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Chalcopyrite Leaching in Acidified Nitrate

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Editorial

Leaching is a frequently used technique in extractive metallurgy in which ore is treated with chemicals to transform the valuable metals contained therein into soluble salts while the impurities remains insoluble. These can then be washed off and treated to yield pure metal; the materials that remain are generally referred to as tailings. Leaching is less difficult to conduct than pyrometallurgy, consumes less energy, and is theoretically less damaging because no gaseous pollution occurs. The disadvantages of leaching include its reduced efficiency and the typically large amounts of waste effluent and tailings produced, which are usually highly acidic or alkaline as well as hazardous (e.g. bauxite tailings). Leaching is carried out in autoclaves, which are lengthy pressure vessels that are cylindrical (horizontal or vertical) or of horizontal tube form. The metallurgy of zinc is another good example of the autoclave leach process. The following chemical reaction best describes it:

2ZnS + O2 = 2H2SO4 2ZnSO4 = 2H2O + 2S

This reaction occurs at temperatures higher than the boiling point of water, resulting in a vapour pressure inside the vessel. Under pressure, oxygen is injected, increasing the total pressure in the autoclave to more than 0.6 MPa and the temperature to 473-523 K. Under mild conditions, precious metals such as gold can be leached with cyanide or ozone.

The leaching of copper from 4.8 wt percent chalcopyrite industrial copper ore by acidified nitrate in seawater-based media was examined. The variables evaluated were water quality (clean water and seawater), temperature (25–70 °C), reagent concentration, and nitrate type (sodium and potassium). Leaching conditions were as follows: 100 g ore/1 L solution; P80 of 62.5 m; 400 rpm; and a leaching duration ranging from 3 to 7 days. Nitrates in sulfuric acid have been shown to be effective oxidants for sulphide ores. This study shown that at 45 °C, up to 80 wt percent copper could be extracted in 7 days. Under the same leaching circumstances and in the absence of nitrate, only a 28 wt percent copper extraction was achieved.

Northern Chile has significant nitrate (caliche) reserves. Sodium nitrate is produced by leaching caliche with water and then crystallising the leaching solution through cooling or evaporation. Even after evaporation, the discharged salts (tailings) from the solar pond contain a significant amount (4.6 wt percent NaNO3) of nitrate salts. These tailings have the potential to be employed as oxidants in chalcopyrite leaching. Several leaching investigations include nitrogen species (e.g., NO3, nitrate, NO2, nitrite, HNO3, nitric acid, or HNO2, nitrous acid, and NO2, nitrogen dioxide) because they boost oxidation capacity and improve kinetics and/or dissolution of ores. The nitrogen species catalysed (NSC) process leaches sulphide ores at high temperatures and pressures using nitric and sulfuric acid. In the mining industry, this procedure has been utilised successfully for pressure leaching of copper sulphides. The key advantage of this method is that it allows for faster reaction times. Copper extraction rates of 80–99 wt percent were obtained by leaching copper ores in sulfuric acid with sodium nitrate/nitrite solutions. Cu2S was leached at various temperatures, NaNO3 and H2SO4 concentrations, stirring rates, and solid-liquid ratios. According to X-ray diffraction (XRD) study of leaching residues, the scientists discovered that Cu2S was leached in two stages, first generating CuS and then elemental S. The process's activation energy was 60 kJmol1. In terms of NaNO3 and H2SO4 concentrations, ore leaching was a first order reaction and a second order reaction, respectively.

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