



Kinetics of pressure oxidative leaching of molybdenite concentrate by nitric acid

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ABSTRACT

The current study was carried out to investigate the kinetics of reactions for the pressure oxidative leaching of a molybdenite concentrate in less than one hour. The effects of oxygen pressure, stirring speed, pulp density, acid concentration and temperature on the leaching rate of the molybdenum were studied. It was found that about 85% of molybdenite was oxidized to molybdic oxide precipitate with remaining molybdenum dissolved in the leaching liquor. Analysis of experimental data showed that the reaction is chemically controlled with activation energy of 68.8 kJ/mol. Furthermore SEM images showed no significant boundary diffusion layer and it was noted that the molybdic oxide precipitates were of fibrous shape.

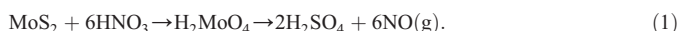
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1. Introduction

As a result of the well known disadvantages of molybdenum pyrometallurgical extraction, hydrometallurgical processes are the most common processes for its extraction nowadays.

Hydrometallurgical processes of molybdenum extraction from molybdenite include: a) leaching in the presence of oxidizing agents (Barr et al., 1977; Barry et al., 1972; Bradburn and Gratch, 1977; Dresher et al., 1956; Jennings et al., 1974; Mounsey, 1977; Parsons et al., 1987; Philips, 1976; Say, 1987), b) pressure leaching at elevated pressure and temperature (Ghasemi, 2001; Habashi, 1998), c) electro-oxidation leaching (Haver et al., 1975; Scheiner et al., 1976), and d) bacterial leaching (Askari Zamani et al., 2005).

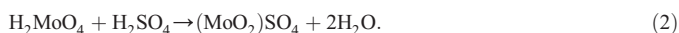
Nitric acid is a relatively strong oxidizing agent which is used in extraction of metals from sulfide ores (Habashi, 1999). In a study on atmospheric leaching of molybdenite concentrate in nitric acid solution, Vizsolyi proposed the following reaction (Vizsolyi and Peters, 1980):



Reaction 1 is a very slow reaction (reaction completed in 96 h) and acid consuming (9 M HNO₃ solution).

Since the solubility of molybdic acid (H₂MoO₄) in water is 1.82 g/L, any process of molybdenum extraction from molybdenite by nitric acid leaching generates a leached liquor supersaturated in MoO₃ with subsequent precipitation of 85% of molybdic acid as hydrated molybdic oxide (MoO₃·1/2H₂O) under suitable operational conditions (Gupta,

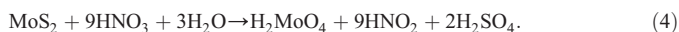
1992) and the remaining, reacts with sulfuric acid to produce (MoO₂)(SO₄) in solution:



If MoS₂ is leached by strong HNO₃ (>4 N), molybdenum is dissolved in the form of molybdenyl cations MoO₂²⁺, according to the following reaction (Gupta, 1992):



But for its pressure leaching in dilute HNO₃ (between 1–4 N) and at temperatures of higher than 110 °C, the following reaction is dominant (Daugherty et al., 1973):



In study conducted by Smirnova et al. in low concentration of nitric acid at the temperature of 180 °C, oxygen over-pressure of 2–2.5 MPa for operation time of 2 to 4 h, it was reported that after completion of reaction, 77% of molybdenum converted to molybdic oxide precipitates. They also reported that at higher temperatures (about 240 °C), the molybdic acid (Reaction 2) completely reacts with sulfuric acid to produce (MoO₂)(SO₄) (Smirnov et al., 2010). The leaching of molybdenite concentrate was accomplished in three steps by their study.

The required concentration of nitric acid for Reaction 4 is about 1/16 of stoichiometric. In the presence of oxygen, nitric acid is regenerated through the decomposition of nitrous acid and subsequent reactions. This is discussed in more detail in Section 3.3.

The pressure leaching of MoS₂ in dilute HNO₃ at about 120 °C and under the oxygen over-pressure was investigated by Kerfoot and Daugherty (Daugherty et al., 1973; Kerfoot and Stanley, 1976). Both

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