

## BIG GUNS NOW IN COPPER CONCENTRATE LEACHING RACE

A growing list of hydrometallurgical processes are lining up to seize the ultimate prize in copper processing, the treatment of primary sulphide concentrates, out of the hands of the incumbent smelters. The serious entry of copper giants Phelps Dodge, BHP Billiton and Codelco indicate that at long last real progress is being made.

The world's second largest copper producer **Phelps Dodge** are building a US\$40 million pressure oxidation demonstration plant at Bagdad Arizona, which will treat about 136 tonnes/day of concentrate to produce just under 16,000 tonnes/annum of copper cathode via conventional SX/EW. This represents about 15% of Bagdad's concentrate output. The plant is scheduled to come on stream during the first half of 2003. The project will use technology developed by Phelps Dodge and Placer Dome.

Meanwhile the worlds largest copper producer **Codelco** have teamed up with major producer **BHP Billiton** to form **Alliance Copper** dedicated to developing and applying bio-technology for copper and molybdenum ores and concentrates. The first project is a US\$60 million prototype bio-leaching facility near Chuquicamata, Chile to treat 77,200 t/a concentrate and produce 20,000 tonnes/annum of cathode copper, with a view to building a commercial facility for the nearby Mansa Mina Project. Billiton had previously run a pilot plant at Chuquicamata utilising their BioCOP technology.

**Others in the line-up include majors such as MIM and Anglo American:**

### ***MIM/Highlands Albion (Nenatch) Process***

The process is jointly owned by **MIM** and **Highlands Pacific**, and was originally developed for the Frieda River Project in PNG. It uses fine grinding to reduce the feed size to about 16-18 microns, then ferric sulphate leaching at about 80C and atmospheric pressure, with oxygen or air sparging. Copper recovery is by conventional SX/EW. It has been successfully run at pilot plant scale. A feasibility study for a commercial plant at Mt Isa is in progress, and other applications are under consideration including zinc concentrate at McArthur River, N.T.

### ***AAC/UBC Hydrometallurgy Process***

**Anglo American Corporation** and the **University of British Columbia** are developing a medium pressure oxidation process operating at 150C, to which surfactant is added to disperse the molten sulphur. The feed is finely ground to 10-20 microns, and copper recovery is via conventional SX/EW. A pilot plant program is underway at the AARL facilities in South Africa.

**Other contenders utilising some form of pressure oxidation include:**

### ***CESL Process***

This pressure oxidation process also operates at about 150 C, but uses chloride as a catalyst. It is preceded by a light regrind to about 40 microns. A second stage copper leach is included to maximise extraction. Copper is recovered by SX/EW. The process is being developed by **Cominco Engineering Services Limited** of Vancouver. Pilot demonstration plant campaigns have been successfully run, and potential commercial applications are being assessed.

### ***Dynatec Process***

**Dynatec Corporation** of Fort Saskatchewan, Canada, is developing another pressure oxidation process operating at 150C. In this case low grade coal is added as molten sulphur dispersant. The feed is ground to 30-40 microns, and unleached copper is floated and recycled to maximise copper extraction. Copper recovery is via SX/EW, though direct SX is being tested. Mini-plant campaigns have been carried out. Dynatec have also developed the flowsheet for MK Gold's Las Cruces Project in Spain. This will treat chalcocite/bornite ore using a combination of atmospheric pressure and low pressure autoclave leaching after grinding to 105 microns.

### ***NSC Process***

This process is based on moderate pressure oxidation at 125-155C, catalysed with nitrogen species supplied from sodium nitrite, preceded by an ultrafine grind to 10 microns. Copper is recovered by conventional SX/EW. A small commercial circuit operated until the mid nineties at Sunshine Mining and Refining in Montana. Further development work is being undertaken by the **Center for Advanced Mineral and Metallurgical Processing**, Montana, USA, including the use of the existing Sunshine plant to treat a cobaltite and chalcopyrite concentrate for the Formation Capital Corporation Idaho Cobalt Project.

### ***ACTIVOX Process***

Under development by **Western Minerals Technology** in Perth, Activox is a low pressure oxidation process operating at about 100C, preceded by ultrafine grinding to 5-15 microns. Copper recovery is via SX/EW. Pilot scale campaigns have been successfully run. WMT are currently focusing on nickel/cobalt/copper type ores, and copper concentrates with impurities that are difficult to handle by smelting. The treatment of copper/gold concentrates will be an area of increasing future focus.

### ***Mt Gordon Ferric Leach Process***

This process is in successful commercial operation at **Western Metals'** Mt Gordon operation in Queensland, which produces about 50,000 tones/annum of high grade cathode copper from chalcocite ore by ferric leaching and low pressure oxidation. It incorporates a moderate feed grind of 75-106 microns, and copper recovery is by conventional SX/EW. Future plans include the treatment of chalcocite concentrates from lower grade ore, and the further development of the process to treat chalcopyrite concentrates.

**Others processes based on bio-technology include:**

### ***BacTech/Mintek Process***

**BacTech** and **Mintek** have now jointly developed their tank bio-leaching process up to demonstration plant level at the Penoles operation at Monterrey, Mexico. The Penoles demonstration plant is designed to produce 500 kg/day of cathode copper via conventional SX/EW. A 25,000 tonnes/annum copper/zinc commercial plant at Penoles is under study.



*BacTech/Mintek Demonstration Plant at Penoles, Mexico*

### ***GEOCOAT Process***

**GeoBiotics** of Lakewood Colorado taking an alternative approach to bio-leaching. Their GEOCOAT® process involves the coating of concentrates onto a suitable substrate, usually barren rock, then stacking the coated material in a conventional heap fashion. The heap is irrigated with acidic solutions containing iron and nutrients, while low pressure ambient air is applied at the heap base. The technology was initially developed for gold recovery, and an extensive program is being carried out for copper sulphides. Plans are now underway for the first large scale field test.

**Finally, the processes using some form of halide leaching include:**

### ***Intec Process***

Involves a chloride/bromide solution leach at 85C and atmospheric pressure. Impurities are precipitated with lime. Silver is precipitated with mercury, and then produced as a chloride for further processing. High purity copper is electrowon in a special cell. Gold is recovered on to carbon for further processing. The process is being developed by Intec in Sydney supported by a consortium of companies. After successful pilot plant and demonstration plant campaigns, **Intec** are assessing opportunities for commercial plants, including Ivanhoe's Turquoise Hill Project in Mongolia.

### ***Outokumpu HydroCopper process***

**Outokumpu** have joined the line-up with a chloride leaching process. Like Intec, they produce a high grade copper powder, which can be melted and cast. Pilot plant testing has been undertaken, and a demonstration plant is being built at Pori, Finland, to produce 1 t/d copper. It is expected to come on stream in late 2002. The first commercial plant is under consideration.

### **Participation by copper majors heralds a potential new growth phase in concentrate leaching:**

The involvement of major players such as Phelps Dodge, BHP Billiton and Codelco suggests that the copper industry has made up its mind to “crack the nut” of hydrometallurgical treatment of sulphide concentrates. This could lead to a major shift in the copper processing scene.

**Alan Taylor**