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RESEARCH OF TECHNOLOGIES FOR THE PRODUCTION OF CHROMIUM FERROALLOYS FROM NON-CONDITIONAL RAW MATERIALS

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Abstract. This article discusses various technologies for producing chromium ferroalloys from non-conditional raw materials. Every year, about 13-14 million tons of chromite ores are mined in the world, the content of the 0-10 mm fraction in which is 75-80%, of which about 30% is in powder or pulverized form. In Kazakhstan, the main preference is to use rich ore, not using poor (substandard) ore. The dust captured by the aspiration units is a fine particle of a fraction of 0.01-1 mm with a metal chromium content of 65-69%. Due to the fineness of the material, it is almost substandard. The volume of generated aspiration and other dust of interest from the point of view of processing into conditioned materials is more than 25,000 tons per year. The crushing of high-carbon ferrochrome produces 1000 tons of aspiration dust per year. Hence, there is a need to study technologies for producing chromium ferroalloys from substandard raw materials. The study of this technology is important not only from the economic, but also from the ecological side. After all, low-quality raw materials are used in small quantities, and the bulk of it is stored in landfills. The data obtained by us are of theoretical value and will be used for laboratory research.

Key words: aspiration dust, ferrochrome, chromite ore, steel, charge-chrome, pellet.

Introduction

Today, South Africa, Kazakhstan, Russia, Zimbabwe, and Madagascar have the largest reserves of chromium. In addition to these countries, there are chromium deposits in Armenia, Turkey, Brazil, India, and the Philippines. According to the U.S. Geological Survey report [1], 95% of all chromium reserves are in Kazakhstan and South Africa. In 2018, our country took the third place in the production of chromite, with a production volume of 4.6 million tons per year.

95% of the world's production of chromium raw materials is used in the metallurgical industry, and the rest is used in foundries, chemical and non-ferrous sectors. In turn, more than 80% of the world's ferrochrome is used in the production of stainless steel. The production of ferroalloys necessary for the steel industry is the largest consumer of chromium.

Currently, South Africa is the world's largest producer of chromium ore, and in 2020 it sent 12.5 million tons of this mineral to China, which is 83% of the total volume of chromium imports to

China. SamancorChrome, based in South Africa, has an annual production capacity of about 1.2 million tons of ferrochrome and chromite ore.

The production volumes of the Aktobe Ferroalloy Plant (AFP) amount to more than 740 thousand tons of ferroalloys per year. Today, almost all AFP workshops produce high-carbon ferrochrome, due to the fact that large reserves of chromite ores are located in the Kempirsay deposit of the Aktobe region.

The main part

Every year, about 13-14 million tons of chromite ores are mined in the world, the content of the 0-10 mm fraction in which is 75-80%, of which about 30% is in powder or pulverized form. Over-grinding of the extracted ores and an increase in the proportion of fine-grained fractions in them occur due to blasting and mechanization of mining. Since the amount of rich ore reserves is small, poor ores can be involved in mining, but they need to be enriched, which is a costly process. Also, during processing, the useful components of chromium ore are redistributed by size, and a significant amount of valuable raw materials is concentrated in fine-grained, as well as fine-dispersed (-3 mm) fractions.

At AFP, ferrochrome is produced in ore recovery furnaces with a capacity of 21-63 MV*A. The melt from the furnaces is fed to the filling machines for casting into ingots weighing up to 40 kg. The cooled ferrochrome ingots from the filling machines arrive at the finished product warehouse and are crushed on jaw crushers, into various fractions from 5 to 50 mm. When crushing, respectively, a large amount of fine fraction is formed, since in high-carbon ferrochrome, carbon is in the range of 7-9%. Dust is captured by aspiration systems (about 30%). Due to the fine dispersion, the material is substandard.

The use of aspiration dust in the powder state in the production of ferrochrome is considered inefficient, since when the dust is loaded into the furnace for further remelting, it is flown by 60-70 %. The volume of formed aspiration and other dust of interest, from the point of view of processing into conditioned materials, is more than 25,000 tons per year. The crushing of high-carbon ferrochrome produces 1000 tons of aspiration dust per year.

Methods

In the Aksu Ferroalloy plant, briquettes and pellets are obtained from aspiration dust by clumping. The first laboratory tests were conducted back in 2004. The aspiration dust of high-carbon ferrochrome was examined. The chemical and granulometric compositions of the dust are presented in Tables 1 and 2, respectively.

According to the content of the elements, the dust is metallic, and corresponds to high-carbon ferrochrome, this can be seen from Table 1. According to the granulometric composition, it is 81.09%

composed of a class of less than 0.08 mm, which fully meets the requirements of the pelletizing process.

Table 1 - **Chemical composition of ferrochrome aspiration dust**

Content of elements, %				
Cr	C	Si	S	P
68,0	8,35	1,40	0,016	0,010

Table 2 - **Granulometric composition**

Fraction, mm	>0,6	0,4-0,6	0,31-0,4	0,2-0,4	0,2-0,08	<0,08
Content, %	1,16	0,17	0,13	0,35	17,1	81,09

First, raw pellets are formed when they are rolled on poppet or drum granulators, from a finely dispersed material moistened to a certain extent. Then, at temperatures from 500 to 1200°C, firing is performed. The main conclusion from this experiment is that at temperatures below 600°C, solid-phase sintering of dust is slow, and the strength of the pellets is low.

Over the past 10 years, low-grade chromium ores and concentrates have been used in the production of ferrochrome, which require an increased specific heat release of the melted charge. At the same time, the cost of obtaining ferrochrome increases. In general, the use of siliceous reducing agents for the metal-thermal process is characterized by a high end-to-end energy consumption, taking into account the costs of obtaining metal reducing agents-energy carriers from natural raw materials. Optimization of the technology for obtaining ferrochrome and improvement of its technical and economic indicators, as well as the implementation of the silicothermic process for obtaining ferrochrome from a variety of raw materials are possible on the basis of an assessment of the conditions of the processes occurring during the interaction of the initial components. The development and application of the technology for obtaining ferrochrome from low-quality raw materials in an electric arc furnace reduces the consumption of expensive siliceous reducing agent. The efficiency of the silicothermic technology depends to a large extent on the thermal and temperature conditions of the processes.

Consider the smelting of charge chromium from substandard raw materials in DC furnaces. The advantage of this process is in contrast to the process using a siliceous reducing agent:

1. use of substandard raw materials;
2. energy saving 20-30% %;
3. use of DC furnaces;

4. high performance by 30 %.

It is proposed that the introduction of a system for heating charge materials with waste gases will save energy by 20-30 %. Due to the large losses of electricity during the smelting of charge chromium, the heating of charge materials is aimed at saving electricity, which will: increase the productivity of equipment, reduce the physical load of working personnel, and increase the stabilization of the process.

It is worth mentioning a new high-efficiency type of melting equipment, which allows you to improve the current technologies, as well as create new ones, ensure high quality of metal using cheap charge, including difficult to process. For the best result, it is worth smelting charge-chromium with preheating of the chrome ore, using the heat released during the combustion of the exhaust gas of closed ferroalloy furnaces. Heating can be carried out in tubular or shaft furnaces. This provides an increase in the productivity of the furnace by 10-20%, if we compare the method without using heating.

Conclusion

Thus, we have considered technological solutions for the possibility of recycling fine aspiration dust, which is one of the main problems of modern ferrous metallurgy. Thanks to scientific progress, metal dust can not only be disposed of, but also recycled and produced from it. Having considered the experience from the Aksu plant, as well as the experience of smelting charge chromium, we can confidently say that substandard raw materials can be processed not only stored in dumps. Based on these technologies, we are convinced that the main environmental, economic and technological problems can be solved. At the moment, there is still no single effective method that compares favorably with the others.

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КОНДИЦИЯЛЫҚ ЕМЕС ШИКІЗАТТАН ХРОМ ФЕРРОҚОРЫТПАЛАРЫН АЛУ ТЕХНОЛОГИЯЛАРЫН ЗЕРТТЕУ

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Аңдатпа. Бұл мақалада аспирациялық шаннан хром ферроқорытпаларын алудың әртүрлі технологиялары қарастырылған болатын. Дәл қазір әлемде шамамен 13-14 млн.т. хромит кендері өндіріледі, 0-10мм фракциялық 75-80% - ды құрайды, оның 30% - ға жуығы ұнтақ немесе тозаң түрінде болады. Қазақстанда негізінен кедей (кондициялық емес) кенді пайдаланбай, бай кенді пайдалануға басымдық беріледі. Аспирациялық қондырғылармен ауланатын шаң құрамында 65-69% металл хромы бар 0,01-1 мм фракцияның

ұсақ дисперсті ұсақшасы болып табылады. Ұсақ дисперсияға байланысты материал іс жүзінде кондициялық емес болып табылады. Қалыптасқан аспирациялық және басқа да шаңдардыңқайта өңдеунеқызығушылық тудыратын, көлемі жылына 25 000 тоннадан астам құрайды. Жоғары көміртекті феррохромды ұсақтау кезінде жылына 1000 тонна аспирациялық шаң пайда болады. Осыдан кондициялық емес шикізаттан хром ферроқорытпаларын алу технологиясын зерттеу қажеттілігі туындайды. Бұл технологияны зерттеу экономикалық жағынан ғана емес, сонымен қатар экологиялық жағынан да маңызды. Себебі кондицияланбаған шикізат аз мөлшерде пайдаланылады, ал негізгі бөлігі үйінділерде сақталады. Біз алған мәліметтер теориялық құндылыққа ие және зертханалық зерттеулер үшін болашақта қолдануға ықтимал.

Түйін сөздер: аспирациялық шаң, феррохром, хромит кені, болат, чардж-хром, түйіршік.

ИССЛЕДОВАНИЯ ТЕХНОЛОГИЙ ПОЛУЧЕНИЯ ХРОМОВЫХ ФЕРРОСПЛАВОВ ИЗ НЕКОНДИЦИОННОГО СЫРЬЯ

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Аннотация. В данной статье рассматриваются различные технологии получения хромовых ферросплавов из некондиционного сырья. Ежегодно в мире добывается около 13-14 млн. т. хромитовых руд, содержание фракции 0-10 мм в которых составляет 75-80%, из них около 30% находится в порошковом или пылеватом виде. В Казахстане в основном отдают предпочтение использованию богатой руды, не используя бедную (некондиционную) руду. Пыль улавливаемая аспирационными установками представляет собой мелкодисперсную мелочь фракции 0,01-1 мм с содержанием металлического хрома 65-69%. Из-за мелкодисперсности материал практически является некондиционным. Объём образующейся аспирационной и других пылей представляющих интерес, с точки зрения переработки в кондиционные материалы составляет более 25 000 тонн в год. При дроблении высокоуглеродистого феррохрома образуется 1000 тонн аспирационной пыли в год. Отсюда, появляется необходимость изучения технологий получения хромовых ферросплавов из некондиционного сырья. Изучение данной технологии важна не только с экономической, но также и с экологической стороны. Ведь некондиционное сырье используется в малом количестве, основная же часть складируется в отвалах. Полученные нами данные имеют теоретическую ценность и будут использоваться для лабораторных исследований.

Ключевые слова: аспирационная пыль, феррохром, хромитовая руда, сталь, чардж-хром, окатыш.