SOLVENT EXTRACTION TECHNOLOGY TRANSFORMS BASE-METAL HYDROMETALLURGY

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Over the last three decades solvent-extraction (SX) technology has undergone a considerable surge in applications in hydrometallurgical flowsheets. Initially commercialized for uranium in the 1950s it was only in the late 1960s that the technology was implemented for base metals and is today firmly established in the processing of copper, nickel, cobalt and zinc.

The first smaller copper SX plants in Arizona, USA, were followed by an incredible growth in the use of SX for the primary processing of copper. The construction of the Nchanga SX plant in 1973 in the African Copper Belt marked the beginning of a new era for large-scale SX operations. Still operational today this was for more than a decade the world's largest SX plant. The integration of SX as an upgrading and purification step between leaching with sulfuric acid and recovery of the metal by electrowinning (EW) enables cost-effective production of high-purity copper (>99.99%) from low-grade and poor-quality oxide and sulfide ore. There are over 50 plants in operation worldwide, the largest, El Abra in Chile treats 5 000 m^3/h through a single SX circuit and produces 225 000 tpa copper cathode. Ketoxime:aldoxime mixtures and modified aldoximes are the copper extractant systems extensively used in commercial processes. They exhibit fast reaction kinetics, excellent selectivity at low pH for copper over base metals and good physical performance.

SX is today extensively employed in cobalt production and because it typically occurs with nickel extractants used exhibit high cobalt-over-nickel selectivity. In chloride medium the anionic complex formed by cobalt enables extraction with tertiary amines and excellent separation from nickel that forms a neutral chloride complex. In sulfate media dialkylphosphorous extractants are used with cobalt-over-nickel selectivity improving with increasing basicity of the ligand. Older plants like Anglo Platinum Base Metal Refiners use the least basic phosphoric acid while the preferred reagent is a phosphinic acid (Cyanex®272) used today to produce more than 40% of the world's cobalt.

SX technology has opened the door to the viable processing of limonitic low-grade nickel laterites. The introduction of a nickel SX step changed the fortunes of Queensland Nickel an established laterite operation treating limonite ore with a reduction roast followed by ammonia leaching. Modern laterite plants employ high-pressure acid leaching (HPAL) that ensures high nickel and cobalt recovery and rejection of the iron to the residue. SX processes feature prominently in the downstream circuits that for the plants built to date are all different. The Goro plant in New Caledonia uses selective SX of nickel and cobalt with Cyanex®301, a sulfur analogue of a phosphinic acid, stripping with HCl, followed by cobalt from nickel separation with an amine. Pyrohydrolysis of nickel chloride gives a nickel powder product and regenerates the HCl for recycle and a cobalt carbonate is produced. The Murrin-Murrin plant produces a sulfide mixed-metal intermediate that is leached in sulfuric acid, zinc and cobalt removed with Cyanex®272 in sequential SX steps and nickel powder is produced with hydrogen reduction. The Cawse operation produces a hydroxide intermediate that was leached with ammonium carbonate followed by

nickel SX with a ketoxime extractant (LIX®84I) and stripping with spent electrolyte from nickel EW. The Bulong plant was the most complex employing sequential cobalt and nickel SX steps on the dilute HPAL liquor. Nickel upgrading was with a Versatic 10, a tertiary carboxylic acid extractant. With this extractant separation of nickel over calcium is dramatically improved with the addition of NickSyn® a Mintek developed synergist. The synergist mixture was successfully tested in the Tati demonstration plant that used a processing route similar to that employed at Bulong to treat a sulfide concentrate feed material.

The Skorpion Zinc operation in Namibia is the world's largest mine-to-metal zinc operation that produces 150 000 tpa of special high-grade zinc. An SX step enables the dilute leaching of the silicate ore (previously considered untreatable) and upgrading into an electrolyte suitable for zinc EW. This operation reports the lowest zinc-industry operating costs.