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Extraction of iron from vanadium slag using pressure acid leaching

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Abstract

The extraction of iron from vanadium slag was attempted using pressure acid leaching. The effects of the several parameters which included reaction time, H⁺/slag ratio, leaching temperature, and concentration of additive (Na₂S) upon leaching efficiency of iron were investigated. The results showed that the leaching efficiency of iron could reach above 76% in the best leaching condition. By using Leaching solution as iron source, Fe₂O₃ hollow spheres have been successfully synthesized via facile hydrothermal method by using carbon spheres as template followed by a subsequent heat treatment. The experimental results show that hollow spheres structures of Fe₂O₃ with the mean particle size of 0.9-1.2 μm is single hexagonal crystal system.

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Keywords: iron; vanadium slag; pressure acid leaching; hollow spheres

1. Introduction

Vanadium is an important product that is used almost exclusively in ferrous and non-ferrous alloys due to its physical properties such as high tensile strength, hardness, and fatigue resistance¹. In China, vanadium resource is

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abundant in vanadium-titanium magnetite ores, from which vanadium-containing hot metal is obtained in blast furnace^{2,3}. The recovery methods of vanadium from vanadium slag have recently been discussed. The well-known methods of roasting leaching process is introduced to recover vanadium from vanadium slag. The roasting process is that the preparation of mixtures of slag with a sodium salt which can be one or combination of NaCl, Na₂CO₃ and Na₂SO₄ under an oxidizing atmosphere, which will convert the vanadium oxide of vanadium slag into water soluble sodium vanadate⁴. In other cases, calcium salt is also used in the roasting stage, and calcium vanadate formed in roasting can be dissolved by leaching with acid or alkali^{5,6}.

In the recovery methods of vanadium from vanadium slag, iron from slag is not involved in the reaction, which is used as a waste residue. The vanadium slag which contains 30%-40% Fe₂O₃ has high recovery value. The main methods of extraction iron have been made during the last decades for possible alternative extraction iron from the slag as such in different domains like magnetizing roast, flotation iron, blending iron etc.

In this work, the high pressure acid leaching is adopted to extract iron from vanadium slag. The effects of various parameters including reaction time, H⁺/slag ratio, leaching temperature, and concentration of additive (Na₂S) are explored. Then, the Fe₂O₃ with hollow spherical morphology is synthesized by using vanadium slag as iron source. The morphologies and structures of precursor and as-prepared phosphors were characterized by XRD, IR and SEM.

2. Material and methods

2.1 Materials

The vanadium slag used in the study was provided from Chengde special steel Co., Ltd., Heibei Province, China. The slag was ground using a planetary high-efficient ball mill and its chemical composition was analyzed by XRF. The results were presented in Table 1. An XRD of the vanadium slag was presented in Fig. 2. It showed that the slag contains MgV₂O₄, Fe₂SiO₄, Fe₃O₄ and MnFe₂O₄. All the reagents used were of analytical grade purity (Chinese medicine group) and were used without further purification.

Table 1. Chemical analysis of the vanadium slag

| Component | V ₂ O ₅ | SiO ₂ | MnO | Cr ₂ O ₃ | CaO | TiO ₂ | Al ₂ O ₃ | TFe |
|-----------|-------------------------------|------------------|------|--------------------------------|------|------------------|--------------------------------|-------|
| wt.% | 13.35 | 18.31 | 7.20 | 1.72 | 2.44 | 6.8 | 2.77 | 28.45 |

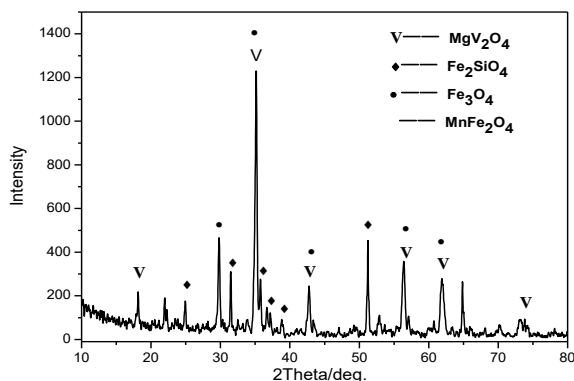


Fig. 1 XRD pattern of original vanadium slag sample

2.2. Experimental procedure

2.2.1 Iron leaching

A sample of 200 g dried slag was added to a titanium autoclave with an agitation of 500 rpm at the desired temperature and then oxygen was continuously aerated into the reactor to produce a total pressure of 1.2 MPa. The reaction time (after achieving the desired temperature), H⁺/slag ratio, leaching temperature and additive (Na₂S)

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