SHORT COURSE

A-Z of Copper Ore Leaching

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Notes

LEACHABILITY OF COPPER MINERALS

- Leachability in sulphuric acid solutions varies enormously (see Table 1). Orebodies frequently contain a mix of minerals, commonly varying with depth.
- Oxide minerals also are amenable to ammonia/ammonium carbonate leaching – reduction roast needed for silicates.
- Secondary sulphides are leachable in ferric sulphate/sulphuric acid and sulphuric acid/chloride solutions.
- Primary sulphides can be rendered leachable in sulphuric acid by roasting, pressure-oxidation, bio-oxidation, hot aeration with ferric sulphate, and galvanic action with pyrite.
- Secondary and primary sulphides are leachable in chloride solutions, and ammonia/ammonium sulphate solutions under pressure.
- A wide range of oxides and sulphides are leachable in glycine (an amino acid) solutions in alkaline conditions with an oxidant (air/O_2, peroxide).
- A working knowledge of the properties of the various minerals is a valuable aid to exploration.

Notes

Table 1 Leachability of Copper Minerals in Sulphuric Acid Solutions

AZURITE MALACHITE TENORITE CHYRSOCOLLA DIOPTASE ANTLERITE BROCHANTITE CHALCANTHITE ATACAMITE PSEUDOMALACHITE COPPER PITCH	LEACHABLE AT AMBIENT TEMPERATURE WITH DILUTE SULPHURIC ACID. KINETICS VARY BUT ARE GENERALLY SUITABLE FOR DUMP, HEAP, VAT AND AGITATED LEACHING. SOME MAY NEED HEATING TO OBTAIN KINETICS FAST ENOUGH FOR AGITATED LEACHING. .
COPPER WAD	10-80% LEACHABLE AT AMBIENT TEMPERATURE WITH DILUTE SULPHURIC ACID.
CUPRITE	50% LEACHABLE AT AMBIENT TEMPERATURE WITH DILUTE SULPHURIC ACID.
CHALCOCITE	PARTIALLY LEACHABLE IN SULPHURIC ACID. LEACHABILITY INCREASES WITH TEMPERATURE AND WITH ACID STENGTH (EG. ACID CURE).
NATIVE COPPER	SLOW LEACHING IN SULPHURIC ACID AT ATMOSPHERIC TEMPERATURE. KINETICS IMPROVE WHEN AGITATED WITH AERATED HOT STRONG ACID.
CHALCOCITE COVELLITE BORNITE	LEACHABLE WITH SULPHURIC ACID/FERRIC SULPHATE SOLUTIONS. KINETICS SUITABLE FOR DUMP OR HEAP LEACHING. KINETICS IMPROVE WITH INCREASED TEMPERATURE
CUPRITE NATIVE COPPER	LEACHABLE WITH SULPHURIC ACID/FERRIC SULPHATE SOLUTIONS
CHALCOPYRITE	VERY SLOW LEACHING

FIG. 9 SEPON OPERATION, LAOS

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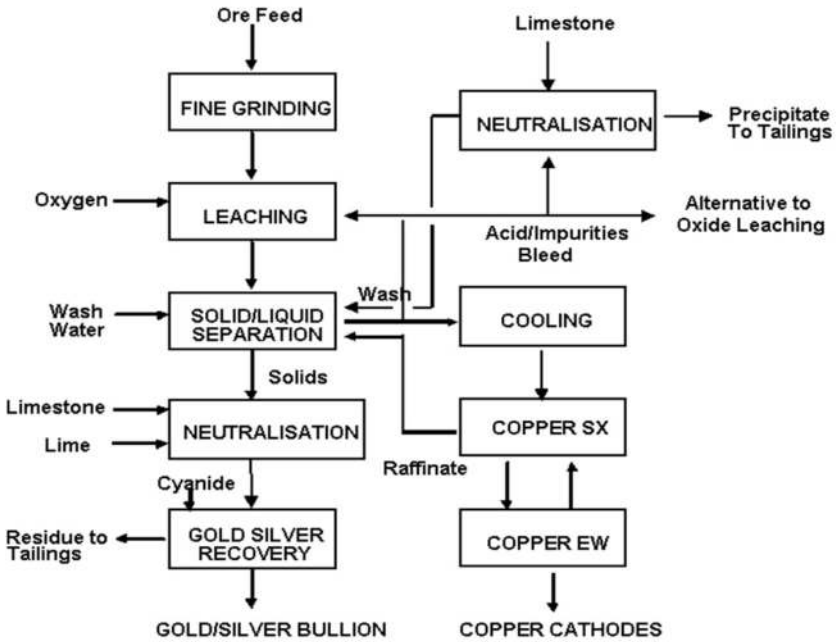
Notes

1. Designed 5.1% Cu ore to produce 60,000 tpa copper cathodes with a recovery of 90% .
2. The copper mineralogy is predominantly chalcocite contained within weathered sediments (clay).
3. Atmospheric ferric leaching with oxygen and air at 80°C for 8 hours in 4 stages each with 1200 m3 live volume.
4. The leach slurry is cooled from to 40°C using a spiral heat exchangers and cooling towers. The cooled copper leached slurry is then pumped to a 5 stage CCD circuit using high capacity thickeners.
5. Pyrite (FeS_2), elemental sulphur and any unleached copper minerals are recovered using a flotation step and are used to generate basic ferric sulphate and sulphuric acid in a pressure oxidation circuit at 220°C for 1 hr. Heat generated from the POX circuit is used to preheat both acidic liquors and slurry prior to atmospheric leaching. The basic ferric sulphate in the POX autoclave residue is redissolved in 2 atmospheric re-leach stages at 95°C for 2 hrs to produce ferric sulphate which is sent to the main leach circuit.
6. The POX system was included to replenish the acid and ferric sulphate required for leaching and was developed because of the high cost of acid in Laos.
7. The plant came into production in 2005 and achieved design capacity in 12 months.

ALBION PROCESS™ ATMOSPHERIC FERRIC LEACH PROCESS

FIG. 28
FLOWSHEET



Notes

1. Involves ferric sulphate leaching at 80°C and atmospheric pressure for about 20 hours, with oxygen sparging to maintain an adequate level of ferric.
2. The feed is ultra-finely ground to less than 20 microns, (approximately 10 microns, depending on feed). Copper recovery is by conventional SX/EW.
3. The degree of oxidation can be varied, but is generally set to yield sulphates in the form of sulphuric acid and iron sulphates.
4. The leach discharge pulp passes to a solid/liquid separation/washing operation, consisting of a belt filter or counter-current CCD thickeners.
5. The resulting solution is cooled, then fed to a conventional SX/EW. The SX raffinate is recycled to leach and CCD, with a bleed being neutralized with limestone to remove excess acid, iron and other impurities.
6. Sulphur is largely oxidized to sulphates. Acid generated could be utilized to leach oxide ore. Limestone is required to remove iron and excess acid from solution.
7. Gold/silver, if present, can be recovered from the residue by cyanidation after neutralization with limestone/lime. Cyanide consumption is reasonable.
8. Copper recovery is expected to be about 98%.
9. Gold and silver recoveries are about 90-95%
10. Also has been referred to as the Nenatech Process.