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# STUDIES IN LEACHING OF SULPHIDE CONCENTRATES OF COPPER AND NICKEL FROM INDIGENOUS SOURCE (*)

M.Totlani & J. Balachandra,
Metallurgy Division,
Bhabha Atomic Research Centre,
Trombay, Bombay.

The work reported in this paper is on the leaching of sulphide concentrates obtained as a bye-product of the beneficiation of an indigenous source of Uranium Ore. The ore body also contains small amount of tourmaline, magnetite, biotite, apatite and sulphides. The sulphides consist of chalcopyrite and pentlandite, nickeliferous pyrrhotite and pyrite, violarite, bravoite, millerite - all containing nickel and molybdenite. These sulphides assayed approximately Ni 0.11-0.2%, Cu 0.15-0.25% and Mo 0.03% in addition to small amount of uranium values in a bulk concentrate.

## Experimental

All tests were carried out in a five-litre stainless steel autoclave, equipped with an agitator and external heating. The rate of agitation was maintained at 500 rpm for all tests.

Most of the pressure leach tests were carried out with a slurry consisting of 2000 m.l. of ammonia leach solution containing 500 gms of concentrate (or 250 gms of concentrate per litre of leach solution). After loading the autoclave, the agitator and the heating were started. The desired pressure was maintained by passing oxygen and the leach carried out under steady state conditions for a selected length of time. Since the reaction is exothermic the reaction temperature was maintained at the desired level by suitable adjustment of the heat input by automatic temperature control. At the end of the run for a selected period of time at temperature the heating was stopped and the autoclave allowed to cool down. The supernatent liquid was siphoned out, and collected for further processing.

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The residue was washed once and the wash water together with the siphoned liquor was filtered and the filtrate boiled to eliminate most of the ammonia and incidentally to reduce the volume of solution to 2 litres. The residue, left in the autoclave, was again subjected to ammonia pressure leaching under similar conditions. At the end of second leaching, the leach liquor together with the residue was removed from the autoclave, filtered and the residue washed. The total volume of second leaching solution was also reduced to 2000 m.l. These clean leachings were then separately analysed for Cu & Ni content.

Discussion of Results.

The reaction in leaching in its simplest form may be described as a reaction of the sulphide minerals in the concentrate with dissolved oxygen, ammonia and water that converts Ni, Cu and Co to soluble ammines, oxidizes sulphur to various sulphur-oxygen compounds and converts iron to insoluble hydrated oxide. The pentlandite, chalcopyrite, pyrrhotite, millerite, Bravoite and violarite particles react to produce soluble salts in a manner that leaves iron in place as pseudomorphic with the original mineral particle. S and Ni diffuse outwards through the porous oxide and oxygen diffuses inwards. On reaching the solid-liquid interface, the Ni forms ammines, which dissolve and sulphur is converted to oxy acids. However, there is no perceptible attack on pyrite as such.

Effect of Variables

Particle size - It has been observed that the particle size is of much consequence in the leaching characteristics of the concentrates. In the earlier set of experiments the 'as received' concentrate treated had a particle size corresponding to that expected in the main plant operation i.e about 50 to 55% through 200 mesh.

Influence of Temperature

It is generally to be expected that the reaction rate increases with increase in operating temperature, thus being advantageous in decreasing the duration of reaction time. While this is also true in the case of the leaching of Cu & Ni, there are other factors involved in the process which offset the gain of operation at higher temperature and limit the optimum operating temperature.

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Influence of ammonia concentration

In an extraction system where ammonia has to play several roles it is generally necessary that it is used in reasonable excess to ensure that all the desirable leaching reactions are established, since most of the excess ammonia is recovered during further processing. Ammonia in the present system reacts to:

a) neutralize the acid formed by oxidation of sulphur.

b) in the formation of sulphamates

c) in the formation of complex ammines with Ni, Cu and Co.

d) as free ammonia in equilibrium with the ammines.

Influence of Oxygen

In the early stages of batch leach, when fresh sulphides are abundant in the pulp, oxygen requirement for the oxidation of sulphides and that of thiosulphates to thionates and thionates to sulphamate and sulphate is very high.

But as the leaching nears completion, the oxygen demand is less and oxygen overpressure may cease to be a rate controlling factor compared to others, such as outward diffusion of sulphide ions through the porous oxide layer surrounding the unreacted sulphide cores.

Oxygen partial pressure, thus as expected accelerates the leaching action during the initial stages but is likely to have less effect on the rate as the leaching proceeds. Variation in oxygen partial pressure within limits may not influence the ultimate extraction of Ni and Cu or S.

Agitation

Agitation has been observed to have a pronounced effect on the extent of leaching. This is to be expected in view of the heterogeneous character of leaching reactions.

From the data presented in the paper it can be observed that ammonia pressure leaching process operated at 190°F with oxygen under a total pressure of 150 spi using a 7% ammonium leach solution can be adopted in leaching and recovery of copper and nickel from the by-product sulphide concentrates obtained from the uranium ore. The recovery of nickel and copper being over 95% in each case.

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