

Review

Selective leaching of a high-iron cobalt matte at atmospheric pressure

Zhengjun Yu*, Qiming Feng, Leming Ou, Yiping Lu, Guofan Zhang

School of Minerals Processing & Bioengineering, Central South University, Changsha 410083, PR China

Received 23 February 2006; received in revised form 4 September 2006; accepted 7 September 2006

Abstract

Selective leaching of high iron cobalt matte in sulfuric acid at atmospheric pressure is being reported. The matte assaying 4.55%Co, 13.58%Ni, 3.72%Cu and 53.6%Fe was produced by carbothermal reduction and pyrite sulfuration of nickel converter slag containing 1.36%Co, 3.39%Ni and 1.01%Cu from the Jinlong nickel smelter (Yunnan, China). The process is made up of three-step countercurrent leaching. In the first step most Fe of the matte is leached as the fresh matte is mixed with some sulfuric acid solution containing low concentrations of Co and Ni ions from the third step. The leach residue of the first step is contacted with the rest leachate of the third step leachate, and Co and Ni partially dissolve. The leach residue from the second leaching step is leached with 5.5 M sulfuric acid, the leachate is diluted and divided into two parts as the leachants to the first and second leaching step. In the first step, 71.6%Fe, 0.6%Co and 0.2%Ni dissolve and 99.0%Co and 99.5%Ni are extracted by injecting H₂S; in contrast, 67.5%Fe, 3.5%Co and 0.4%Ni dissolve in the first step, and 96.1%Co and 99.2%Ni are extracted without H₂S input.

© 2006 Elsevier B.V. All rights reserved.

Keywords: Cobalt matte; Selective leaching; Cobalt; Nickel

Contents

1. Introduction	1
2. Experimental	2
2.1. Material	2
2.2. Experimental	2
3. Results and discussion	3
3.1. The first leaching step	3
3.2. The second leaching step	4
3.3. The third leaching step	5
3.4. Continuous three-step countercurrent leaching	6
4. Conclusions	6
References	7

1. Introduction

Valuable metals, such as Co, Ni and Cu are present in the smelter and converter slags either in chemically dissolved forms or as physically entrapped metal or metal sulphide droplets during smelting non-ferrous metal sulphides.

There are two kinds of methods to recover these valuable metals, i.e. pyrometallurgical and hydrometallurgical methods. The hydrometallurgical method is to directly treat these slags, such as sulfuric and ammonia leaching; aqueous sulphur dioxide leaching; roasting with ferric sulfate, pyrite, ammonium sulfate, and sulfuric acid followed by leaching; pressure leaching [1–8]. The pyrometallurgical method is to enrich valuable metals in matte at first, followed by blowing and refining with a converter to reduce Fe from 50 to 13% for high-grade matte [9–13], and then to treat with hydrometallurgical methods. The latter method has been used in practice.

* Corresponding author. Tel.: +86 731 8830227; fax: +86 731 8830229.
E-mail address: yzhengjun@gmail.com (Z. Yu).

Hydrometallurgical methods for the treatment of these high-grade mattes include atmospheric pressure leaching or high pressure leaching. High pressure acid leaching has been conducted by many researchers for extracting valuable metals from high-grade mattes. Plasket and Romanchuk recovered nickel and copper from a high-grade matte at Impala platinum by the Sherritt Process [14]. Rademan studied the leaching characteristics of a Ni–Cu matte in the acid–oxygen pressure leaching process [15]. Dutrizac, Fugleberg and Hofirek determined the leaching reactions in the processes [16–18]. Hofirek, Llanos, Symens, Brugman and Baglin investigated the kinetic behaviour of a Ni–Cu matte in the atmospheric leaching processes [18–22]. Llanos applied the atmospheric leaching process in the first stage, followed by oxidation and digestion, to treat mattes ranging in composition from 37 to 72%Ni, from 7 to 49%Co and from 0.5 to 2%Fe [19]. Symens processed mattes containing in excess of 2%Fe at atmospheric pressure, followed by a pressure leaching process, to solubilize over half the matte's nickel values while attaining nearly complete rejection of the electrolyte's acid, copper, and iron content [20]. Hofirek treated the non-magnetic sulphide matte ranging 43%Ni, 29%Cu, 0.5%Co, 1.5%Fe and 22.5%S under atmospheric pressure in the first stage, followed by two pressure leaching stages [18]. The patent assigned to AMAX presented a flowsheet to recover nickel from a high-iron sulphide matte and with variable sulfur contents [23]. The process consisted of an optional iron preleaching of the matte followed by two-stage atmospheric leaching—the first stage employing air and the second using oxygen.

Previously the hydrometallurgical methods were mainly used to treat high-grade mattes with a concentration of Fe below 15%. High-iron mattes prepared by carbothermal reduction in an electric furnace are generally required to reduce iron from 50 to 15% by blowing and refining in a converter. The reactivity of the low-iron mattes becomes lower after the pyrometallurgical pre-treatment, and is little soluble in acids at atmospheric temperature and pressure. Therefore, previous focus has been put on the high-pressure and high-temperature leaching of the low-iron mattes or a combination of atmospheric leaching and high-pressure and high-temperature leaching. The objective of this paper is to conduct a feasibility study of selective recovery of Co, Ni and Cu from a low grade matte with a high-iron content using sulfuric acid leaching at atmospheric pressure. An innovative process is proposed to directly leach the high-iron cobalt matte at atmospheric temperature and pressure. Iron is selectively removed during the leaching process and nickel and cobalt are recovered from the leachate with copper remaining in the leach residue.

2. Experimental

2.1. Material

The matte sample used in this investigation was produced by carbothermal reduction and pyrite sulfuration of a nickel converter slag containing 1.36%Co, 3.39%Ni and 1.01%Cu from the Jinlong nickel smelter (Yunnan, China). The chemical composition of the matte is given in Table 1. A mineralogical

Table 1
Chemical composition of the matte sample

Constituent	Amount (%)
CO	4.54
Ni	13.63
Cu	3.82
Fe	58.42
S	20.4
SiO ₂	2.07
MgO	1.31
CaO	0.78

study showed that this matte consisted of a metallic fraction and a sulphide fraction. More than 80%Co and 70%Ni were in metallic forms and more than 75%Cu was in the form of sulphide.

2.2. Experimental

Samples were first crushed and ground to a particle size of 80% passing 0.1 mm. The standard atmospheric leaching was performed in a 250 mL three-necked-flask equipped with a condenser and thermometer, and heated directly by water bath with a magnetic stirrer. After leaching, the pulp was filtered and washed. The leachates were subjected to chemical analysis by using an atomic absorption spectrophotometer. Batch experiments of the first, second and third step atmospheric leaching were conducted as well as a continuous three-step countercurrent leaching. A representative flowsheet of the three-step countercurrent leaching process is shown in Fig. 1 for the recovery of Ni and Co from the high-iron matte.

The aim of the first step atmospheric pressure leaching tests was to optimize the operation parameters, such as concentration of sulfuric acid and concentrations of nickel and cobalt ions in the dilute leachate of the third step, leaching time, and leaching temperature. According to experience of tests the concentration ratio of Ni to Co in the leachate of the third step is approximately 8, for the sake of simplicity, the initial concentration ratio of Ni to Co in the acid from the dilute leachate of the third step was set at 8. A sample of 20 g was mixed with varying amounts of sulfuric acid and Co and Ni. The mixture was placed into the flask, heated, and stirred. The feed of the second step atmospheric leaching is the residue from the first step atmospheric leaching under suitable conditions. The aim of the second step atmospheric leaching test was to examine the effects of the concentration of sulfuric acid in the dilute leachate of the third step, and leach time on leaching of iron, cobalt and nickel. The residue obtained from the second step atmospheric pressure leaching was leached with 5.5 M sulfuric acid in the third step. The effects of the concentration of sulfuric acid and leaching time on leaching of iron, cobalt and nickel were investigated in the overall process.

The continuous three-step countercurrent leaching was carried out with optimised parameters obtained from the step-wise batch experiments. Artificial acid solutions containing ions of nickel and cobalt were used in the first cycle.

Download English Version:

<https://daneshyari.com/en/article/644334>

Download Persian Version:

<https://daneshyari.com/article/644334>

[Daneshyari.com](https://daneshyari.com)