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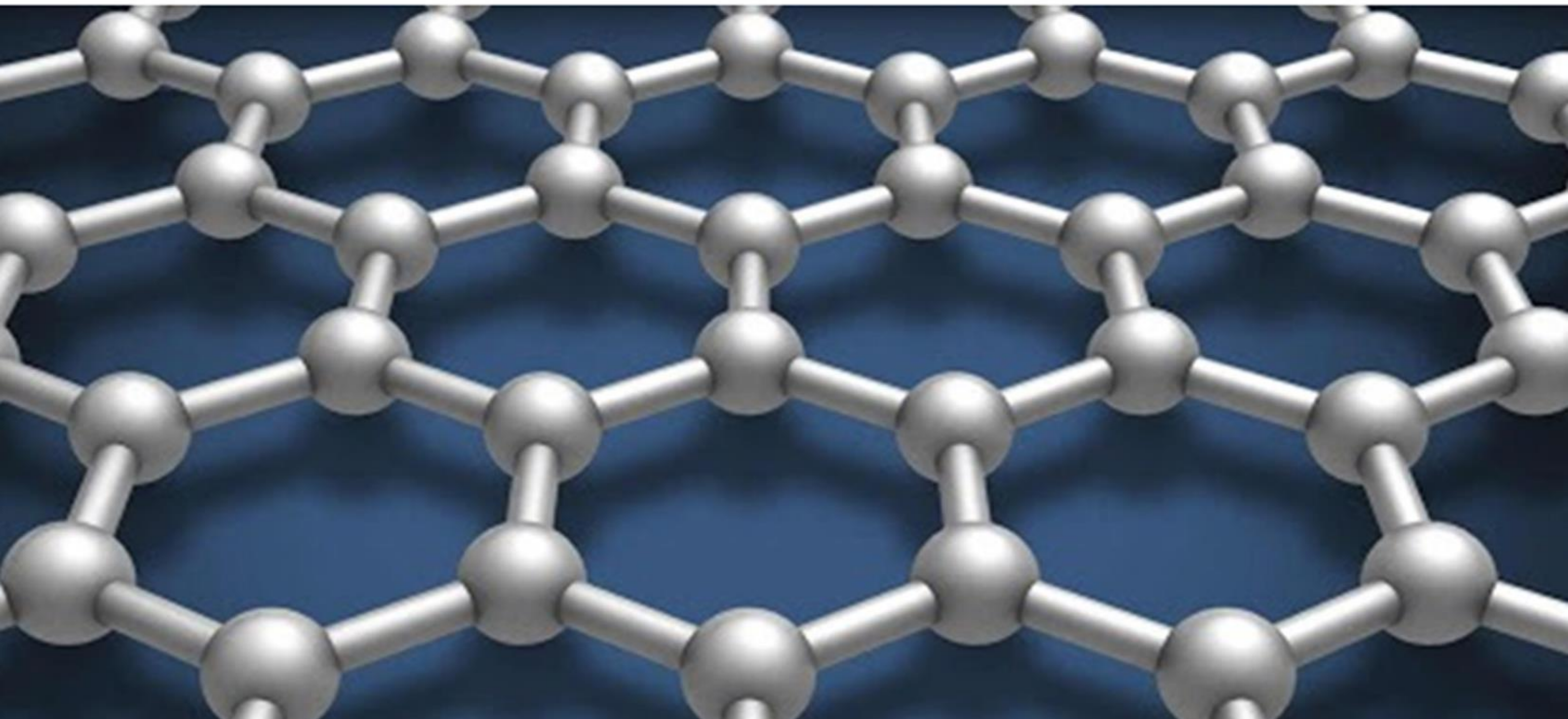
O‘zbekiston

Kompozitsion Materiallar

Ilmiy-texnikaviy va amaliy jurnali



Узбекский научно-технический и производственный журнал

Композиционные материалы

Xulosa. Xondiza boyitish fabrikasida amalga oshirilgan texnologik rekonstruksiya ishlari va innovatsion yondashuvlar natijasida ishlab chiqarish samaradorligi sezilarli darajada oshganligini ko‘rishimiz mumkin.

2015–2020 yillarda amalga oshirilgan rekonstruksiya tadbirlari natijasida korxona quvvati oshirilib, texnologiyalarning energiya va resurs tejamkorligini yaxshilashga erishildi. Rux, mis va qo‘rg‘oshin konsentratlarining quyultirish jarayoniga qo‘shilgan innovatsion uskunalar konsentratlarning namligini kamaytirib, tashish va qayta ishlash jarayonlarini optimalashtirildi.

Ushbu ilg‘or texnologiyalar polimetall rudalarni boyitish sohasida yangi imkoniyatlarni ochib bergan holda, sanoatdagi boshqa korxonalar uchun namuna sifatida qo‘llashimiz mumkin. Qilingan ishlar rudalarni qayta ishlashda yuqori darajada samarali usullardan foydalanish imkonini beradi, konchilik va metallurgiya sanoati rivojiga xizmat qiladi.

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THE PRODUCTION OF IRON-CONTAINING ALLOYS FROM SLAGS OF COPPER PRODUCTION

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Abstract. The article shows the study of the possibility of obtaining iron-containing raw materials during the processing of old slags of copper production of “Almalyk MMC” JSC. Laboratory tests of high-temperature and low-temperature reduction were carried out using Angren coal as a reducing agent. The use of this type of reducing agent is characterized by low cost and several qualities that were described in the article itself.

The most optimal sample composition, reduction temperature, and time were chosen to achieve a high degree of reduction of iron and copper oxides. In the above laboratory studies of low-temperature reduction at a temperature of 900-1100°C, the degree of reduction of iron oxides was 64,5%, and copper oxides 40.3%. During high-temperature reduction, two types of products were obtained: an iron-containing alloy with an iron content of 84,5-92,9% and copper up to 1,4%, and slags were also obtained, which can be recommended for use in the construction industry.

Keywords: copper slag, reduction, iron-containing alloys, recovery, Gibbs energy, chemical reactions.

Introduction. Currently, the demand for ferrous and non-ferrous metals worldwide is very high, and a large amount of technogenic waste is formed during their production. Therefore, the efficient use of this secondary raw material plays a vital role in the complex processing of these wastes and the extraction of valuable components from them and an important role. In this aspect, the development of methods for recovering iron-containing alloys from steel-smelting and copper-smelting slags in metallurgical plants, the creation of additional raw materials for the metallurgical and cast-iron industries, and the introduction of residual products in the construction industry are essential.

In the world, the development of technology for producing iron-based alloys from steel-smelting and copper-smelting slags is carried out research, including the study of the grain size distribution of steel-smelting and copper-smelting slags, determination of factors affecting gravitational enrichment, determination of physicochemical and technological properties of compounds formed as a result of smelting in slag, the study of the process of reduction of iron compounds in slags using carbon-containing reducing agents, analysis of thermodynamic regularities occurring in the process of ore-thermal removal, development of energy and resource-saving technology for production of iron-based alloys steel-smelting and copper-smelting slag.

The study aims to develop the scientific basis for producing iron-containing alloys from copper slags [1-2].

Stale slags of copper production of “Almalyk MMC” JSC contain up to 2,0 % copper in their composition, and the content of iron oxides, including magnetite, can reach more than 35%. These indicators make it possible to consider copper slags as an additional source of obtaining copper- and iron-containing raw materials with further production of iron alloys. The relevance of this study lies in the fact that the demand for iron products is growing in the world, and the studies were aimed at solving the problem of waste processing, where the authors studied the processes of recovery of iron oxides from old slags of copper production. The results obtained were positive, thus showing the effectiveness of this processing technology [3].

Materials and Methods. Selection of objects and methods for processing slags of copper production provides information on the choice of the research object, the main physicochemical properties of the products used and the use of modern methods and devices (IR spectroscopy, electron microscopy, particle size analysis) when studying physical, mechanical, chemical and physical properties [4].

Copper-smelting slag of “Almalyk MMC” JSC and Angren brown coal were selected as research objects.

The main methods of studying the work are the production of alloys and the smelting of copper-smelting slags using the carbothermic reduction method. Therefore, infrared spectroscopy, electron microscopy, particle size analysis and various other modern research methods were used to study chemical, physicochemical and physicomechanical properties. During the studies, the following auxiliary equipment was used: laboratory sieve of various sizes, laboratory muffle furnace, and power and gas furnace [5].

The obtained results and their discussion. The results obtained were based on thermodynamic substantiation of the physicochemical processes occurring during the carbothermic reduction of metal oxides in slag. A technique was used to assess the equilibrium of chemical reactions with increasing temperature and determine the slowest (limiting) chemical process between them based on changes in the Gibbs energy [6].

Carbothermic reduction reactions between liquid slag and carbon have been created, which include:

$$Cu_2O + C = 2Cu + CO\uparrow \quad (1)$$

$$FeO + C = Fe + CO\uparrow \quad (2)$$

$$Fe_2SiO_4 + 2C = 2Fe + SiO_2 + 2CO\uparrow \quad (3)$$

$$Fe_2SiO_4 + 2CaO + 2C = 2Fe + Ca_2SiO_4 + 2CO\uparrow \quad (4)$$

From the standard values of thermodynamic calculations, it follows that all chemical reactions are endothermic reactions, of which the values of the standard Gibbs energy are positive. In all carbothermic chemical reactions, a certain amount of heat absorption has been observed.

The next stage of the research was the high-temperature reduction of copper slag to produce metal alloys. Large-scale laboratory experiments were carried out using a gas oven. A sample weighing 20 kg and a reducing agent was loaded into a graphite crucible with a size of ø60xH63 and placed in a furnace heated to a temperature of 1300-1400^{0}C. The gas oven is equipped with a rotating mechanism; loading and unloading were carried out manually [7].

The study of the effect of temperature on the degree of iron metalization was carried out in several stages. Melting time was 60 minutes. The results are shown in Fig. 1.

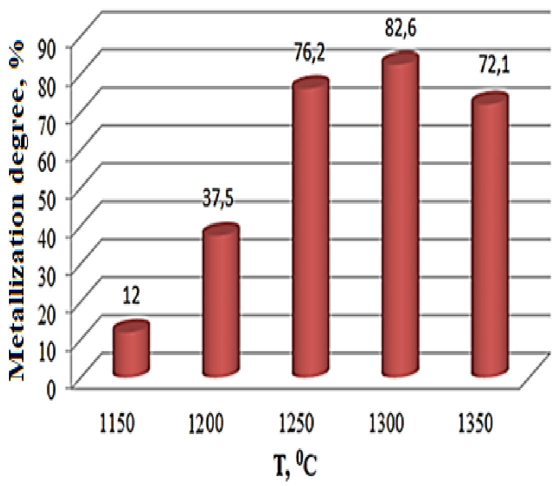

Fig.1. Influence of melting temperature on the degree of metallization of iron

As can be seen from Figure 1, with increasing temperature the degree of metallization increases and the occurrence of reverse reactions is insignificant, i.e. the degree of reduction reactions is not high. This fact can be explained by the fact that newly formed metallic iron can be oxidized again.

Based on the mathematical expressions calculated by the authors, the probability of each reductive chemical process occurring when the temperature in the reaction system increases by 50 units is determined. As a result of calculations, the probability of all reduction reactions occurring in the temperature range of 1150–1300^{0}C increases with increasing temperature. In this case, it is necessary to pay attention to the fact that at temperatures above 1300°C the degree of metallization of iron in the slag decreases.

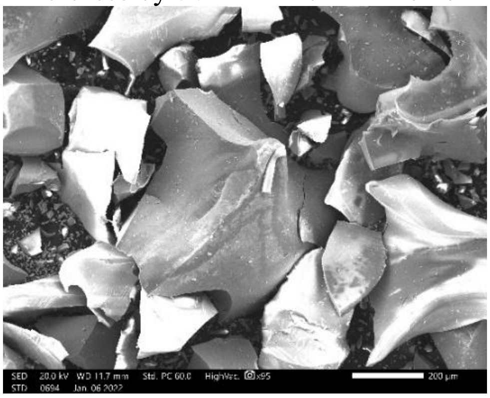

Fig. 2. A microscopic view of the alloy formed (200 nm)

Fig. 2 shows the view of the molten charge at a temperature of 1300^{0}C for 1 hour. Here you can see the resulting iron alloy and slag. It was determined that when copper slag is reduced at high temperatures, the resulting product is a copper-iron alloy. Its composition depends on the amount of reduced iron, and the amount of copper varies within the range of 1,4-2,24% and the degree of its conversion into the alloy is 55,7-75,6%.

Conclusions. As a result of research conducted on the reduction of copper slag to obtain iron-containing alloys, it was possible to achieve a high degree of iron reduction. The scientific basis of the ore-thermal reduction of copper slag makes it possible to develop a technology for producing an iron-containing alloy, which can be used as a raw material for the production of white cast iron, which is widely used in the production of parts for the engineering industry of the Republic of Uzbekistan.

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