HILL PUBLISHING

OAJRC Material Science, 2019, 1(1), 1-4
https://www.hillpublisher.com/journals/oajrcms/
ISSN Online: 2632-2072

Basic research on properties of high-carbon ferrochromium slag and its resource application

ZL Musabekov

K.Zhubanov Aktobe regional state university, Kazakhstan.

How to cite this paper: ZL Musabekov. (2019) Basic research on properties of high-carbon ferrochromium slag and its resource application. *OAJRC Material Science*, 1(1), 1-4.
DOI: 10.26855/oajrcms.2019.12.001

Received: October 15, 2019
Accepted: November 13, 2019
Published: December 12, 2019

***Corresponding author:** ZL Musabekov, K.Zhubanov Aktobe regional state university, Kazakhstan.

Abstract

High-carbon ferrochromium slag is an important waste of ferrochrome alloys. Its emission is large, the slag phase is complex, and its composition is uneven. It is an important source of ferrochrome alloys. How to effectively develop and utilize resources has become an important topic for environmental protection workers and the material industry. Through the systematic analysis and research of high-carbon ferrochrome slag, combined with its own characteristics, the development and utilization of high-carbon ferrochrome slag and other industrial solid wastes are preliminarily discussed, and a new way is proposed to reduce the cost of raw materials.

Keywords

high carbon ferrochromium slag; performance; resource utilization

Introduction

High-carbon ferrochrome slag is an industrial waste slag used to smelt high-carbon ferrochrome alloys. After preliminary analysis, it was found that it contains forsterite, spinel and other available substances. The research on ferrochrome slag mostly focuses on paving materials and glass-ceramics, but rarely involves the physical properties and structural characteristics of high-carbon ferrochromium slag. The research on the physical and chemical properties, structure and performance of high-carbon ferrochrome slag in this paper has laid a foundation for its application in actual production [1].

1. The characteristics of high-carbon ferrochrome waste residue and the importance of basic resource utilization

In this paper, through the study of the basic properties and toxicity leaching characteristics of high-carbon ferrochrome slag, its application in porous ceramics and composite materials has been deeply studied, and the following useful conclusions have been obtained: (1) high-carbon ferrochrome slag It contains well-developed forsterite and spinel with large stars, and its structure is hard and its surface is rough. TG-DSC analysis showed that the contained chromium, iron and oxides would be decomposed at higher temperature. The toxicity test results show that the leaching amount of chromium ions in high-carbon ferrochrome slag is only 0.25mg/L, which belongs to ordinary solid waste. (2) High-carbon ferrochrome slag was used to prepare porous ceramics, and porous ceramics with good comprehensive properties were obtained at high temperature for 90 minutes. Its porosity rate is 39.1%, compressive strength is 37.9MPa, acid resistance is 98.65%, and alkali resistance is 99%. Adsorption tests were carried out on high-concentration methylene blue, and it was found that porous ceramics can effectively remove methylene blue, and the removal rate reached 79.2%. (3) Using high-carbon ferrochrome slag to prepare forsterite-spinel composite material, the results show that: under the heat treatment condition of 1200℃, when the content of high -carbon ferrochrome slag is 70wt%, the composite material Comprehensive performance has been well improved. At room temperature, its compressive strength can reach 108.8MPa, and it can reach 8 times under thermal shock, and the leaching concentration of

chromium ions is 0.14mgL. Increasing the heat treatment temperature and adding periclase can accelerate the conversion rate from enstatite to forsterite, and improve its physical properties and thermal shock resistance. Spinel can not only resist thermal stress shock, but also enhance its thermal shock resistance, and make free chromium ions into solid solution [2].

2. Properties and structure of high carbon ferrochrome

(1) Basic characteristics of high-carbon ferrochrome waste slag

The chemical composition of the crushed high-carbon ferrochrome slag was analyzed by sampling by quartering method. The results showed that the main components of high-carbon ferrochrome slag were MgO, AlOs and SiO, and also contained a small amount of ferrochromium and other oxides. Things [3].

The melting point and softening temperature of high carbon ferrochrome slag were roughly measured by fire resistance test method. Experiments show that high-carbon ferrochrome softens at 1280°C, and high-carbon ferrochrome slag disintegrates at 1350°C at high temperatures. High-carbon ferrochrome is magnesium-aluminum slag, 0,-SiO in the ternary system, and its melting point depends on the technology of smelting ferrochrome alloy. Theoretically speaking, the melting point of high-carbon ferrochrome slag should be 1650-1750 °C, but the slag must have certain fluidity, so during the melting process, adding fluxes such as silica can lower the melting point of slag, but it will also reduce the melting point of slag. fire resistance[4].

(2) Research on thermal conductivity of high carbon ferrochrome slag

Thermal conductivity is an index of thermal conductivity, and thermal conductivity is an important indicator that affects product life. Today, with the rapid development of economy, it advocates saving energy and reducing emissions. Therefore, it is necessary to conduct research on thermal conductivity.

high carbon ferrochrome slag at 100 - 500°C. High-carbon ferrochrome slag has a low heat rate, and its thermal conductivity at 100°C is 1.396W/(mK), and the thermal conductivity decreases with the increase of temperature [5].

The more complex the phase structure of the material contained in the general material, the greater the difference in size, and the lower the thermal conductivity. The content of forsterite in high-carbon ferrochrome slag is high, and the thermal conductivity of forsterite is 0.8W/mK (600°C). In addition, there are a lot of pores in high-carbon ferrochrome slag. Due to the rich mineral phase and a large number of pores inside the slag body, it has a low thermal conductivity and can be used for heat insulation [6].

3. Basic research on the application of high-carbon ferrochrome slag porous ceramic materials

(1) Background of topic selection

It not only has the characteristics of chemical corrosion resistance, stable performance, high temperature resistance, high porosity, large specific surface area, uniform distribution and other characteristics of traditional ceramics, it can be widely used in filter materials, adsorption materials and catalyst carriers , sound absorption, sound absorption, heat storage Materials, etc., have better economic effects [7].

Methylene blue is a kind of heterocyclic aromatic hydrocarbon compound, which is mainly used in textile, leather, paper and other printing and dyeing industries . If it has a large effect , it will also cause permanent burns to the eyes of humans and animals. In severe cases, it will even cause nervous disorders and methemoglobinemia, which will cause great harm to the human body. Methylene blue cannot be degraded naturally under natural conditions, so the treatment in printing and dyeing wastewater has always been a difficult point. At present, the commonly used method is to use activated carbon as an adsorbent, but its cost is too high and limited [8].

Replacing activated carbon with porous ceramics is a current research hotspot, but in porous ceramics, the relationship between pore strength and pore structure must be achieved. Since high porosity and sufficient mechanical strength are obtained, the process of adding a pore-forming agent is a relatively common process. This is an agricultural waste made of wood fiber and silica, which has a complex three-dimensional structure inside, and its structure is fine and refined far beyond the current level of science and technology. As a pore-forming agent, because the internal organic matter is carbonized and ablated, perforation is formed inside. This pore structure is developed, and the average pore size is between 10-50 microns. This structure makes it have a good adsorption effect: Amorphous SiO can support its pore structure and has high mechanical properties, so it can be used as a pore-forming agent for porous ceramics. It can be seen that there are a large amount of acid and alkali corrosion-resistant silicate minerals in the high -carbon ferrochromium slag. Under high temperature conditions, iron oxide will generate cracks in situ, thereby accelerating liquid phase sintering. However, there are few studies on the application of high carbon ferrochrome slag in porous ceramics [9].

(2) Preparation and synthesis

High carbon ferrochrome slag (0.074 mm), rice husk (0.074 mm), binder (deionized water). Dry mix high-carbon ferroch-

romium waste residue with rice husk for 4 hours, then use 80-mesh sieve method for particle treatment, compact cylindrical sample q20x20mm after 24 hours, hold the pressure for 1min, put the green body in an oven, and first Dry for 1h, 50°C for 1h, then 90°C for 24h , set the heating system according to the temperature change curve of rice husk.

The decomposition of rice husk is divided into three stages:

(1) At the temperature of 100-260°C, the TG curve tends to be stable, and the DTA curve rises, indicating that the bound water in the rice husk and the pyrolysis reaction of part of the cellulose.

(2) At 260 - 550°C, the TG curve of rice loses weight rapidly, indicating that the organic matter in the rice husk has been decomposed, and in this temperature range, the rice husk begins to carbonize, and in this temperature range, the combustion of rice husk The speed is very fast, and the DTA curve shows two sharp peaks, which shows that there are different decomposition temperatures and heat in the rice husk.

(3) In the temperature range of 550 - 850 °C, the TG curve decreased steadily and the DTA curve increased, indicating that the residual carbon in the rice husk continued to burn and released CO: weight loss.

the temperature range of 825 - 950 ℃, the TG curve has no obvious change, and the DTA curve shows that endothermic and exothermic phenomena appear in this stage, which is the result of the transition from unformed SiO_2 crystal form to crystalline SiO_2.

4. The nature and utilization of high-carbon ferrochrome waste slag

(1) In the high-carbon ferrochrome slag, MgO, AlzOs, and SiO are the main ones, in which the ferrochrome alloy content is about 8% by weight, the Vickers hardness is 977.79HV5/20, and the thermal conductivity is low. High-carbon ferrochromium slag has the characteristics of rough surface, porous and complex phase, which makes it have high hardness and low thermal conductivity. Using TG-DSC to study it, the results show that: under high temperature conditions, ferrochrome and iron oxide will decompose at high temperature and form pores, which is beneficial to sintering at lower temperature. The leaching concentration of high-carbon ferrochrome slag varies with particle size, and the leaching amount of chromium ions in spinel and glass phases is small, which is common industrial solid waste.

(2) Porosity has a certain influence on the physical properties and pore structure of porous ceramics. Rice husk is a new type of pore-forming agent, and its porosity increases with the increase of rice husk addition. The sintering temperature has a certain influence on the phase composition of porous ceramics and the growth of products. The results show that: with the increase of sintering temperature, the pores inside the porous ceramics are from irregular to closed, and the pore diameter is from large to small. The fractal dimension has a great influence on the compressive strength. The holding time has a great influence on the pores The structure and crystal form development have a certain influence, which is beneficial to the growth and development of purple flower cordierite and improves its acid resistance [10].

Conclusion

High-carbon ferrochrome slag was used as porous ceramic aggregate, agricultural waste rice husk was used as pore-forming agent, and high-carbon ferrochrome slag-based porous ceramics were used as raw materials. The adsorption experiments were carried out. This paper focuses on the pore structure of porous ceramics under different temperatures and forming pressures. Through the influence on the pore parameters and physical properties of porous materials, the adsorption characteristics of methylene blue in porous ceramics are preliminarily discussed. Application lays the theoretical foundation.

References

[1] Bai Z, Qiu G, Yue C, et al. Crystallization kinetics of glass–ceramics prepared from high-carbon ferrochromium slag [J]. Ceramics International, 2016, 42(16): 19329-19335.

[2] Sahu N, Biswas A, Kapure G U. A short review on utilization of ferrochromium slag [J]. Mineral Processing and extractive metallurgy Review, 2016, 37(4): 211-219.

[3] Murthy I N, Babu N A, Rao J B. High carbon ferro chrome slag–Alternative mould material for foundry industry [J]. Procedia Environmental Sciences, 2016, 35: 597-609.

[4] Zayakin O V, Statnykh R N, Zhuchkov V I. Study of the possibility of obtaining non-decomposing slag during low-carbon ferrochrome production[J]. Metallurgist, 2019, 62(9): 875-881.

[5] Sibanda V, Kopong R, Ndlovu S, et al. Ball milling of high carbon ferro chrome slag to liberate the alloy for gravity concentration [J]. International Journal of Mineral Processing, 2016, 157: 46-54.

[6] Bondarenko I V, Tastanov E A. Obtaining multi-component pellets from finely dispersed chromium concentrates, refined ferrochrome

slags and diatomite raw materials of Kazakhstan [J]. Metallurgist, 2019, 62(11): 1213-1218.

[7] Sprinzl F R M. Valorization of ferrochrome slag: towards increasing the beneficial utilisation of ferrochrome slag in South Africa [D]. Stellenbosch: Stellenbosch University, 2016.

[8] Panigrahi M, Mohanty S, Ganguly R I, et al. An advanced cured high carbon ferrochrome slag (HCFCS) geopolymer (GP): A constructional materials [C]//IOP Conference Series: Materials Science and Engineering. IOP Publishing, 2018, 410(1): 012002.

[9] Sariyev O R, Musabekov Z B, Dossekenov M S. Disposal of slag of refined ferrochromium by obtaining a sintered and carbonized construction products [J]. Kompleksnoe Ispolzovanie Mineralnogo Syra, 2019, 311(4): 26-34.

[10] Horckmans L, Spooren J, Kukurugya F. Chromic: new processes to recover metals from carbon steel, stainless steel and ferrochrome slags[C]//the 9th European slag conference Euroslag. 2017.