frisch reactions take place:

$2[FeO] + [Si] — (SiO_2) + 2[Fe]$

$[FeO] + [Mn] — (MnO) + [Fe]$

$[FeO] + [C] — CO + [Fe]$

Dephosphorisation also takes place: $2[P] + 5(FeO) + 4(CaO) — 4(CaO + P_2O_5) + 5[Fe]$

Text explanations

1. tiltable - опрокидывающийся
2. bearing ring - опорное кольцо
3. Bearing pin - опорная цапфа (шейка).
4. the chute - спускной желоб, спуск
5. the travelling crane - мостовой кран
6. Nernst's law of distribution - закон распределения Нернста.

X. Discuss the converter procedure in a dialogue.

XI. Read text C and find the answers to the following questions in it:

1. What is the purpose of the electric steel process?
2. In what way is the heat generated in the electric arc furnace?
3. What is the capacity of an electric arc furnace?
4. What is the structure of the induction furnace?
5. How is the heat generated in the induction furnace?
6. Where are the electric steels used?

TEXT C
ELECTRIC STEEL PROCESS

The electric steel processes allow the melting of very pure high quality steels, as there are no contaminating combustion gases. However, electricity as a heat source is more costly and is therefore only used for deep refining or for melting together alloys of pure starting materials.

In the electric arc furnace, two or three adjustable[1] carbon electrodes pass through the furnace roof. The current passes from the electrodes as an arc into the liquid bath and then back to the electrodes. The liquid raw steel is largely freed of sulphur, phosphorus and oxygen by the heat generated by the electrodes and brought to the desired composition by additions. The capacity[2] reaches up to 200 t.

The melting process is even more carefully controlled in induction furnaces. A crucible-shaped melting vessel of acidic or basic mass is surrounded by a water-cooled copper coil. A frequency current of about 50 hertz is sent through this coil. Heating is achieved by inductively generated eddy currents[3] in the metal itself4. The furnace can even be operated in a vacuum if, for the highest demands, air is to be prevented from entering the metal bath.

The electric steels produced in the arc furnace are reserved as structural steels for parts with the highest limit stresses, e.g. in aircraft construction5. Tool steels are almost exclusively melted in the arc furnace. For high-alloy steels with special chemical, thermal or magnetic properties, the frequency furnace is preferred.

Text explanations

1. adjustable - передвижной.
2. capacity - вместимость, емкость.
3. eddy currents - вихревые токи
4. come about - осуществляться
5. reserved - оставлять (что-либо за кем-либо или чем-либо).

XII. Discuss the advantages of the steel making processes described in Text C in dialogue.

XIII. Read text D. Look up in the dictionary the words that make it difficult to understand its content.

TEXT D
POWDER METALLURGY - A PROMISING MANUFACTURING PROCESS

When people began to process metals with a high melting point, such as molybdenum and tungsten, and to improve the technological methods for producing materials with special properties, a new branch of metallurgy emerged - powder metallurgy. Metal powder is used in forming processes to produce components with the highest precision at the lowest possible cost in terms of energy, raw materials and human labour. This is a manufacturing process that is becoming increasingly important in view of the global raw material situation. The following article gives an overview of this manufacturing process.

A powder (usually iron powder) with a diameter of less than one millimetre is produced from various metal alloys. The grain size of the currently used metal powders is generally between 100 and 400 μm (μm - micrometre - микрон).

How are such metal powders obtained? Several methods are possible. The two currently most commonly used, the direct reduction process and atomisation (spraying of melts), will be discussed in more detail. Only a relatively short time ago, there was no unanimous opinion among scientists in this field about the most effective way to produce these metal powders. In 1971, the reduction process was still preferred. Then atomisation or spraying was considered the most promising method. Only practical analysis led to the conclusion: the production technology depends on the purity of the starting material and its properties.

Pure iron ore, which is first reduced in size like all other starting materials, is deprived of oxygen by the gaseous hydrogen or carbon at a temperature of up to 1,000°C. The result is iron sponge, from which the iron is extracted. Sponge iron is formed, from which iron powder can easily be produced mechanically. This direct reduction process produces about 40 to 50 per cent of the world's iron powder.

Alloyed iron or other metal alloys can be processed into powder by atomising liquid metal, i.e. the melt. The application area of the atomisation process ranges from iron and bronze powders to powders for high-speed steels. The desired properties of the end product, the sintered moulded part, are already decided when the metal powders are mixed.

Four alloying techniques are used in practice: mixed alloying, initial alloying, final alloying and combined mixed alloying and final alloying of the powders. Mixed alloying is of the greatest importance within powder metallurgy.

Mixing of pure metal powders and alloy additions is carried out in the powder state. The pressing properties of such mixtures are not influenced by the alloy components. Only during sintering do they form compounds with the metal. This is also the disadvantage of the mixed process. Long sintering times and high sintering temperatures are required. This is not the case with alloying. Here, mixed-alloy powders are subjected to annealing, which causes localised alloying of the powder particles. This shortens the sintering times and the sintering temperatures. Finished alloyed powders are created by atomising alloys produced by melting metallurgy. These powders are difficult to press due to the hard mixed crystals produced in the process. They are mainly used to produce corrosion-resistant properties and copper-based alloys. The combination of mixed alloying with ready-alloyed powders has been tested for some time. For example, iron powder is mixed with a ready-alloyed powder of high alloy content. Such a powder can be pressed well with a simultaneous higher utilisation of the alloying constituents. One thing must be emphasised in principle, however, that any material can be produced by mixing powders, whereas in the melting process - due to different densities as well as a lack of miscibility in the liquid state - the range of materials that can be produced is limited.

The almost dust-like metal powder is generally poured into a primary mould, i.e. a tool that presses a material into the desired shape for the first time, and then compacted under pressure. This is done in such a way that the metal particles become cohesive. Then the metal powder is sintered in a furnace - usually after it has been removed from the tool. Sintered parts of different porosity can be produced with different pressures. During sintering, the inner and outer surfaces of the body pressed from a powder are reduced. Powder particles in contact are bonded together by reducing the void ratio. At least one of the material components involved remains solid throughout the process. The bonding of the porous pressed metal powder occurs predominantly due to diffusion processes. They cause a permanent bond between the particles, whereby the cavities inside the pressed part (and as a consequence also the external dimensions) are reduced.

In addition to this pressing, there are other ways of compacting powder - for example, powder rolling to produce nickel strips, or extrusion and extrusion of powder blanks and finished pieces.

The decisive shaping is sintering in an inert gas atmosphere or in a vacuum. Only here does the pressed part obtain its required strength through the addition of heat. The compact is subjected to a temperature that is still below the melting point, usually around 1000°C. This is the temperature at which the powder is compacted. In this process, the contact points of the powder particles created during compaction unite to form a solid structure. The mass transport triggered by the heat is caused by diffusion processes - as already mentioned.

XIV. Read text D again and say which assertions given below correspond to its content.

1. Powder metallurgy is an ancient branch of metallurgy.

2. Metallic powder is used to make components of the highest precision.

3) powder metallurgy is a manufacturing process that is becoming increasingly important.

4. The diameter of the individual grains of the metal powders is less than one millimetre.

5. There is only one possible process for obtaining the metal powders.

6. There was a unanimous opinion among scientists on the most effective way to produce the metal powders.

7. The reduction process was used first, then atomisation or sputtering.

8. The production technology does not depend on the purity of the raw material.

9. Pure iron is first reduced. 10.

10. Then the oxygen is removed from the iron ore. 11.

11. Sponge iron is formed, from which iron powder can be easily produced.

12. 40-50% of the iron powder is obtained by the indirect reduction process.

13. Alloyed iron and other metal alloys can be processed into powder by atomising liquid metal.

14. The field of application of the atomisation process is very limited.

15. Four alloying techniques are used in practice.

16 Mixed alloying is the most important.

17. Mixing of metal powders and alloying additions is done in the liquid state.

18. The alloying constituents influence the press properties of the mixtures.

19. Finished alloy powders are used to produce corrosion resistant metals.

20. The combination of mixed alloying with finished alloyed powders is not possible.

21. Not every material can be produced by mixing powders.

22. In the melting process, the range of materials that can be produced is limited.

23. The almost dust-like metal powder is poured into a primary mould and compacted under pressure.

24. Then the metal powder is sintered in a furnace. 25.

25. Diffusion processes take place during sintering.

26. There are no other ways of compacting powder except pressing.

27. An important shaping process is sintering in an inert gas atmosphere or in a vacuum.

XV. Give the content of the text in English. Use the assertions from task XIV.

XVI. Tell what you have learned about powder metallurgy.

XVII. Look at the schematic diagram of the metallurgical cycle of extraction of rolled material from iron ore given below.

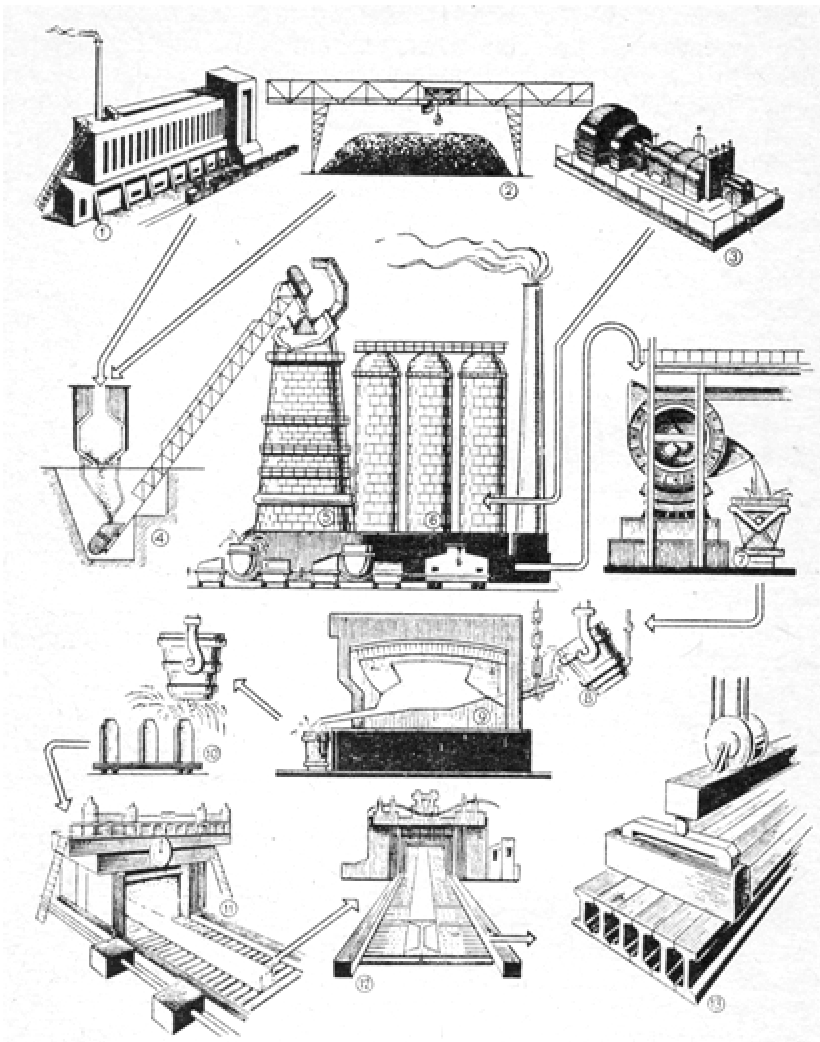

Figure 1.8. Schematic representation of the metallurgical cycle

1. der Koksofen 2. der Laufbagger 3. die Gebläsemaschine 4. der Schrägaufzug 5. der Hochofen 6. der Winderhitzer 7. der Mischer 8. die Gießpfanne 9. der Martinofen 10. die Kokille 11. die Blockstraße 12. die Barrenstraße 13. das Walzgut

KEYS

Unit I

IV: 1. gold; 2. solid; 3. conductor; 4. rising; 5. solid; 6. mercury

V: 1 the property; 2) the metal; 3) work; 4) the element

VIII: a) в четыре раза больше, в шесть раз лучше, в сто раз меньше, в тысячу раз теплее, в пятьдесят раз прочнее;

b) те свойства, тот металл, тот кислород, то условие, те различия, те элементы;

c) 200 лет назад, в его время, по определению Ломоносова, при нормальных условиях, с повышением температуры

Unit II

IV: transparent - opaque, outside - inside, above - below, left - right, dependent - independent.

V: 1. metal alloy; 2. carbon; 3. nuclear charge; 4. electrons; 5. positive; 6. take ... off

VI: 1) the alloy; 2) the non-metal; 3) the property; 4) the atom

Unit III

II*. 1. to melt; 2. to pour; 3. to grow; 4. to begin; 5. to happen; 6. to remain; 7. to sink; 8. to measure; 9. to decrease; 10. to increase.

VII*: 1. low-melting; 2. destroyed; 3. the melting point; 4. solid; 5. divided; 6. as soon as

VIII*: a) rise - fall; b) increase - decrease; c) cool - heat;

d) pure - impure; e) melting - solidifying.

IX*: свойство металлических материалов, известное с давних пор; ртуть, жидкая при нормальных условиях; элементы, легко соединяющиеся с кислородом; металлы, нагретые до 1000°C; металлы, примененные в форме сплавов; химические элементы, упорядоченные в соответствии с ядерным зарядом атомов; атом, состоящий из ядра и оболочки; Периодическая система элементов, созданная Д. И. Менделеевым; порядок, наличествующий в твердом состоянии; много кристаллов, растущих одновременно

Unit I

II*. 1. to bend; 3. to know, to break; 4. to overcome, to shift; 5. to deviate; 6. to accept; 7. to enter; 8. to interrupt; 9. to deviate; 10. to avoid; 11. to bring.

VII*: 1) the stress; 2) the force; 3) the solidification; 4) relieve; 5) change; 6) originally; 7) either ... or ...

VIII*: 1. обрабатывают; 2. исходная форма; 3. напряжение; 4. смещения; 5. избежать; 6. воздействующие

Unit V

VI*: the aqueous solution – водный раствор; the numerous procedures – многочисленные методы; the superficial treatment – обработка поверхности; the dangerous influence – опасное воздействие; the natural corrosion protection – природная защита от коррозии; the resistant metals – устойчивые металлы

VIII*: d) the property, d) the time, a) the environment, c) the exposure, b) the protection method, a) act

IX*. 1. металлические окислы; 2. встречаются; 3. содержит; 4. среда; 5. потери; 6. постепенно; 7. совершенно; 8. разрушающе; 9. простейшая; 10. возможности

Unit VI

III*: 1. occurs – сказумое; 2. arises – сказумое; 3. increasing – определение, increases – сказумое; 4. determining – именная часть именного составного сказуемого; 5. made – определение, mentioned – определение; 6. shiny – определение; 7. contained – часть сказумого; 8. preventive – определение, used – часть сказумого; 9. exempt – часть сказумого; 10. operate – сказуемое, destructive – обстоятельство

VII*: c) harder; b) firmer; a) less; d) more

IX*: 1. в) только; 2. в) чем .., тем …; 3. г) до; 4. а) поэтому; 5. г) при этом; 6. в) прежде всего; 7. в) тем самым; 8. а) около

Unit VII

II*: 1. gain, process; 2. represent; 3. discover; 4. displace; 5. employ; 6. be; 7. produce; 8. achieve; 9. melt; 10. find; 11. behave.

VII*. the Earth's crust - a) the Earth's crust
use - d) employ
manufacture - d) produce
process - b) treat
designate - b) name
frequently - c) often
essential - a) significant
small - d) little

VIII*: преимущество – b) the advantage
ценность – d) the value
сырье – c) the raw material
открывать – a) discover
добывать – b) gain
лудить – d) tinning
обрабатываемый – a) workable
вначале – c) first

***IX*:* 1. areas; 2. the Earth's crust; 3. raw material; 4. jewellery; 5. aircraft construction; 6. advantages; 7. totals; 8. representatives; 9. leaders; 10 tin plate**

Unit VIII

VI*: башня – c) the tower
обладать – a) own
примыкать – c) join
вдувать – d) blow in
подходящий – a) appropriate
внутренний – b) inside
из-за – c) because of
время от времени – b) from time to time

Unit IX

III*: 1. The smelting process; 2. The starting material; 3. The steel grade; 4. The metal product.

IV*: 1. Ingots; 2. Lining; 3. Pig iron; 4. Preheated; 5. The converter process; 6. Suitable; 7. Liquid; 8. Bricks

PART II

ANNOTATE AND REFER

При обучении чтению недостаточно усвоить информацию оригинала в целом или по частям, необходимо также научиться выделять главное содержание, кратко его сформулировать и представить в логической последовательности. Аннотирование (от лат. **annotatio** – замечание) и реферирование (от лат. **refero** – сообщаю) – это способы обработки информации и компрессии текста. В их основе лежат два метода мышления: анализ и синтез. Анализ необходим, чтобы выделить наиболее ценную информацию, отделить второстепенные сведения и данные, извлечь основное содержание оригинала. Одновременно с анализом текста следует осуществлять процесс его синтеза, т.е. соединять в логическое целое ту основную информацию, которая получена в результате аналитических операций. Так происходит смысловое свертывание текста и создается вторичный текст, содержащий основную суть первичной информации.

Как аннотация, так и реферат призваны передать основное содержание информации, имеющейся в читаемом тексте, в максимально обобщенном и сжатом виде. При аннотировании и реферировании сообщение освобождается от всего второстепенного, иллюстративного, дополнительного, сохраняется лишь сама суть содержания. Однако существует принципиальная разница между аннотацией и рефератом. **Аннотация** лишь перечисляет те вопросы, которые освещены в первоисточнике, не раскрывая их содержания. **Реферат** не только перечисляет все эти вопросы, но и сообщает существенное содержание каждого из них. Таким образом, аннотация дает только общее представление об источнике и является указателем при отборе первоисточников для чтения и дальнейшей научной работы, реферат же во многих случаях может вполне заменить сам источник, так как сообщает существенное содержание материала, основные выводы.

Процесс аннотирования и реферирования текста первичного документа (книги, статьи, патента и т.п.) в учебных целях следует проводить в три этапа:

1-й этап – это чтение исходного текста и его анализ – обычно несколько раз – с целью детального понимания основного содержания текста, осмысления его фактической информации (ознакомительное и изучающее чтение).

2-й этап – это операции с текстом первоисточника: текст разбивается на отдельные смысловые фрагменты с целью извлечения основной и необходимой информации каждого из них.

3-й этап – это свертывание, сокращение, обобщение, компрессия выделенной основной фактологической информации и оформление текста реферата в соответствии с принятой моделью реферата.

Структура аннотации и реферата

Изложение материала в аннотации и реферате должно проводиться в следующем порядке:

Предметная рубрика. В этом пункте называется область или раздел знания, к которому относится аннотируемый или реферируемый источник.

Тема источника. Обычно тема определяется наименованием источника либо формулируется самим референтом.

Библиографическое описание первоисточника. В этой части записывается на иностранном языке автор, заглавие книги или журнала, из которого взят текст, издательство, место и время издания. Затем эти же данные даются в переводе на русский язык.

Главная мысль аннотируемого материала.

Сжатая характеристика материала в виде плана. Здесь последовательно перечисляются все затронутые в источнике вопросы (главы, разделы, параграфы, абзацы).

Критическая оценка первоисточника. Эта рубрика может содержаться не в каждой аннотации.

Объем аннотации зависит от объема первоисточника и от того, сколько основных пунктов плана могут быть в нем выделены. При этом 6-8 предложений в учебной аннотации, характеризующие предметную рубрику, тему источника, его библиографическое описание и главную мысль, являются ее обязательными компонентами, а сам текст аннотации не должен превышать, как правило, 500 знаков.

Структура реферата в значительной степени напоминает структуру аннотации. Реферат сохраняет все пункты аннотации. Однако автор реферата не ограничивается простым перечислением затронутых в источнике вопросов, а излагает его содержание (фактологическую информацию) в последовательности первоисточника по главам, разделам, параграфам, абзацам, сопровождая их выводами автора реферируемого источника и своими комментариями. В реферат включаются, как правило, фрагменты из первоисточника. Это обобщения и формулировки из первичного документа, которые в готовом виде переносятся в реферат (цитируются).

Таким образом, реферат содержит следующие дополнительные пункты:

Краткое изложение содержания.

Выводы автора по реферируемому материалу.

Комментарии референта (не всегда).

Составленный по данной структуре реферат свидетельствует о тщательном изучении первоисточника и может заменить его при изучении описанной в нем проблемы. Объем реферата не должен превышать 10-15% реферируемого текста.

Краткая характеристика языка аннотации, реферата

Аннотация и реферат представляют собой новый, самостоятельный документ и имеют свои специфические лексические и грамматико-стилистические средства изложения. Они должны отличаться точностью, краткостью, ясностью и доступностью. Предложения аннотации и реферата строятся в соответствии с их стилем, который характеризуется однозначным употреблением терминов, простых законченных предложений, имеющих правильную грамматическую форму. Широко используются неопределенно-личные предложения без подлежащего, концентрирующие внимание читающего только на факте, усиливая тем самым информационно-справочную значимость аннотации или реферата. Часто встречаются также пассивные конструкции.

При составлении аннотации или реферата употребляются определенные речевые клише. **Клише** – это речевой стереотип, готовый оборот, используемый в качестве легко воспроизводимого в определенных условиях и контекстах стандарта. Они облегчают процесс коммуникации, экономят усилия, мыслительную энергию и время референта-переводчика и его адресата.

PATTERNS OF ANNOTATING AND REFERENCING

Клише, рекомендуемые студентам для составления аннотаций и рефератов

Предметная рубрика:

This article belongs to the scientific (popular-scientific) style. – Данная статья относится к научному (научно-популярному) стилю.

The field of science is metallurgy. – Область науки – металловедение.

Тема источника:

The topic of the article … – Тема статьи …

The article considers ... The article reveals ... The article describes ... – В статье речь идет о …

Библиографическое описание источника:

The text is published in the textbook ... (in the book ..., in the journal ..., in the newspaper ...). – Текст опубликован в учебнике …, (в книге …, в журнале …, в газете …).

The textbook ... (the book ..., the journal ..., the newspaper ...) is published by the publisher ... 2008. – Учебник …, (книга …, журнал …, газета …) издан издательством … в 2008 году.

The textbook ... (the book ..., the journal ..., the newspaper ...) was published by ... in 2008. – Учебник …, (книга …, журнал …, газета …) появился в издательстве … в 2008 году.

The article has the following title … – Статья имеет следующее название …

The title of the article is … – Название статьи звучит …

The article is ... titled. – Статья называется …

The author of the article is … – Автор статьи …

Главная мысль источника:

The main thought of the article is … – Главная мысль статьи …

The main idea of the article is … – Главная идея статьи …

The article is dedicated to the question .... – Статья посвещена вопросу …

The aim of the article is to acquaint the reader with the problems .... – Цель статьи – познакомить читателя с проблемами …

Сжатая характеристика материала:

The article sets out the following questions … – В статье излагаются следующие вопросы …

Firstly ... Secondly ... Thirdly … – Во-первых … Во-вторых … В-третьих …

It is noted that … – Констатируется, что …

It is underlined / emphasised / stressed that ... – Подчеркивается, что …

It is pointed out that … – Указывается на то, что …

It is the processes ... that are examined. – Исследованы процессы …

The r**esults of the experiments are analysed / presented / confirmed. – Результаты оытов анализируютя / представляются / подтверждаются.**

Критическая оценка источника:

It follows that … – Отсюда следует …

According to the content of the text, we may summarise that … – Согласно содержанию текста мы можем резюмировать (обобщить, сделать вывод), что …

The article contains valuable information about ... and makes the reader pay more attention to the problem (facts) described. – Статья содержит ценную информацию о … и заставляет читателя уделить больше внимания описанной проблеме (описанным фактам).

The information is detailed / thoroughly presented. – Информация изложена подробно / основательно.

The article contains sound conclusions. – Статья содержит обоснованные выводы.

I find the article interesting / informative / boring / worthless / difficult to understand. – Я нахожу статью интересной / информативной / скучной / ничего не стоящей / трудной для понимания.

Кроме того, следует запомнить часто употребляемые в аннотациях и рефератах слова и словосочетания, такие как:

Share – сообщать
dedicate – посвещать
intend – намереваться
integrate – включать
aim– нацеливать (на что-либо)
lead back– объяснять (чем-либо)
include – содержать
determine – определять
investigate – исследовать
mark – характеризовать
view – рассматривать
prove – доказывать
explain – объяснять
demonstrate – показывать
Give examples – приводить примеры
Obtain results – достигать результатов
According to the author – по мнению автора

to my mind – по моему мнению

by taking into consideration – принимая во внимание, имея в виду, учитывая

Draw attention – обращать чье-либо внимание (на что-либо)

TEXT FOR ANNOTATING

SUPERALLOYS, THE MOST SUCCESSFUL ALLOY SYSTEM OF MODERN TIMES - PAST, PRESENT AND FUTURE

Art Kracke
Vice President Business Technology

Superalloys are successful today because they have solved pressing demands for durability and strength in machines and systems that were barely imaginable a hundred years ago. Superalloys have helped us conquer air and space, plumb the depths of the earth and ocean, and address many other challenges of modern life. As such, they deserve to have their story told. The nature of this industry, however, makes the telling a challenging task. Its history is one of many small events and inventions that took place across the boundaries of nations, industries and countries. Many individuals contributed to the state of the art today and only a few left their names in the scattered records. This paper is an attempt by one of those individuals who has been witness to many of the industry's milestones to combine eyewitness history with industry research and begin to set the story down in print. It is hoped that we can begin the dialog needed to create a complete history, and set the stage for a view of the superalloy industry's bright and exciting future. Because it is, to some extent, a first person account, I would like to state that this paper has a bias. It is written by an engineer who spent his career working for a superalloy mill; furthermore a mill that was a pioneer in the industry. With full disclosure out of the way let me close this introduction with the following: Alloy 718, Waspaloy and their derivatives are the most successful alloy systems of our time. Their success is due to a combination of factors that include the properties and performance of superalloys in service, the added value provided by vacuum melting, the success of gas turbines and the continuous development of superalloys and the 13 products made from them. This success was and is driven by the dedicated professional engineers who work in the industry, to whom we owe a debt of gratitude and recognition. A Working Definition Superalloys have been defined many times by metallurgists for books and conferences, with reasonable consistency. A few of the most comprehensive definitions follow: 1. A superalloy, or high-performance alloy, is an alloy usually based on Group VIII A elements that exhibits excellent long-time strength, creep resistance, corrosion and erosion at temperatures above 1200o F, good surface stability, and corrosion and oxidation resistance. Superalloys typically have a matrix with an austenitic face-centered cubic crystal structure. A superalloy's base alloying element is usually nickel, cobalt, or iron. Superalloy development has relied heavily on both chemical and process innovations and has been driven primarily by the aerospace and power industries. 2. Superalloys were originally iron-based and cold

wrought prior to the 1940s. In the 1940s investment casting of cobalt base alloys significantly raised operating temperatures. The development of vacuum melting in the 1950s allowed for very fine control of the chemical composition of superalloys and reduction in contamination and in turn led to a revolution in processing techniques such as directional solidification of alloys and single crystal superalloys.
3. A superalloy is a metallic alloy which can be used at high temperatures, often in excess of 0.7 of the absolute melting temperature. Creep and oxidation resistance are the prime design criteria. Superalloys can be based on iron, cobalt or nickel, the latter being best suited for aeroengine applications. The essential solutes in nickel based superalloys are aluminum and/or titanium, with a total concentration which is typically less than 10 atomic percent. This generates a two-phase equilibrium microstructure, consisting of gamma (γ) and gamma-prime (γ'). It is the γ' which is largely responsible for the elevated-temperature strength of the material and its incredible resistance to creep deformation. The amount of γ' depends on the chemical composition and temperature. A good working definition, although less technically precise, is: superalloys are the nickel-, cobalt- and iron-based alloys used in the hottest, most demanding components in gas turbines and oil and gas equipment. Superalloys facilitate improved operating efficiency and reduce environmental emissions.

TEXT FOR REFERENCE

TECHNICAL DEVELOPMENTS IN HOT ROLLING OF FLAT AND LONG PRODUCTS

Christian Overhagen
University of Duisburg-Essen

During the last years, developments and innovations in flat steel production for hot strip, plate and cold strip have been characterized by growing demands on the quality of the products. This has generated numerous innovations in plant engineering as well as control and regulation technology solutions aiming at higher product quality, increased efficiency and reducing energy consumption. Many of these efforts have been focused on the integration of systems measuring and controlling different parameters, such as temperature, profile, flatness and surface-roughness. For bar and wire rod production, it is necessary to attain the desired material properties directly from the rolling heat and the possibility of further processing the material without preliminary heat treatment. The introduction of near-net-shape beam-blank casting has markedly changed processes in section rolling. The number of passes has been reduced, the rolling mill plants are smaller in size and the rolling process has become simpler, more cost-effective and less energy consuming.

C.P. Manning and R.J. Fruehan

ADVANCES IN IRON AND STEELMAKING

The blast furnace, in various forms, has remained the workhorse of world-wide virgin iron production for more than 200 years, producing carbon-saturated "hot metal" for subsequent processing by steelmaking processes. However, the modern blast furnace has advanced a long way from its earlier ancestors. Most modern large-capacity blast furnaces represent extremely efficient chemical reactors, capable of stable operation with an impressive range of reactant feed materials. The injection of pulverized coal, natural gas, oil, and, in some cases, recycled plastics to replace a portion of the metallurgical coke used as the primary reductant and source of chemical energy represents an important development in the process.

Coke is produced by baking coal in the absence of oxygen to remove the volatile hydrocarbons contained in coal. The resulting coke is mechanically strong, porous, and chemically reactive, which are all critical properties for stable blast furnace operation. In addition to supplying carbon for heat and the reduction of iron ore, coke must also physically support the burden in the blast furnace shaft and remain permeable to the hot air blast entering from the bottom. Coke-making is extremely problematic from an environmental perspective, as many of the hydrocarbons driven off during the coking process are hazardous. Also, not all types of coal are suitable for the production of coke. Recently, demand has decreased for the byproducts from coke-making for secondary processing into chemical products.[3] In developed countries, aging coking facilities and tightening environmental control have made coke-making an economic liability. Therefore, decreasing both the coke rate and the over-all fuel rate of the blast furnace has been a major focus of recent developments. Figure 1 shows the evolution of blast furnace consumption of reductants in France in the last 30 years.

Similar trends can be observed in most developed countries. However, the relative proportions of coal, natural gas, and oil usage are dependant on several factors. These factors include local availability, fuel price, and the capital requirements of the injection equipment. Figure 2 shows the coke and coal consumption rates per ton of hot metal in Europe, Japan, and the United States. At high coal injection rates, partially combusted coal char builds up in the area near injector. This can lead to reduced gas permeability and currently sets the practical limit for coal injection. Extensive experimentation in the United States and elsewhere has found an optimum combination of fuels that allows for stable operation at low coke rates. That ideal mix, per ton of hot metal produced, includes metallurgical coke, 230 kg; nut coke, 40 kg; injected coal, 180 kg; and injected natural gas, 50 kg.

Improvements in process control and reduced refractory wear have increased blast furnace campaign life significantly, which is critical to the economics of the process. The current expected lifetime of newly rebuilt furnaces is 20 years or greater. Improved process control, burden design, regular maintenance, and reduction of unscheduled shut-downs has had a dramatic effect on the productivity of blast furnace operations.[4–7] Many steel companies have shut down older furnaces while maintaining or increasing hot-metal production by increasing the productivity of newer furnaces.

In the past 5 to 10 years, there has been a rapid increase in the production of iron via direct reduction processes. This new production has been dominated by the gas-based Midrex and Hyl processes, although several new plants based on other processes have begun production. This additional world wide ironmaking capacity has primarily served the electric arc furnace industry, providing an alternative to high quality and expensive scrap as a source of clean, low residual iron units.

In the last 40 years, the basic open-hearth process has been almost completely replaced worldwide by various top, bottom, or combination blown basic oxygen steel making (OSM) processes.[1] Since the adoption of basic oxygen steelmaking, continuous incremental improvements on the various forms of the process have improved the productivity and efficiency of oxygen steelmaking vessels. Development efforts have included experimentation with various combination top and bottom blowing configurations, natural gas shielding of bottom oxygen tuyeres, bottom stirring, top lance design, post combustion, slag formation control, process monitoring and control, and refractory design. A recent, important development in oxygen steelmaking has been the adoption of slag-splashing practices to increase furnace lining campaigns to more than 20,000 heats.[3,8] In this practice, the furnace refractory lining is coated with slag between heats by nitrogen injection into the vessel after tapping of the liquid steel. Although the solidified slag coating eventually remelts in the subsequent heat or heats, this practice has effectively extended furnace lining life.

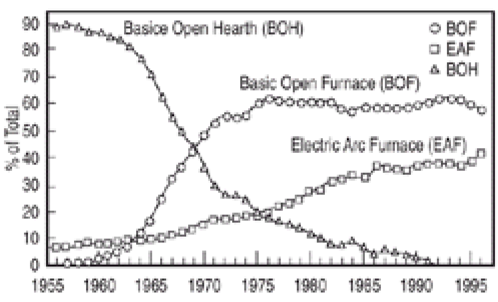

Figure 3. Evolution of steel by process from 1955 to 1996. Adapted from Fruehan.1 (Original source: International Iron and Steel Institute.)

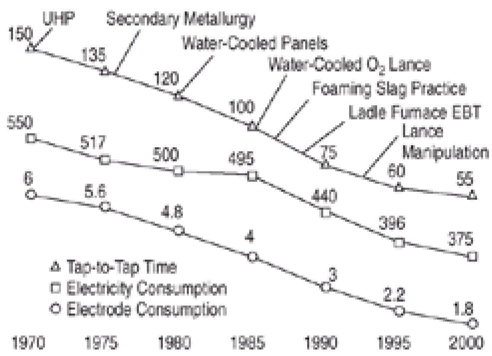

Figure 4. Evolution of EAF performance from 1970 to 2000. (Source: *AISI Technology Roadmap*.)[2]

The abandonment of open-hearth steelmaking practices for oxygen steel-making was accompanied by a parallel widespread departure from ingot casting and slabbing practices to the continuous casting of steel. The increases in productivity and yield associated with continuous casting have had a dramatic effect on the steel industry worldwide. From the mid- to late 1960s to present, the amount of continuously cast steel as a percentage of total steel production has risen from essentially 0% to more than 90% in most countries. Most of that change occurred in the relatively short period from 1970 to 1990.[9] Critical research regarding the fundamentals of solidification, defect formation and modification, fluid flow in the continuous-caster mold and developing steel shell, refractory interactions, and mold flux design have led to improvements in the control and reliability of continuous-casting processes. In North America, this knowledge base was developed through the research efforts of individual steel companies and through significant contributions by such universities as Carnegie Mellon University, the Massachusetts Institute of Technology (MIT), The University of British Columbia, The University of Illinois, and others.

Because oxygen steelmaking processes melt less scrap than open-hearth steelmaking, the adoption of oxygen steelmaking in developed countries was associated with a decrease in the price of scrap steel.[1] This increase in scrap availability and decrease in price created an opportunity for growth of scrap-based steel-making. With lower capital costs than an integrated mill, minimills based upon electric-arc furnace melting (EAF) of scrap were able to establish a cost advantage for the production of certain steel products. Figure 3 shows the proportion of crude steel production by process in the United States over the last 50 years.

The development of ultra-high-powered electric-arc furnaces and reliable billet and bloom continuous-casting machines provided a low-cost route for the production of lower quality steel long products, such as reinforcing bar and structural steels. As a result, integrated steel producers have been completely displaced from this low-end segment of the steel market in developed countries. This has allowed integrated producers to focus on the production of high-quality plate and thin-gauge flat products. The quality of steels produced via EAF is restrained by the level of metallic residuals such as copper, nickel, and tin, in the scrap metal charge and dissolved gasses such as hydrogen and nitrogen, which are contained in the scrap and picked up during processing. At very low levels these contaminants can significantly degrade the physical properties of many steel grades. However, continuous improvements in EAF process control and the use of ore-based scrap substitute materials such as direct reduced iron, hot briquetted iron, and pig iron to dilute tramp elements in scrap, have significantly increased the product quality range. Improved chemistry control and the successful implementation of thin-slab casting by Nucor has demonstrated that EAF producers can also be competitive in producing quality flat products as well. The continued expansion of EAF steelmaking for the production of higher quality steel products is projected to continue.[10] However, this expansion will require continued technological development of the basic process of electric furnace steel-making. More than 40% of steel produced in the United States is produced by EAF, and that figure is expected to rise to 50% by 2010.

In the last 30 years, a number of major technical modifications of the electric arc furnace have dramatically improved the efficiency and productivity of the process. Up to the present, the primary focus of electric furnace development has been to increase productivity and energy efficiency by decreasing tap-to-tap time. Large heat losses occur while the scrap pile or liquid steel is at high temperature. Greater energy efficiency is achieved when the rate of energy input is increased and the time at temperature is decreased. As a result, many of the developments in EAF steelmaking have focused on increasing the net energy density that the furnace is capable of delivering.[1] The development of foamy slag practices, whereby the hot electrode(s) and plasma arc are enveloped in foamed steelmaking slag, has significantly improved EAF performance. This practice protects the furnace roof and side walls from radiation and excessive heating, helps to stabilize the arc, and increases heat transfer to the steel, thus allowing furnace operators to run at much higher rates of power input.

Most modern electric furnaces also use a combination of oxy-fuel burners, pulverized coal injection, and oxygen injection to supplement electrical energy input. For modern EAF operations, 35% of the energy input is in from chemical energy sources.[3] Recently, additional chemical energy has been recovered via post-combustion reducing of product gases by the controlled injection of additional oxygen into the furnace above the slag. In the most modern furnaces, oxygen injected to combust pulverized coal injection and carbon charged into the furnace in scrap steel, direct reduced iron, pig iron, coke or coal can be as high as 40 Nm3/ton. For furnaces with post-combustion systems, the oxygen usage may be as high as 70

Nm3/ton.[1] At these very high rates of oxygen usage, significant additional heat energy is released by the exothermic oxidation of iron at high temperature. The additional heat input is gained at the expense of yield, due to the loss of iron as iron oxide in the slag. As a result, slag chemistry control and yield will become a focus of future developments in process control. Figure 4 shows the progress of EAF steelmaking in the last 30 years with respect to several key performance indicators.

The large quantities of hot combustion product gasses generated in the modern EAF have led to the development of several novel scrap preheating systems, whereby the heat energy of the exhaust gas is used to preheat scrap prior to melting. Between 10–30 percent of the energy input into an EAF can leave the furnace with the hot exhaust gas. Theoretically, 10 kWhr/ton of energy can be saved for every ~50 8C of preheating of the scrap charge.[2] In practice, capture of the heat from furnace exhaust gas has been problematic, primarily due to emissions control complications. Until recently, relatively low energy prices have made the economics of scrap preheating marginal, particularly in cases where the efficient heat transfer could not be achieved. The Fuchs shaft furnace, the Consteel process, and the Nippon Steel/Davy-Clecim twin shell electric arc furnace concept are some examples of scrap preheating systems that are currently in commercial use. Several processes are under development that allow for continuous preheating, feeding, and melting of scrap.[1]

TEXT 1
TEXTS TO ANNOTATE AND REFEREE

I. Read the text, try to understand its content as much as possible.

NEW TECHNOLOGIES FOR IRON AND STEELMAKING

The following article appears in the journal *JOM,* 53 (10) (2001), pp. 20-23.

Worldwide, direct-reduction capacity via existing gas-based technologies is likely to increase in order to support the expansion of EAF steelmaking to new, high-quality products. However, the blast furnace is likely to remain the backbone of worldwide iron production for several decades. Current fluidized bed and shaft furnace direct-reduction processes rely on natural gas as the primary reductant and source of heat for the reaction. One exception is the hydrogen-based Circored process. A Circored hot-briquetted iron plant in Trinidad produces reduced iron using byproduct hydrogen from the local petroleum industry. In regions where an abundant and inexpensive source of natural gas (or hydrogen) exists, gas-based direct reduction of iron followed by melting in an EAF can provide a cost-competitive alternative to quality steel products. However, in areas where low cost natural gas is not available, coal-based iron reduction processes will have an advantage. The efficiency and productivity of modern large-capacity blast furnaces will be difficult to surpass.

However, high capital requirements make it unlikely that any new blast furnaces will be built in developed countries in the near future. Nevertheless, the shut-down of aging coking operations and older, smaller blast furnaces will force the industry to pursue one or a combination of three options:

Stretch remaining hot metal supply with increased scrap melting in new steelmaking processes

Increase the productivity of remaining large capacity furnaces

Adopt or develop an entirely new process(es) for the production of hot metal or steel to complement or replace the blast furnace

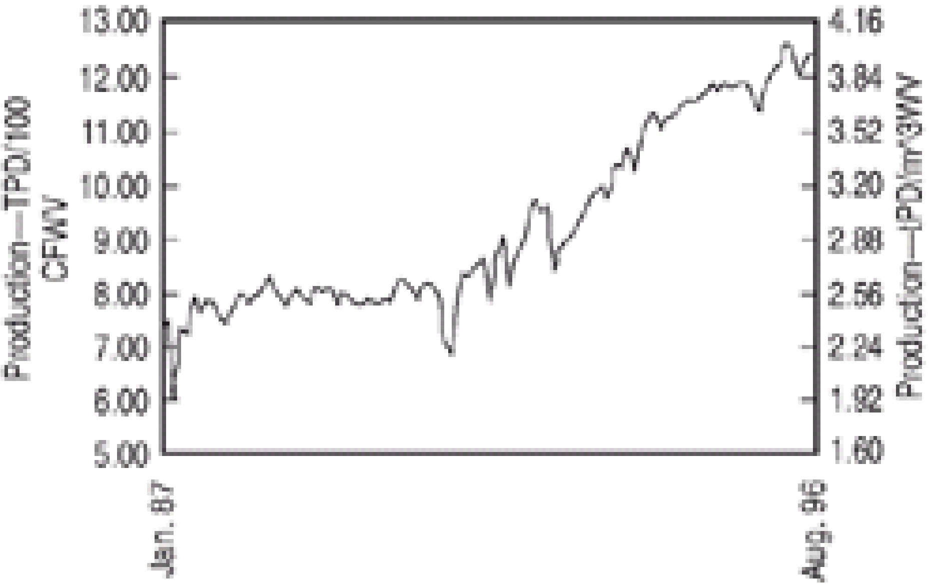

Figure 5. Productivity at AK Steel's Midland No. 3 blast furnace from June 1987 to August 1996. Adapted from Rabold and Hiernaux.18

There are several methods by which a limited supply of hot metal could be stretched by increasing scrap utilization. Process optimization of current oxygen steelmaking technologies will result in small improvements in yield by reducing both the iron content and total volume of slag produced. Scrap preheating and improved post combustion in conventional oxygen steelmaking vessels could be used to increase the scrap usage in these processes. Entirely new oxygen steelmaking furnace designs have been proposed, such as the energy optimizing furnace11, which makes use of high rates of post combustion, additional fossil fuel additions, and elaborate scrap preheating to increase scrap melting to as high as 70% during hot metal refining. Alternatively, direct hot metal addition and increased oxygen usage in a conventional EAF can dramatically decrease the electrical energy requirements per tonne of steel. The latter option allows the steelmaker to produce steel using anywhere from 20% to 100% scrap, producing the entire range of steel qualities with respect to residual content. Such a hybrid EAF-OSM process offers a great deal of process flexibility using proven and well-understood processes.

One limitation of stretching hot metal through significantly increased scrap utilization is related to the control of residual elements. As mentioned earlier, the quality of steels that can be produced via conventional EAF steelmaking is currently limited by control of residual metallic tramp elements in scrap and dissolved gasses. The increased production of steel long products via EAF steelmaking has resulted in a general decline in the quality of #2 and heavy melting scrap steel. If scrap is used in increasing quantities for the production of all steels, levels of residual elements can be expected to rise in the entire scrap supply. One solution to this dilemma is an economical process by which residual tramp elements can be removed from scrap, thus upgrading the scrap quality. Several processes have been demonstrated on laboratory and pilot scales12–17 that have been successful in removing certain tramp elements. However, in each case, unfavorable economics have prevented widespread commercial implementation.

One alternative to removing metallic tramp elements is to reduce their deleterious effects on steel properties. Most metallic residuals reduce steel hot strength and hot and cold ductility by segregating to and weakening grain boundaries. Tolerance to such chemical impurities could be improved through the design of alloys in which these elements were tied up in heterogeneously nucleating second-phase particles, which might not have the same negative effect on steel properties. Also, new near net shape casting processes, which will be described in following sections, may dramatically reduce the overall effect of residual elements for two reasons. As its name implies, near net shape casting describes solidification processes by which steel is cast in dimensions near to the specifications of the final product.

Although hot reduction at some level may still be required for microstructure control, near net shape casting significantly reduces the dimensional forming requirements of hot reduction processes and may reduce problems such as hot tearing. Even more importantly, near net shape casting processes for the production of thin gauge steel involve much higher rates of heat removal, solidification, and cooling than conventional casting or thin-slab casting processes. As a result, microstructural evolution in strip cast materials is fundamentally different from conventionally processed materials. Macro-segregation in strip-cast steel is significantly suppressed. Experiments have shown that a wide range of properties can be achieved from a single steel chemistry entirely through variation of casting speed and solidification and cooling rates. This has significant implications for the future of residual element control in steelmaking.

Industry leaders continue to demonstrate the significant potential for increased productivity of the blast furnace.18 Figure 5 shows the production rate at AK Steel's Middletown No. 3 blast furnace over a ten-year study period.

For blast furnace production to continue into the future even at current levels in the United States and other developed countries, continued progress must be made on reducing the coke rate of furnaces through coal injection. Significant progress has been made in evaluating the benefits of oxygen enrichment of the hot blast. Industrial trials are in progress to evaluate an oxy-coal injection system, which promises to allow for complete combustion at elevated coal injection rates.19 New, environmentally acceptable and economically feasible processes for new or replacement coke production capacity should be evaluated. If less coke is to be used in the blast furnace, the mechanical property requirements of the coke that is used will become more critical to maintaining permeability and stable furnace operation. If antiquated coke production methods cannot produce material of the required strength, exporting the environmental problems of coke production to developing countries with less stringent regulations may become functionally as well as socially unacceptable.

II. Familiarise yourself with the bibliographical data of the text. Formulate them in English and Russian.

III Say what the text is talking about in Russian.

IV. Write out the technical terms from the text that belong to the field of knowledge "metallurgy".

V. Find a sentence in each paragraph which, in your opinion, expresses its main idea. Justify your choice.

VI. Annotate the text in writing (not more than 500 characters).

TEXT 2
NEW TECHNOLOGIES FOR HOT METAL PRODUCTION

I. Read the text, look up in the dictionary the unknown words that make it difficult to understand the text.

The following article appears in the journal *JOM,* 53 (10) (2001)**, pp. 20-23.**

Several new processes for producing hot metal are in various stages of development around the world. For example, technologies have been developed for the reduction of iron ore or steel mill waste oxides to produce a solid direct-reduced iron product. That product could be discharged to a second reactor for melting or cooled and stored for later use. Several processes based upon the direct reaction of coal and iron ore in a rotary kiln, such as the SL/RN process, have reached various stages of development since the 1960s.20 Due to the high gangue and low specific productivity of these processes, they have not received a great deal of attention for commercial production. Several processes are currently commercially available that use a rotary hearth furnace to reduce composite pellets containing both iron-oxide fines from ore or wastes and carbon from coal, coke, wood char, or mill wastes. Due to the intimate contact between the carbon and iron oxide in the composite pellets, iron reduction is very fast at elevated temperatures. The off gasses from the reduction reaction and/or coal devolatization can be post combusted in the rotary hearth chamber to provide a significant portion of the heat required for the process. Midrex is currently marketing a rotary-hearth-based process, Fastmet, for recycling mill waste oxides.21 Two commercial Fastmet units have been installed at Kobe Steel and Nippon Steel, both in Japan. Iron Dynamics, a subsidiary of Steel Dynamics, currently operates a rotary hearth furnace to produce 85 percent reduced iron pellets. Those pellets are subsequently melted in a submerged arc furnace to produce hot metal for use in a nearby Steel Dynamics EAF shop. The Iron Dynamics rotary hearth-submerged arc process uses proven technologies to produce liquid iron at a reasonable cost for use in the EAF.22 However, the total energy efficiency of this process is not very high as compared with the blast furnace or other new coal-based technologies.

NOVEL PROCESSES FOR IRON PRODUCTION

As the supply of coke becomes more critical, smaller blast furnaces are closed down, and additional hot metal capacity is needed, an opportunity exists to develop an entirely new process that better fits the needs of contemporary and future steelmakers. The characteristics of a new, ideal process for increased iron unit production should include the following:

Very high efficiency with respect to energy and materials usage—A new technology will be replacing conventional reactors, which are extremely efficient at present and will only continue to improve in the near future.

Greater flexibility in feed materials—Dependency of the modern blast furnace on coke is the greatest weakness of the process. Any process that could use coal directly would have an enormous advantage over the blast furnace. In addition, the direct use of fine or lump iron ore and/or waste iron oxides without agglomeration would further reduce capital costs as compared with conventional processes.

Reduced capital costs—Due to efficiencies of scale, which are inherent to the process, high-efficiency, high-productivity blast furnaces represent a daunting capital investment for most individual steel companies without state subsidization. A process that could be operated on a smaller unit scale without compromising efficiency would greatly reduce the capital requirements for adding new ironmaking capacity. Also, as mentioned above, a process that could use coal and unprepared ore directly would eliminate the additional capital requirements of coke making and pelletizing/sinter plants. As was discussed previously, the direct use of hot metal in the EAF as a scrap substitute offers the advantage of excellent process flexibility in terms of electrical versus chemical energy usage and in product quality. The combination of a new technology for small-scale hot metal production with the EAF minimill concept could offer a new route to high quality steel products with very favorable economics.

Operational flexibility—Although recent advances in blast furnace productivity exhibit that the process can be operated at a range of production rates, even greater flexibility would be advantageous.The economics of steelmaking are very sensitive to the cycles of economic boom and slowdown. Therefore, an ideal process would be capable of operating at a range of production rates without compromising efficiency or the economics of the process. Because the production costs associated with a new process will not vary significantly from those of conventional processes, the economics of the overall process are largely tied to the capital costs of the process. Provided production costs do not increase dramatically, a process with lower capital costs can be operated at lower production rates while maintaining profitability.

Capability of producing steel or low carbon iron directly—The highly reducing environment of the blast furnace produces “hot metal” or carbon saturated iron (~5 wt.% C). However, most steel products have a carbon content of less than 1 wt.% C. During oxygen steelmaking, most of the carbon is removed via reaction with injected oxygen to form carbon monoxide. This practice has evolved over centuries as a result of the extreme difficulty in controlling the reduction of iron ore to low-carbon iron in a highly productive and cost-effective process. Using modern monitoring and control technologies and expanded fundamental knowledge of reaction thermodynamics and kinetics, a new process capable of producing steel or low-carbon iron in a single continuous reactor might be possible. By this process, the conventional unit processes of the coke plant, sinter or pelletizing plant, blast furnace, and oxygen steelmaking furnace could be replaced by a single reactor.

Several new technologies take advantage of the rapid-reaction kinetics and high specific productivity of smelting reactors to accomplish at least part of the reduction of agglomerated, lump, or fine iron ore using coal directly. Coal devolatization and gasification also occurs in the smelter reactor. Volatile hydrocarbon compounds make up 10–15 percent of low-volatile coals and 40–45 percent of high-volatile coals.23 In theory, the high-temperature removal and controlled combustion and/or reaction of these compounds to CO/CO2 and H2/H2O alleviates some of the environmental problems associated with conventional coke making.

The Corex process,24 commercialized by Voest Alpine, combines an iron melter/coal gasifier vessel with a pre-reduction shaft to produce a liquid product that is very similar to blast furnace hot metal. Coal, oxygen, and pre-reduced iron are fed into the melter/gasifier to melt the iron and produce a highly reducing off-gas. The primarily CO-H2 off-gas is then fed through a pre-reduction shaft furnace, where lump and/or agglomerated ore is reduced to over 90 percent for feeding into the melter/gasifier. The gas exiting the pre-reduction shaft still has a very high energy content, which can be used elsewhere in the steel plant or for electric power generation. Voest Alpine and POSCO jointly continued to develop the original commercialized process, leading to several important modifications including the limited direct reduction and smelting of ore fines 25 . If the high energy content of the exhaust gas from the reduction shaft is not utilized, the Corex process requires a relatively high fuel rate as compared with a blast furnace. Although Corex has a relatively high capital cost 23 , it is so far the only smelting process to be operated on a commercial scale. The first commercial Corex plant with a capacity of 300,000 tonnes per year began production in 1989. Other installations are operating, under construction, or planned in Korea, South Africa, and India.

In the HIsmelt process, iron reduction and coal gasification take place in a liquid metal bath. The fundamental processes of HIsmelt began with early experiments in Englishy with bottom-blown oxygen steelmaking converters (LD, LD-AC, KMS, among others) to allow for coal, lime, and/or iron ore injection through the bottom nozzles.26 Experiments with combination blown oxygen converters serendipitously discovered that simultaneous bottom oxygen blowing and soft or low velocity top oxygen blowing resulted in post combustion of the decarborization product gases in the area above the bath. High heat transfer rates from the hot post combusted gasses to the metal bath were achieved via heat transfer to metal droplets ejected into the gas above the bath, which then fell back into the molten pool. Bottom injection of coal augmented this post-combustion phenomenon and allowed for significantly increased scrap melting (100% in the KS process) or smelt reduction of iron ore. Early experiments by Klöckner Werke and CRA (now Rio Tinto) with smelt reduction via simultaneous bottom injection of coke and ore into a KMS converter indicated that the reduction reaction kinetics were extremely fast and that the iron reduction, coal gasification, and post combustion reactions could be predicted and controlled. A small-scale test facility was built in Englishy in 1984 to produce hot metal.

In 1989, CRA and Midrex formed a joint venture to build a demonstration plant in Western Australia to further develop the HIsmelt process. Since that time, the process has been significantly modified, simplified, and improved, allowing for extended continuous operation and very high specific productivity performance. The extensive pilot scale testing in Australia resolved many of the technical problems, such as refractory wear, post-combustion control, and slag-foaming control, which limit the stable operation of all bath smelting processes.27 One unique feature of HIsmelt is that all reactants are injected through submerged lances. Pilot scale testing data indicate that this results in much better coal utilization than with top-charged processes. Like Corex, HIsmelt produces a hot exhaust gas with significant thermal and chemical energy content, which can be used for pre-reduction and pre-heating of the iron feed or on-site power generation. A production-scale demonstration HIsmelt plant producing around 600,000 tonnes per year is planned for Kwinana, Western Australia.

Simultaneous independent development of the direct iron ore smelting (DIOS) process in Japan 28-30 and the AISI direct steelmaking process in North America 31,23 produced two similar routes to hot metal production. Both processes utilize a smelting reactor where the primary reactions occur in a deep slag bath as opposed to in the metal phase as in HIsmelt. Pre-reduced iron ore, coal, and oxygen are injected into a deep steel-making slag. The coal is devolatilized and partially combusted to CO. The uncombusted coal char either directly reacts with iron oxide dissolved in the slag to form iron and carbon monoxide or dissolves in the iron bath. Dissolved carbon in the metal also reacts with iron oxide in the slag to form iron and carbon monoxide. Stirring gas injected through the bottom of the reactor and gas evolved within the slag and at the slag-metal interface result in foaming of the slag and energetic mixing and intermixing of the slag and metal phases. Secondary low-velocity oxygen is injected either above or into the top portion of the slag layer to partially post-combust the CO and H2 produced by coal devolatilization, combustion, and iron-oxide reduction reactions. The thick slag layer separates the iron-carbon melt and char from the oxidizing post-combustion products, providing a medium for heat transfer. The exiting gas is then used to preheat and pre-reduce the iron ore feed materials. The DIOS process uses a series of fluidized bed reactors for preheating and pre-reduction of iron ore fines. The AISI process uses a Hyl or Midrex type shaft furnace for pre-reduction and must use primarily lump or agglomerated ore as its feed material. In these smelter reactors, post combustion provides approximately 60% of the required energy. However, uncontrolled post combustion or poor heat-transfer efficiency downward to the bath can cause excessive slag foaming, damage to the reactor, and generally unstable operation. Precise process control is required for stable operation. Pilot-scale plants of both the DIOS and AISI smelter processes have been built and operated using a variety of feed materials, including low and high volatile coals, different types of ore, and steel mill waste-oxide materials. The AISI smelter has been evaluated as a potential method for the recycling of high iron content steel mill waste oxides. No commercial production facilities are currentlyplanned for these two processes.

Several additional combinations of smelting reactors and pre-reduction reactors are also under consideration. The cyclone converter furnace (CCF), developed initially by Hoogovens Staal BV, has been considered for use in combination with the bath smelting reactors described previously.23 In the CCF, iron-ore fines are introduced at the top of the furnace and hot off-gasses from the smelter reactor enter from the bottom. The feed gas heats and partially reduces the descending iron ore. Injected oxygen partially combusts the gas, providing enough heat to melt the iron oxide before it exits the converter. The intensive mixing of the swirling gasses and iron-ore fines promotes excellent heat transfer. Hoogovens evaluated the commercial scale-up of a process combining the CCF with a DIOS type smelter.

The Center for Iron and Steelmaking Research at Carnegie Mellon University is currently conducting a study, partially sponsored by the U.S. Department of Energy, regarding the use of biomass energy sources for hot-metal production.32 The scheme that is currently being evaluated uses a rotary hearth furnace to heat and partially reduce composite pellets of iron ore fines and wood char. These pellets are then fed into an AISI smelter or DIOS-type reactor, where the final reduction and melting occurs. The off-gas from the smelter would be fed back to the rotary hearth to provide a portion of the energy requirement of that reactor.

II Say in Russian what new things you have learned about heat treatment from the text.

III. Find a sentence in each paragraph that expresses its main idea. Give reasons for your choice.

IV. Present the text in writing (10-15 sentences).

TEXT 3
DIRECT STEELMAKING

I. Read the text, try to explain its title.

A process which could produce steel or low carbon iron directly and continuously would be a revolutionary development in ferrous process metallurgy. The AISI direct steelmaking project evaluated a continuous refining process for the conversion of hot metal as from a bath smelter to steel.10 The project studied a single zone and two zone reactors. In the two-zone reactor, hot metal is decarborized to approximately one percent carbon. Final decarborization occurs in the second reactor. It was found that the slow kinetics of the final oxidation of carbon from iron at low concentrations resulted in excessive oxidation of the iron and related control and containment complications. IRSID had developed a unique design for a continuous steelmaking reactor, which has been tested on a demonstration scale.10 The IRSID continuous-steelmaking process decarborizes hot metal in a slag-metal emulsion, which results when oxygen is impinged upon the entering hot metal. Due to the violent stirring and large metal droplet surface area present in the emulsion, mass transfer rates in the IRSID reactor are predicted to be 3.3 to 5 times higher as compared with a BOF. However, the violent nature of this reactor may also result in rapid refractory wearand containment problems.

The IFCON process, developed by ISCOR in South Africa, is capable of producing steel directly from coal and iron ore.1 In this process, coal and ore are added continuously to a channel type induction furnace containing a slag-metal bath. Electrical energy is supplied by the induction furnace for heating and stirring the bath. Oxygen is added for post combustion of hydrogen and carbon monoxide released from the iron reduction reaction and the coal. Although the claims of this process are truly revolutionary, few details regarding the process or test results have been reportedpublicly.

II. Read the text again, write out the key words that explain the topic of the article.

III. Annotate the text orally and in writing (the annotation - not more than 500 characters).

TEXT 4
DIRECT IRON AND STEELMAKING CHALLENGES

I. Read the text and see what high-tech ideas are set out in it.

Because the new iron and steelmaking technologies described previously share some common attributes, they also share some common technical challenges.33 For example, technologies that use coal directly will have to deal with higher levels of sulfur than the blast furnace. Coal contains both volatile organic sulfur and mineral sulfur as FeS. During coke making and initial coal pyrolisis in smelting reactors, the organic sulfur is driven off primarily as H2S. In the blast furnace and smelter reactors, mineral FeS dissolves in the slag and a portion is transferred to the metal. In coke making, the volatile organic sulfur is captured and processed. During smelting, the H2S will exit with the exhaust gas, where it will likely react with CaO and FeO dusts to form CaS and FeS. Subsequent dust recycling will result in dissolution of these phases in the slag and eventual transfer to the metal. In addition, higher FeO levels in bath smelting slags as compared with the blast furnace will also promote higher sulfur transfer from the slag to the metal phase. As a result, highly efficient hot metal desulfurization practices will be necessary when using bath smelter metal to produce high quality steel products. Fundamental research at Carnegie Mellon University regarding the kinetics of sulfur transfer resulted in the development of a kinetic model that can be used to predict and control sulfur in smelter metal.34

New iron-making processes that use coal directly will generate a large volume of carbon monoxide, hydrogen, and hydrocarbons, which must be utilized to avoid condensation of complex and hazardous hydrocarbon compounds and improve the energy efficiency of the processes. Most new technologies under investigation use some form of post combustion to supply a large amount of the energy required for the endothermic reduction of iron oxide. The post-combustion degree (PC) can be measured as the proportion of the combustion products and reactants in the off gas of the reactor.

PC =

$CO_2 + H_2O$

$CO_2 + H_2O + CO + H_2$

In conventional reactors such as the BOF and EAF, additional oxygen injected at low velocity above the slag-metal bath combusts CO and H2 to CO2 and H2O, releasing a large amount of heat energy. However, the oxidizing product gasses must be shielded from the metallic iron and carbon in the metal and char to prevent depost-combustion reactions, namely:

CO_2 + C ® 2CO

CO_2 + Fe ® FeO + CO

H_2O + C ® H2 + CO_2

H_2O + Fe ® FeO + H_2

These reverse reactions can make it very difficult to attain high degrees of post combustion when the hot metal and post combustion gasses are in intimate contact. At the same time, the intended goal of post combustion is to transfer the heat generated by the combustion reactions downward to the slag and metal. Poor heat-transfer efficiency (HTE) to the slag and metal can result in an unacceptable increase in thermal load imposed on the vessel roof and sidewalls and the gas handling system. In bath-smelting reactors, the iron reduction and coal pyrolisis reactions are endothermic, thus heat transfer to the site of the reactions can be a rate-limiting factor for the process. In addition, special care must be taken when designing the gas handling system for bath-smelting reactors. The large volumes of hot gas produced and high particulate content of the gas can easily overwhelm an insufficient system. The HIsmelt process uses preheated air instead of oxygen for post combustion.26 The post-combustion products are diluted by the nitrogen content of the air, allowing for simultaneous high post-combustion degrees and high heat-transfer efficiency. This also increases the total volume of gas exiting the vessel. In the DIOS and AISI smelter reactors, submerged post combustion, or post combustion in the top portion of the deep slag layer using submerged oxygen injection, was investigated.33 Combustion within the slag layer should result in high heat-transfer efficiencies from the post combustion reactions to the slag and, subsequently, to the metal. If the post combustion is limited to only the top portion if the slag bath, the metal droplets and char should be shielded from the oxidizing product gasses by the thick slag layer. Both the potential benefits and limitations of post combustion were studied extensively for each of the bath-smelting processes described above. Experience gained from the continued development of post combustion systems for conventional reactors will aid in the design of future post-combustion systems for bath-smelting reactors.

Steelmaking slags tend to foam when gas is passed through them. The properties of slag (i.e., high viscosity and high surface tension) are such that the kinetics of bubble film rupture are relatively slow, and thus, bubbles tend to form stable rafts. Slag foaming is a feature of most conventional steelmaking processes. In the modern EAF, maintaining a stable foamed slag to submerge the arc is critical for high productivity operation. In the BOF, controlling slag foaming is important for the prevention of slag slopping from the vessel during processing. In the deep slag-melting processes such as DIOS and the AISI smelter, a highly stirred, foamy slag forms the medium in which the iron reduction and coal pyrolisis reactions take place. A large amount of gas is passed through or generated within the thick slag layer due to bottom stirring gas injection and the in situ production of carbon monoxide and hydrogen from the reduction, pyrolisis, and combustion reactions. The control of slag foaming is critical to the stable operation of the processes. The fundamentals of slag foaming were studied extensively on a laboratory scale 35,36 and also in the actual pilot-scale reactors 28-31 .

It was found that by maintaining a certain amount of char in the smelter slag and/or operating at an elevated pressure-slag foaming could be controlled to an acceptable degree.

Process monitoring and control are critical for stable operation of smelting reactors. The development or implementation of inexpensive, durable sensors capable of continuous real time measurement of key process parameters, such as slag height, post combustion degree, temperature, reactant feed rates, and possibly slag and/or metal chemistry, are critical to the commercial success of a smelting process. Significant recent advancements have been made in the development of such technologies for use with conventional iron and steel-making processes.37

All the bath-smelting reactors described previously are vigorously stirred reactors intended for continuous operation possibly at elevated pressures. Refractory wear is a significant concern for bath smelting processes and all conventional iron- and steelmaking processes. The use of water-cooled panels can alleviate this problem, but also reduces the energy efficiency of the process. The development of erosion-resistant refractories and hearth designs, combined with water-cooled panels in problem areas, has significantly extended blast furnace hearth life. Reliable containment is possible in similar solutions for smelting reactors, but continued refractory development will make these and conventional processes more reliable.

Refer to the text orally (10-15 sentences).

ПРИЛОЖЕНИЯ К РАЗДЕЛУ ГРАММАТИКА

ПРИЛОЖЕНИЕ 1

Группы местоимений

По своему значению местоимения в английском языке делятся на несколько групп:

- Личные
  - ✓ именительный / объектный падеж *(who?/кто?; what?/что?)*:
    I, you, he / she / it, we, you, they
  - ✓ объектные падежи *(кому?/чему?; кем?/чем?; о ком?/о чём? и т.д.)*:
    me, you, him / her / it, us, you, them
- Притяжательные
  - ✓ присоединяемая форма *(т.е. ставится перед существительным)*:
    my, your, his, her, its, our, their
    E.g.: This is ***my*** apple. – Это моё яблоко.
  - ✓ абсолютная форма *(т.е. используется без существительного)*:
    mine, yours, his, hers, its, ours, theirs
    E.g.: This apple is ***mine***. – Это яблоко моё.
- Указательные

This – этот, that – тот, these – эти, those – те, such – такой

- Возвратные

myself, yourself, himself, herself, itself, ourselves, yourselves, themselves

- Взаимные

each other – друг другу, one another – один другому

- Вопросительные

who, what, which, whose, whoever, whatever, whichever

- Относительные

who, whose, which, that

- Неопределенные

some, something, somebody, someone, any, anything, anybody, anyone

- Отрицательные

no, nothing, nobody, no one, none, neither

- Разделительные

another, other

- Универсальные

all, each, both, either, every, everything, everybody, everyone

ПРИЛОЖЕНИЕ 2

Количественные и порядковые числительные

Количественные *How many? – Сколько?*	**Порядковые** *Which? – Который?*
1 one	1st first
2 two	2nd second
3 three	3rd third
4 four	4th fourth
5 five	5th fifth
6 six	6th sixth
7 seven	7th seventh
8 eight	8th eighth
9 nine	9th ninth
10 ten	10th tenth
11 eleven	11th eleventh
12 twelve	12th twelfth
13 thirteen	13th thirteenth
14 fourteen	14th fourteenth
15 fifteen	15th fifteenth
16 sixteen	16th sixteenth
17 seventeen	17th seventeenth
18 eighteen	18th eighteenth
19 nineteen	19th nineteenth
20 twenty	20th twentieth
21 twenty-one	21st twenty-first
22 twenty-two	22nd twenty-second
23 twenty-three	23rd twenty-third
24 twenty-four	24th twenty-fourth
25 twenty-five	25th twenty-fifth
30 thirty	30th thirtieth
40 forty	40th fortieth
50 fifty	50th fiftieth
60 sixty	60th sixtieth
70 seventy	70th seventieth
80 eighty	80th eightieth
90 ninety	90th ninetieth
100 a (one) hundred	100th hundredth
101 a (one) hundred **and** one	101st hundred **and** first
116 a (one) hundred **and** sixteen	116th hundred **and** sixteenth
125 a (one) hundred **and** twenty-five	125th hundred **and** twenty-fifth
200 two hundred	200th two hundredth
500 five hundred	500th five hundredth
1,000 a (one) thousand	1,000th thousandth
1,001 a (one) thousand **and** one	1,001st thousand **and** first
1,256 a (one) thousand two hundred **and** fifty-six	1,256th thousand two hundred **and** fifty-sixth
2,000 two thousand	2,000th two thousandth
25,000 twenty-five thousand	25,000th twenty-five thousandth
100,000 a (one) hundred thousand	100,000th hundred thousandth
1,000,000 a (one) million	1,000,000th millionth
1,000,000,000 a (one) milliard в Англии; a (one) billion в США	1,000,000,000th milliardth или billionth

ПРИЛОЖЕНИЕ 3

Таблица неправильных глаголов

Infinitive	Past simple	Past participle	Перевод
be [bi:]	was [wɔz], were [wɜ:]	been [bi:n]	быть
beat [bi:t]	beat [bi:t]	beaten ['bi:tn]	бить
become [bi:kʌm]	became [bi:keim]	become[bi:kʌm]	становиться
begin [bi'gin]	began [bi'gæn]	begun [bi'gʌn]	начинать
bleed [bli:d]	bled [bled]	bled [bled]	кровоточить
blow [blou]	blew [blu:]	blown [bloun]	дуть
break [breik]	broke [brouk]	broken ['brouk(e)n]	ломать
bring [briŋ]	brought [brɔ:t]	brought [brɔ:t]	приносить
build [bild]	built [bilt]	built [bilt]	строить
burn [bɜ:n]	burnt [bɜ:nt]	burnt [bɜ:nt]	гореть
burst [bɜ:st]	burst [bɜ:st]	burst [bɜ:st]	разразиться
buy [bai]	bought [bɔ:t]	bought [bɔ:t]	покупать
catch [kætʃ]	caught [kɔ:t]	caught [kɔ:t]	ловить, хватать
choose [tʃu:z]	chose [ʃəuz]	chosen [tʃəuz(ə)n]	выбирать
come [kʌm]	came [keim]	come [kʌm]	приходить
cost [cɔst]	cost [cɔst]	cost [cɔst]	стоить
creep [kri:p]	crept [krept]	crept [krept]	ползать
cut [kʌt]	cut [kʌt]	cut [kʌt]	резать
do [du:]	did [did]	done [dʌn]	делать
draw [drɔ:]	drew [dru:]	drawn [drɔ:n]	рисовать, тащить
dream [dri:m]	dreamt [dremt]	dreamt [dremt]	мечтать, дремать
drink [driŋk]	drank [dræŋk]	drunk [drʌŋk]	пить
drive [draiv]	drove [drouv]	driven ['drivn]	водить
eat [i:t]	ate [et]	eaten ['i:tn]	есть

fall [fɔ:l]	fell [fel]	fallen ['fɔ:lən]	падать
feed [fi:d]	fed [fed]	fed [fed]	кормить
feel [fi:l]	felt [felt]	felt [felt]	чувствовать
fight [fait]	fought [fɔ:t]	fought [fɔ:t]	бороться
find [faind]	found [faund]	found [faund]	находить
fit [fit]	fit [fit]	fit [fit]	подходить по размеру
fly [flai]	flew [flu:]	flown [floun]	летать
forget [fə'get]	forgot [fə'gɔt]	forgotten [fə'gɔt(ə)n]	забывать
forgive [fo'giv]	forgave [fo'geiv]	forgiven [fo'givn]	прощать
freeze [fri:z]	froze [frouz]	frozen ['frouzn]	замерзать
get [get]	got [gɔt]	got [gɔt]	получать
give [giv]	gave [geiv]	given [givn]	давать
go [gou]	went [went]	gone [gɔn]	идти
grow [grou]	grew [gru:]	grown [groun]	расти
hang [hæŋ]	hung [hʌŋ]	hung [hʌŋ]	вешать
have [hæv]	had [hæd]	had [hæd]	иметь
hear [hiə]	heard [hɜ:d]	heard [hɜ:d]	слышать
hide [haid]	hid [hid]	hidden ['hidn]	прятать
hit [hit]	hit [hit]	hit [hit]	попадать в цель
hold [hould]	held [held]	held [held]	держать
hurt [hɜ:t]	hurt [hɜ:t]	hurt [hɜ:t]	ушибить
keep [ki:p]	kept [kept]	kept [kept]	содержать
kneel [ni:l]	knelt [nelt]	knelt [nelt]	стоять на коленях
know [nou]	knew [nju:]	known [noun]	знать
lay [lei]	laid [leid]	laid [leid]	класть
lead [li:d]	led [led]	led [led]	вести
lean [li:n]	leant [lent]	leant [lent]	наклоняться
learn [lɜ:n]	learnt [lɜ:nt]	learnt [lɜ:nt]	учить

leave [li:v]	left [left]	left [left]	оставлять
lend [lend]	lent [lent]	lent [lent]	занимать
let [let]	let [let]	let [let]	позволять
lie [lai]	lay [lei]	lain [lein]	лежать
light [lait]	lit [lit]	lit [lit]	освещать
lose [lu:z]	lost [lɔst]	lost [lɔst]	терять
make [meik]	made [meid]	made [meid]	производить
mean [mi:n]	meant [ment]	meant [ment]	значить
meet [mi:t]	met [met]	met [met]	встречать
mistake [mis'teik]	mistook [mis'tuk]	istaken is'teik(e)n]	ошибаться
pay [pei]	paid [peid]	paid [peid]	платить
prove [pru:v]	proved [pru:vd]	proven [pru:vn]	доказывать
put [put]	put [put]	put [put]	положить
quit [kwit]	quit [kwit]	quit [kwit]	выходить
read [ri:d]	read [red]	read [red]	читать
ride [raid]	rode [roud]	ridden ['ridn]	ездить верхом
ring [riŋ]	rang [ræŋ]	rung [rʌŋ]	звенеть
rise [raiz]	rose [rouz]	risen ['rizn]	подниматься
run [rʌŋ]	ran [ræŋ]	run [rʌŋ]	бежать
say [sei]	said [sed]	said [sed]	говорить
see [si:]	saw [sɔ:]	seen [si:n]	видеть
seek [si:k]	sought [sɔ:t]	sought [sɔ:t]	искать
sell [sel]	sold [sould]	sold [sould]	продавать
send [send]	sent [sent]	sent [sent]	посылать
set [set]	set [set]	set [set]	ставить
sew [sou]	sewed [soud]	sewn [soun]	шить
shake [ʃeik]	shook [ʃuk]	shaken ['ʃeik(ə)n]	встряхивать
show [ʃəu]	showed [ʃəud]	shown [ʃəun]	показывать

shrink [ʃriŋk]	shrank [ʃræŋk]	shrunk [ʃrʌŋk]	уменьшать
shut [ʃʌt]	shut [ʃʌt]	shut [ʃʌt]	закрывать
sing [siŋ]	sang [sæŋ]	sung [sʌŋ]	петь
sink [siŋk]	sank [sæŋk], sunk [sʌŋk]	sunk [sʌŋk]	тонуть
sit [sit]	sat [sæt]	sat [sæt]	сидеть
sleep [sli:p]	slept [slept]	slept [slept]	спать
slide [slaid]	slid [slid]	slid [slid]	скользить
sow [sou]	sowed [soud]	sown [soun]	сеять
speak [spi:k]	spoke [spouk]	spoken ['spouk(e)n]	говорить
spell [spel]	spelt [spelt]	spelt [spelt]	произносить по буквам
spend [spend]	spent [spent]	spent [spent]	тратить
spill [spil]	spilt [spilt]	spilt [spilt]	проливать
spoil [spɔil]	spoilt [spɔilt]	spoilt [spɔilt]	портить
spread [spred]	spread [spred]	spread [spred]	расстилать
spring [spriŋ]	sprang [spræŋ]	sprung [sprʌŋ]	прыгать
stand [stænd]	stood [stu:d]	stood [stu:d]	стоять
steal [sti:l]	stole [stoul]	stolen ['stəulən]	красть
stick [stik]	stuck [stʌk]	stuck [stʌk]	колоть
sting [stiŋ]	stung [stʌŋ]	stung [stʌŋ]	жалить
sweep [swi:p]	swept [swept]	swept [swept]	выметать
swell [swel]	swelled [sweld]	swollen ['swoul(e)n]	разбухать
swim [swim]	swam [swem]	swum [swʌm]	плавать
swing [swiŋ]	swung [swʌŋ]	swung [swʌŋ]	качать
take [teik]	took [tuk]	taken ['teik(ə)n]	брать, взять
teach [ti:tʃ]	taught [tɔ:t]	taught [tɔ:t]	учить
tear [tɛə]	tore [tɔ:]	torn [tɔ:n]	рвать
tell [tel]	told [tould]	told [tould]	рассказывать

think [θiŋk]	thought [θɔ:t]	thought [θɔ:t]	думать
throw [θrəu]	threw [θru:]	thrown [θrəun]	бросать
understand [ʌndə'stænd]	understood [ʌndə'stud]	understood [ʌndə'stud]	понимать
wake [weik]	woke [wouk]	woken ['wouk(e)n]	просыпаться
wear [wεə]	wore [wɔ:]	worn [wɔ:n]	носить
weep [wi:p]	wept [wept]	wept [wept]	плакать
wet [wet]	wet [wet]	wet [wet]	мочить
win [win]	won [wʌn]	won [wʌn]	выигрывать
wind [waind]	wound [waund]	wound [waund]	извиваться
write [rait]	wrote [rout]	written ['ritn]	писать

ПРИЛОЖЕНИЕ 4

Предлоги

1. Общая информация

Предлог – это служебная часть речи, отражающая пространственные, временные, причинные или другие виды отношений между двумя значимыми словами. Предлоги в английском языке являются служебной частью речи и как следствие не могут употребляться самостоятельно или изменяться. Предлоги не считаются членами предложения.
Английские предлоги делятся на:
простые (simple), производные (derived), сложные (compound) и составные/фразовые (composite/phrasal).

Простые: in, about, against.

Производные (происходят от слов других частей речи):
concerning, including, depending, granted.

Сложные (включают в себя несколько компонентов):
within, hereafter, wherewith, whereupon и т.д.

Составные (словосочетание):
because of, instead of, by virtue of, for the sake of, with regard to и т.д.

2. Различия в употреблении английских предлогов с русским языком

Некоторые глаголы, которые требуют наличия предлога в английском языке, используются без него в русском, и наоборот:
to ask **for** - просить
to wait **for** - ждать
to look **for** - искать
to listen **to** - слушать
to belong **to** - принадлежать
to care **for** - любить
to explain **to** - объяснять
to answer - отвечать **на**
to climb - подниматься **на**
to cross - переходить **через**
to doubt - сомневаться **в**
to enter - входить **в**
to fight - бороться **с**
to follow - следовать **за**
to join - присоединиться **к**

to leave - уехать **из**
to need - нуждаться **в**
to play - играть **в**
to affect - влиять **на**

3. Грамматическое значение английских предлогов

Если в русском языке отношения между двумя значимыми словами часто выражаются при помощи падежей, то в английском языке эту роль берут на себя предлоги. При этом сами предлоги не переводятся, а соответствующее им существительное ставится в нужном падеже:

- ✓ **of** («кого? чего?») – **родительный падеж**:

This is the hat ***of*** *Mr. White.*
Это шляпа мистера Уайта.

- ✓ **to** («кому? чему?») – **дательный падеж**:

Send it ***to*** *my secretary immediately.*
Немедленно отправьте это моему секретарю.

- ✓ **by** («кем? чем?») – **агентивный творительный** падеж. Существительное с предлогом **by** используется для описания действующего лица или силы – того или чего, что совершает некое действие:

This book is written ***by*** *a famous journalist.*
Эта книга написана известным журналистом.

- ✓ **with** («чем?») – **инструментальный творительный** падеж. Существительное с предлогом **with** характеризует инструмент действия, нечто, чем было что-либо совершено:

Such toys are cut ***with*** *a knife.*
Такие игрушки вырезают ножом.

- ✓ **about** («о ком? о чем?») – **предложный** падеж:

Tell us more ***about*** *him,*
Расскажи нам о нём подробнее.

4. Место предлога в предложении

Обычно предлог, выражающий отношения между двумя словами, располагается между или перед ними:

We are planning to ***return in September****.*
Мы планируем вернуться в сентябре.

*She is sitting **under a big old apple tree**.*
Она сидит под старой большой яблоней.

Но в некоторых случаях это правило может нарушаться:

- ✓ в специальных вопросах:

*What are you laughing **at**?*
Над чем это ты смеешься?

- ✓ В некоторых предложениях, начинающихся с союзных и относительных местоимений и в придаточных предложениях:

*What I'm really surprised **about** is this nasty weather.*
Чем я действительно удивлен, так это этой ужасной погодой.

- ✓ В восклицательных предложениях:

*What a terrible thing to brag **about**!*
Какая ужасная вещь, чтобы хвастаться!

- ✓ В пассивных конструкциях:

*He doesn't like to be spoken **about**.*
Он не любит, когда о нем говорят.

- ✓ В некоторых синтаксических конструкциях с инфинитивом или герундием:

*She is so boring to talk **to**.*
С ней так скучно разговаривать.

5. Полный список английских предлогов

Простые

aboard	на борту
about	кругом, вокруг, в, где-то на, в пределах, о , относительно, о
above	над, до, более, свыше, выше
absent	(амер.) без, в отсутствие
across	через, сквозь, по ту сторону
afore	вперед
after	за, после, по, позади
against	против, в, о, обо, на, к
along	вдоль, по
amid	среди, посреди, между

amidst	среди, посреди, между
among	между, посреди
amongst	между, посреди
around	вокруг, по, за, около
as	в качестве, как
aside	в стороне, поодаль
aslant	поперек
astride	верхом на, по обе стороны, на пути
at	у, около, в, на
athwart	поперек, через, вопреки, против
atop	на, поверх, над
bar	исключая, за исключением, кроме
before	перед, до, в
behind	позади, за, после
below	ниже, под
beneath	под, ниже
beside	рядом, близ, около, ниже
besides	кроме
between	между
betwixt	между
beyond	по ту сторону, за, вне, позже, сверх, выше
but	кроме, за исключением
by	у, около, мимо, вдоль, через, к, на
circa	приблизительно, примерно, около
despite	несмотря на
down	вниз, с, по течению, вниз по, вдоль по, по, ниже, через, сквозь
except	исключая, кроме
for	на, в, в течение дня, за, ради, к, от, по отношению, в от-

	ношении, вместо
from	от, из, с, по, из-за, у
given	при условии
in	в, во, на, в течение, за, через, у, к, из
inside	внутри, внутрь, с внутренней стороны, на внутренней стороне
into	в, на
like	так; как что-л.; подобно чему-л.
mid (от "amid")	между, посреди, среди
minus	без, минус
near	около, возле, к
neath	под, ниже
next	рядом, около
notwithstanding	не смотря на, вопреки
of	о, у, из, от
off	с, со, от
on	на, у, после, в
opposite	против, напротив
out	вне, из
outside	вне, за пределами
over	над, через, за, по, свыше, больше, у
pace	с позволения
per	по, посредством, через, согласно, из расчёта на, за, в, с
plus	плюс, с
post	после
pro	для, ради, за
qua	как, в качестве
round	вокруг, по
save	кроме, исключая

since	с (некоторого времени), после
than	нежели, чем
through	через, сквозь, по, в, через посредство, из, от, в продолжение, в течение, включительно
till	до
times	на
to	в, на, к, до, без
toward	к, на, с тем чтобы, по отношению к, около, почти
towards	к, на, с тем чтобы, по отношению к, около, почти
under	под, ниже, при
underneath	под
unlike	в отличие от
until	до
up	вверх, по
versus (сокр. «vs.»)	против, в сравнении с (чем-л.), в отличие от (чего-л.), по отношению к (чему-л.)
via	через
vice	взамен, вместо
with	с, в, от
without	вне, без, за, не сделав чего-либо

Производные

barring	исключая, за исключением, кроме
concerning	относительно
considering	учитывая, принимая во внимание
depending	в зависимости
during	в течение, в продолжение, во время
granted	при условии
excepting	за исключением, исключая
excluding	за исключением

failing	за неимением, в случае отсутствия
following	после, вслед за
including	включая, в том числе
past	за, после, мимо, сверх, выше
pending	в продолжение, в течение, до, вплоть
regarding	относительно, касательно

Сложные

alongside	около, рядом, у
within	внутри, внутрь, в пределах, не далее, не позднее чем
outside	вне, за пределами, за исключением
upon	на, у, после, в
onto	на, в
throughout	через, по всей площади, длине, на всем протяжении
wherewith	чем, посредством которого

Составные

according to	согласно
ahead of	до, в преддверии
apart from	несмотря на, невзирая на
as far as	до
as for	что касается
as of	с, начиная с; на день, на дату; на момент, от (такого-то числа)
as per	согласно
as regards	что касается, в отношении
aside from	помимо, за исключением
as well as	кроме, наряду
away from	от, в отсутствие
because of	из-за
by force of	в силу

by means of	посредством
by virtue of	в силу, на основании
close to	рядом с
contrary to	против, вопреки
due to	благодаря, в силу, из-за
except for	кроме
far from	далеко не
for the sake of	ради
in accordance with	в соответствии с
in addition to	в дополнение, кроме
in case of	в случае
in connection with	в связи с
in consequence of	вследствие, в результате
in front of	впереди
in spite of	несмотря на
in the back of	сзади, позади
in the course of	в течение
in the event of	в случае, если
in the middle of	посередине
in to (into)	в, на
inside of	за (какое-л время), в течение
instead of	вместо
in view of	ввиду
near to	рядом, поблизости
next to	рядом, поблизости
on account of	по причине, из-за, вследствие
on to (onto)	на

on top of	на вершине, наверху
opposite to	против
out of	из, изнутри, снаружи, за пределами
outside of	вне, помимо
owing to	из-за, благодаря
thanks to	благодаря
up to	вплоть до, на уровне
with regard to	относительно, по отношению
with respect to	относительно, по отношению

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