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Determination of Optimum Conditions for the Leaching of Oxidized Copper Ores with Ammonium Nitrate

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Abstract : The most common lixiviant in the leaching process of copper minerals is H_2SO_4, however, the current situation requires more environmentally friendly reagents and in certain situations that have a lower consumption due to the presence of undesirable gangue as muscovite or kaolinite that can make the process unfeasible. The present work studied the leaching of an oxidized copper mineral in an aqueous solution of ammonium nitrate, in order to obtain the optimum leaching conditions of the copper contained in the malachite mineral from Peru. The copper ore studied comes from a deposit in southern Peru and was characterized by X-ray diffractometer, inductively coupled-plasma emission spectrometer (ICP-OES) and atomic absorption spectrophotometry (AAS). The experiments were developed in batch reactor of 600 mL where the parameters as; temperature, pH, ammonium nitrate concentration, particle size and stirring speed were controlled according to experimental planning. The sample solution was analyzed for copper by atomic absorption spectrophotometry (AAS). A simulation in the HSC Chemistry 6.0 program showed that the predominance of the copper compounds of a Cu-H_2O aqueous system is altered by the presence in the system of ammonium complexes, the compound being thermodynamically more stable $Cu(NH3)_4^{2+}$, which predominates in pH ranges from 8.5 to 10 at a temperature of 25 °C. The optimum conditions for copper leaching of the malachite mineral were a stirring speed of 600 rpm, an ammonium nitrate concentration of 4M, a particle diameter of 53 um and temperature of 62 °C. These results showed that the leaching of copper increases with increasing concentration of the ammonium solution, increasing the stirring rate, increasing the temperature and decreasing the particle diameter. Finally, the recovery of copper in optimum conditions was above 80%.

Keywords : ammonium nitrate, malachite, copper oxide, leaching
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