

Cu/Ni innovation

Many new processes are available or being researched, John Chadwick looks at AmmLeach, floating coarse particles, ion exchange resins, the Direct Nickel process, HCl leach, autoclave management and more

Copper to remain very strong, is the opinion of most. One example, Foster Stockbroking, is fairly typical: "We continue to be firmly of the view that the structural fundamentals for the commodity remain sound:

- Mining majors have begun to delay capex commitments for copper operations and expansions; this was also seen throughout the global financial crisis and exacerbated the supply squeeze
- Copper grades from existing operations (and new discoveries) continue to fall
- Greenfield discoveries are becoming far scarcer with companies now having to venture into previously considered high-risk jurisdictions in an effort to have exploration success."

Recent commentary from majors BHP and RIO supports these arguments, with the companies expecting mined copper grades to continue to fall to below 0.6%, putting pressure on supply which will need to meet a consolidated annual growth rate (CAGR) of >5% until 2025. A 5% growth rate in world demand of ~20 Mt is around 1 Mt/y of additional supply (i.e. the equivalent of two new Oyu Tolgoi mines being brought on-line each year!).

In late June, Peter Beavan, BHP Billiton President Base Metals confirmed that copper is a material of choice, being energy efficient and carbon sensitive. "Overall substitution remains small (~2% of the global market), especially in high volume sectors. Even at a price ratio of 4:1 for copper: aluminium, substitution has not significantly increased penetration." He also

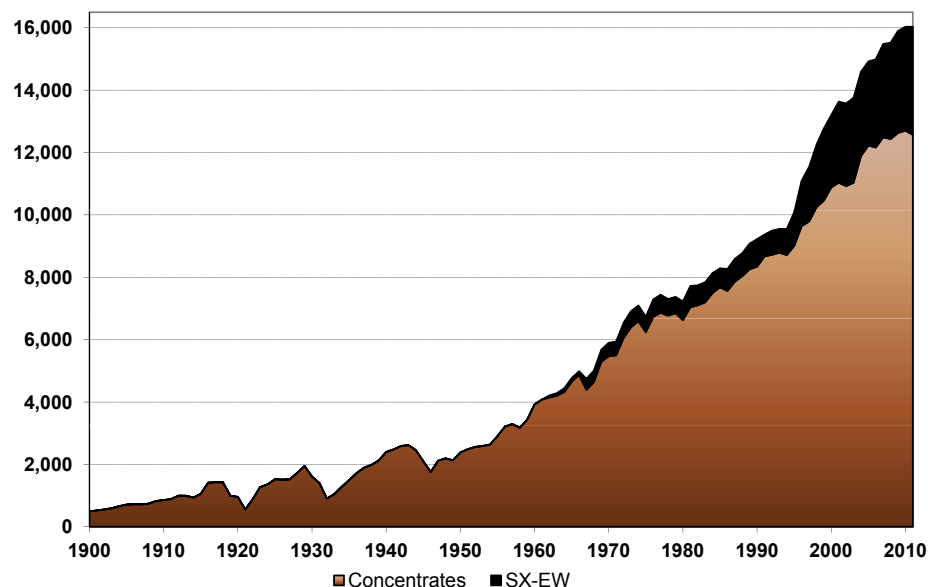
said "the copper industry is evolving to defend market share."

There is less bullish sentiment about nickel, but generally its short-term future looks promising. Judging by its current exploration budget, Vale remains confident; "Expenditures will be dedicated to further develop our reserves of iron ore (\$ 282 million) and nickel (\$ 202 million), and to explore opportunities in copper (\$ 156 million), coal (\$ 75 million), and potash and phosphate rock (\$ 50 million).

Around the mining world, the desire to embrace new technologies to reduce costs and increase efficiencies has seen significant change in the industry's past image of being slow to change. As this demand intensifies, the greatest potential for technical innovation appears to be in mineral processing – in particular getting more out of lower grade ore. Just look at the growth in SX/EW shown in the diagram.

Ammleach® is one of the innovative solutions just starting to get used in the commercial production of copper, and cobalt. Its owner, Alexander Mining recently saw the successful commissioning of an AmmLeach copper/cobalt plant in South Africa in partnership with MC Process in Johannesburg. This is the first AmmLeach plant in the world with two circuits going through to produce copper and cobalt cathode metal, whereas the majority of Democratic Republic of Congo (DRC) cobalt is currently produced as a concentrate requiring further processing outside the DRC. The DRC currently supplies over half of the world's annual cobalt mine production (98,000 t), which has a current global annual value of around \$2.8 billion. Martin Rosser, Chief Executive Officer believes the "AmmLeach process offers a clear competitive advantage for the production of cobalt through to metal cathode in the DRC, as well as offering a way to treat high-acid-consuming carbonate copper ores in the DRC that hitherto have been uneconomic to treat."

Ammleach commercialisation is planned through licensing, partnerships in producing mines and equity interests in advanced projects.



World Copper mine production, 1900-2010 (thousand metric tonnes. Source:ICSG)

Other recent achievements include:

- In DRC - Patent for a *Method of Ammoniacal Leaching* granted and important progress with copper/cobalt opportunities
- In Australia - *Method for Leaching of a Copper-containing Ore* patent granted, plus favourable test work for Altona Mining for samples from the Blackard deposit at its Roseby copper project in Queensland
- In Turkey - Red Crescent Resources to investigate AmmLeach for copper and zinc projects.

Alexander Mining's MetaLeach® subsidiary is focused on the ammoniacal leaching (Ammleach) of copper, copper-cobalt and zinc oxide ores. The technology, an alkaline/ammonia leach process at ambient pressure and temperature, has been tried and tested through laboratory and field tests on leach pads and in pilot plants. Rosser says it is "a breakthrough mineral processing technology with major technical and economic advantages for a large number of major base metals deposits."

There are a number of major operational and economic advantages reported by MetaLeach. It is a proprietary two stage leaching process with an ore specific pre-treatment stage and heap or tank leaching. The proprietary SX step avoids ammonia carry-over into electrolyte. The first leaching step converts the metals into a soluble

form and then the main leaching step uses recycled raffinate from the SX stage. SX is used to separate and concentrate the metals, whilst also changing from ammoniacal media to acid sulphate media from which metals can be directly electrowon using industry standard unit operations.

AmmLeach® reagent consumption is greatly reduced, compared with conventional treatment of high-acid-consuming ores. Also:

- Clean target metals PLS, unlike acid leach
- Uses conventional equipment

EW is identical to conventional acid circuits

Direct replacement for acid leaching in current operations

Minimal changes to plant; higher organic transfer efficiencies requires smaller plant

The environmental benefits include reduced transport/shipping impact and costs; and

minimal likelihood of Acid Mine Drainage (AMD).

The technology is suitable for both low grade heap leaching and higher grade tank leaching; the choice is dictated by the grade and deposit economics. Polymetallic deposits can be readily handled using standard SX and solution purification techniques.

The difference from acid leaching is that the leaching is conducted in moderately alkaline solution with ammonia present to selectively leach base metals. The use of alkaline conditions allows the use of AmmLeach on high-carbonate ores where acid consumption would be prohibitive.

The process has an

The Ammleach pilot plant



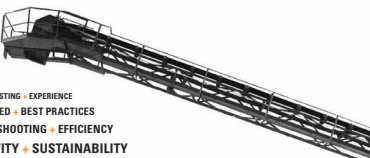
extremely high selectivity for the target metal over iron, aluminium and manganese, which are insoluble under AmmLeach conditions. Calcium and magnesium solubilities are also significantly suppressed by the presence of carbonate and extremely low sulphate levels in the leaching solutions.

These features ensure that there are no potential problems due to jarosite or gypsum precipitation that reduces permeability in the heap or causes scaling problems in the SX plant. Also, silica is insoluble in the process, obviating problems of the formation of precipitates that cannot be filtered within an acid leach plant during pH adjustment and the need to handle high viscosity solutions. Ammonia, unlike acid, doesn't react with aluminosilicates and ferrosilicates, whose products can cause drainage and permeability problems in heaps.

Compared with previous ammoniacal processes, almost any ore mineralogy can be treated as the pre-treatment step is specific to each orebody. The whole process is tailored to individual orebodies and consequently has substantially lower ammonia losses than earlier processes. In theory, all the ammonia can be recovered, however in practice small losses do occur.

Decommissioning of the heap is extremely simple as no neutralisation is necessary and the potential for acid mine drainage is virtually eliminated. After final leaching the heap is simply washed to recover ammonia and then left to revegetate, with the residual ammonia acting as a fertiliser.

An analysis of the economics of the process compared with conventional acid leaching for high acid consuming copper ores is dependent



TESTING + EXPERIENCE
FOCUS + BEST PRACTICES
TROUBLESHOOTING + EFFICIENCY
PRODUCTIVITY + SUSTAINABILITY
TECHNOLOGIES + KNOW HOW
EXPERTISE + TECHNICAL DEPTH
TRANSPARENCY + RISK MITIGATION
MARKET INSIGHT + COST REDUCTIONS
DEVELOPMENT + STREAMLINED PROCESSES
CONFIDENCE + EFFICIENT LOGISTICS
SPEED-TO-MARKET + GLOBAL NETWORK
COMPETITIVE ADVANTAGE + PRODUCTIVITY

MORE + LEAN

GROWTH EFFICIENCIES

If you need **MORE** growth or want to generate **LEAN** efficiencies, contact SGS. Daily, the SGS global team delivers technical expertise, effective services and sustainable solutions that can enhance your project.

SGS IS THE WORLD'S LEADING INSPECTION, VERIFICATION, TESTING AND CERTIFICATION COMPANY

www.sgs.com/minerals
minerals@sgs.com

WHEN YOU NEED TO BE SURE



upon a multitude of parameters specific to the mineralogy of the deposit and its location. Suffice to say that the capital and operating cost savings can be major, particularly for high acid consuming ore bodies located in remote locations with long transport distances.

For even a moderately high acid consuming ore, ten to fifteen times as much acid (50kg/t) as ammonia will be consumed. This is due to the fundamental difference between the two leaching processes in that whereas acid is consumed by gangue minerals during leaching, ammonia is not. The reagent can be recycled and only relatively small losses of ammonia need to be made up.

AmmLeach can achieve much higher copper solution concentrations in the PLS than are seen in acid plants. Typical copper concentrations for an acid leaching operation are of the order of 1-2 g Cu/litre compared with PLS concentrations for AmmLeach of 6-12 g Cu/litre. This, coupled to the much greater copper transfer between aqueous and organic, allows the efficient handling of high copper tenors in PLS (in acid plants this would necessitate larger volume mixer-settlers due to the higher volume of PLS and lower transfer between aqueous and organic phases); i.e. more metal produced per unit capacity of plant than in a corresponding acid leach SX-EW plant.

MetaLeach is particularly focusing on the DRC



Metso has signed a contract with Codelco to supply large cone crushers for a process improvement project at Chuquibambilla division. Metso will supply three of the biggest cone crushers it has ever manufactured. The contract, with a value exceeding €9 million, also includes an automatic control system for the crushers. The operational weight of one MP1250 series cone crusher exceeds 150 t, and the crusher can process up to 1,800 t/h in secondary position for this application. The total project delivery comprises three Nordberg MP[®]1250 cone crushers. The MP1250 continues the success of the MP 1000 and MP 800 using the same footprint as the MP 1000, but delivering up to 25% increase in capacity. With an increased power rated up to 932 kW, the MP1250 performs more work per crushing cycle, and its power-to-production ratio exceeds that of its similarly sized competitors in the market, Metso says

because its predominant geology/ore mineralogy is of high-acid-consuming copper/cobalt oxides – the world's largest sediment-hosted stratabound copper and cobalt province. The current focus is on developing the highest grade copper deposits, typically >2.0% Cu with agitated leaching. However, MetaLeach says there is a massive tonnage of resources ≤2.0% Cu with significant cobalt. The cobalt recovery using acid is complex and costly, and often not successful. And capital and operating costs in the DRC are typically high. Finally, the

SCANTECH
Process control specialists

On-belt Real Time Analysis for Process Control

- Iron ore
- Base metals
- Bauxite / Alumina
- Coal, cement
- and others
- Continuous analysis
- Minute by minute results

Contact us:
Tel: +61 7 3710 8406
Fax: +61 7 3710 8499
www.scantech.com.au
minerals@scantech.com.au

GEO.SCAN

THROUGH BELT
ELEMENTAL
ANALYSER



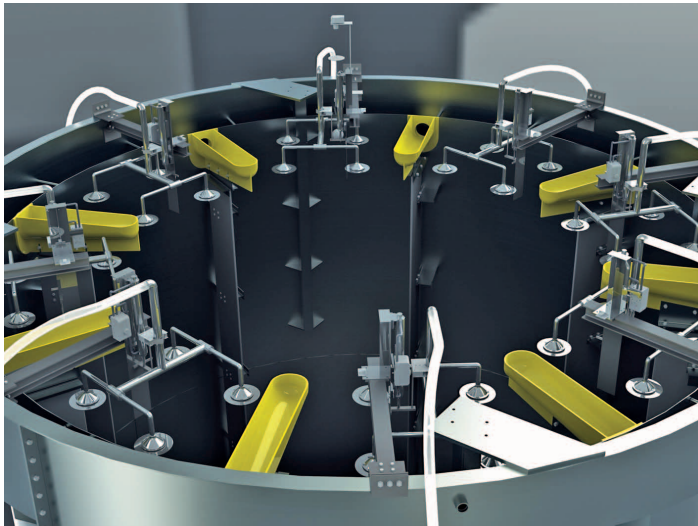
Model 1500
NATURAL GAMMA
MINERALS
MONITOR

Over 1,000 units
installed in 55
countries

TBM 200 SERIES

MICROWAVE
MOISTURE
MONITOR





FL Smidth's SFR extraction device positioned between eight sets of radial launders. This configuration allows the effective placing of the skimmer in the cell and also helps overcome a froth removal issue that comes with the use of the high volume cells. The SFR system would also be used to increase the froth removal efficiency in a flotation cell

government policy is for in-country processing to produce metal rather than an intermediate product. These all play to Ammleach advantages.

In Australia, the favourable test work for Altona Mining achieved its best results on the Blackard deposit (resource of 46.3 Mt at 0.63% Cu), of which a significant portion (~60%) is in the native copper mineralisation zone below the oxide zone. The AmmLeach results for the native copper zone are highly encouraging, with copper recoveries into solution of more than 80%. Alexander and Altona are investigating the next steps.

The coarse/fine conundrum

FL Smidth's R. Silva and T Olson¹ note that floating coarse particles is a problem in most concentrators. They need a longer residence time to float, and most of the coarse particles that attach to a bubble are lost before recovery in the launder. But, an excessive residence time for the fines, could result in higher entrainment for the process, so the recovery of coarse and fine particles in a flotation circuit is a controversial matter. To achieve the best performance for each one, the two need different conditions in a cell (hydrodynamics, froth depth, reagents, etc.). Although this performance can be greatly improved if the right circuit configuration and/or flotation machine is used in the flotation circuit.

FLSmidth's Selective Froth Recovery (SFR) system (patent pending) is a way to overcome this issue. This system consists of a floating skimmer or extractor, pump and cyclone. The

Based on investigations of the froth layer, FLSmidth has developed a latest design that allows automatic control of the suction point in the froth layer. This new design will work in conjunction with the level control already existing in the flotation cell, allowing setting a point above the slurry level where the suction will occur and keep it constant even with changes in the froth depth. (Figure right)

skimmer is normally used to skim oil from the surface of water.

The skimmer or extractor is placed at or near the slurry-froth interface where there is a higher concentration of valuable mineral particles. The authors explain that "with assistance of hydrocyclones, it is possible to classify the extracted particles into coarse and fine particle streams that can be handled separately. It also allows the coarser solids to be separated from entrained low-value fines. The first test results with the SFR system significantly improved both coarse and fine particle recovery in a flotation cell.

"The SFR system was tested in the flotation circuit at a copper-molybdenum concentrator, and the results show that the use of the skimmer has huge potential to increase the froth recovery (RF) of both molybdenum and copper."

For the SFR assembly, an extraction device catches the froth from an opening on the top of the skimmer. A pump is used to extract the froth out of the cell and then either reports to the

peripheral launder together with regular froth or to a hydrocyclone.

"The SFR pilot system was able to handle slurry volumes up to 1.8 m³/h. For these tests just one unit was used and it was not sized for the cell tested, the main purpose of this first phase was to check the potential for the application. In future applications with a well-sized system overall recovery gains would be expected."

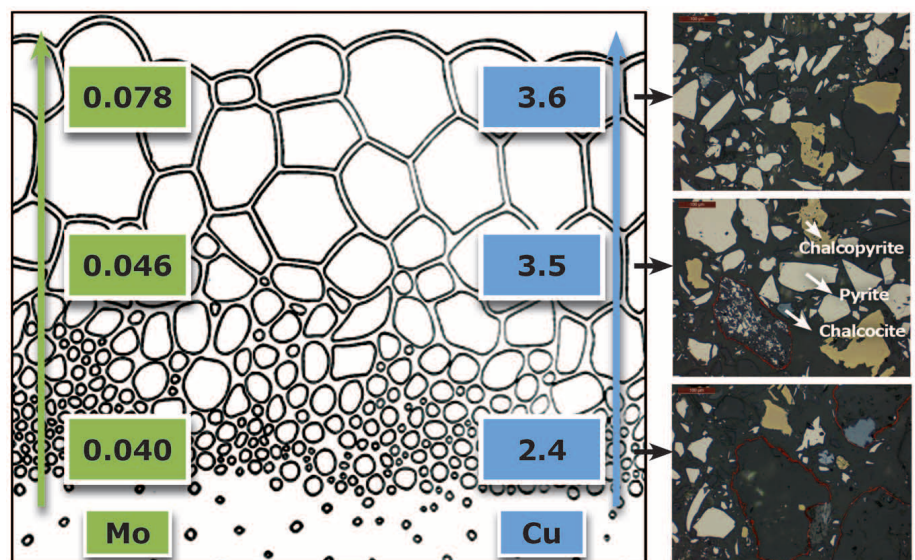
The Skimmer was able to recover coarse particles on the bottom of the froth as hoped. The size distribution curves for copper and moly showed that the skimmer product was coarser than regular froth. Hydrocyclones can be used to select the coarse particles and return the fine particles back to the circuit.

In this test, the use of the SFR system produced "an increase in the overall single cell recovery of 7% for copper and 38% for moly. For the moly recovery by fraction, the recovery increased for all the size fractions.

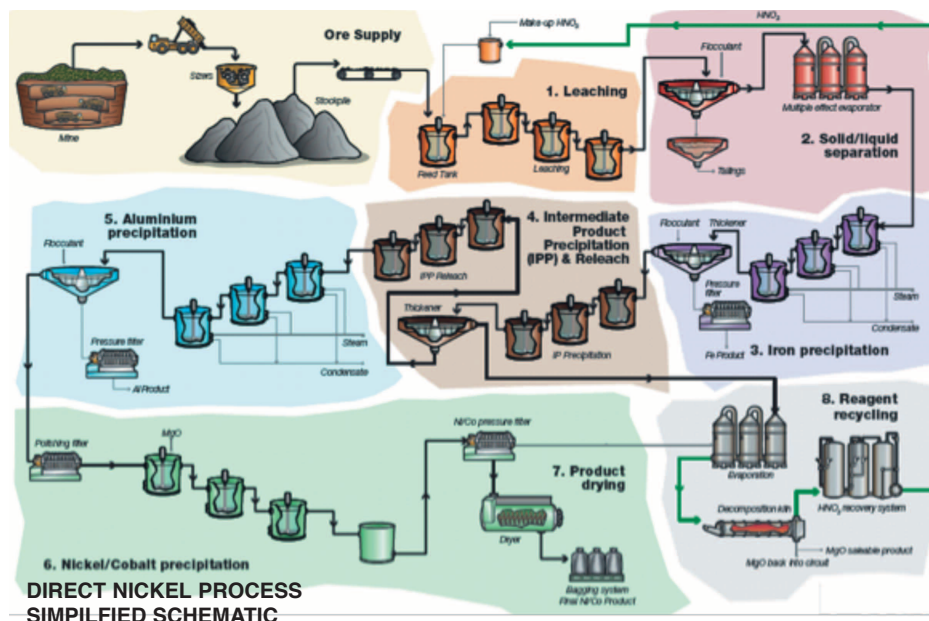
"The position where the froth is caught is very important. There is a variation in the copper and moly grades that goes from lower grades on the froth base to higher grades in froth top." Additional will further investigate this.

Using a hydrocyclone to classify the skimmer product froth into a coarse and fine product offers "options in terms of flexibility or improvements in the circuit configuration and possible performance," Silva and Olson suggest. "Based on this, following are some alternatives using the SFR system in the flotation circuit:

- Use separate coarse and fine flotation circuits, where the underflow (UF) goes to the coarse circuit and overflow (OF) to the fine circuit
- Return the OF to the cell and remove just the coarse particles
- Add the OF to the last few scavengers so the



Cu and Mo grades along the froth



finer can help stabilise the weak froth, which can recover more of the slow floating particles.”

This data helps understand the particle profile as it varies with height in the froth and the potential to increase recovery of locked, coarse and slower floating minerals.

Flash smelting has been a very significant technology in copper, and continues to be so. Outotec has been awarded multiple orders, worth a total of €265 million, for technology deliveries to National Iranian Copper Industries Co's (NICICO) copper and molybdenum projects in Iran. Outotec will deliver technology and services to NICICO's Khatoun Abad copper smelter, Miduk copper concentrator expansion, Nowchun copper and molybdenum concentrator and Sarcheshmeh copper concentrator expansion. The scope of delivery includes, for example, engineering, operating licenses for Outotec® Flash Smelting technology, the supervision of detail engineering, supply of proprietary equipment, installation supervision and training services.

Nickel

The Direct Nickel (DNI) Process is a hydrometallurgical process for treating lateritic ore. It is a process capable of treating the full laterite profile, from limonitic to saprolitic ores using a single flowsheet.

Operating and capital costs are claimed by DNI to be less than half those of existing processes because the process does not need high pressures or high temperatures. The minimum threshold plant size is, at 5,000 t/y nickel, “a fraction of the scale competitors must start from,” DNI says.

Its technical partners, Teck Resources and the CSIRO, are worldclass experts in the field and both are positive about the DNI Process.

DNI also reports “the process is most efficient for extracting nickel from laterites and the first to treat both of the layers that comprise a laterite deposit – meaning much better use of the resource. [It] is environmentally friendly because almost all the reagent is captured and recycled.”

DNI also reports:

- “High recoveries of nickel and cobalt from all parts of the orebody
- High recovery of nitric acid leads to low consumption of 20-40 kg/t of nitric acid compared to +500 kg/t of sulphuric acid in the HPAL process where recycle is not possible
- Various marketable products can be made by produced (MHP, MSP, metal) to maximise marketability and revenue
- Valuable co-products are produced and are expected to provide revenue streams but are not critical to the economics of the process
- Maintenance costs are reduced by the low intensity of the process, and the simple

Basic stainless steels (304 and 316) are passivated by nitric acid; hence materials of construction are amenable to ‘welding rod construction’ and therefore quite simple and low cost

materials of construction and straightforward plant layout

- All NOx gases are captured and converted to reusable nitric acid
- Leach residue is mainly silicates with minor residual nitrate content
- Nitrates in residue break down to usable nitrogen for plant growth and return to the natural Nitrogen Cycle
- Production of saleable magnesite solves the magnesium disposal problem experienced by HPAL operations
- The mass of waste residues is less than half that of HPAL processes due to minimal disposal of reagent and neutralising agents – and production of saleable co-products. This is a major advantage in high-rainfall tropical environments.”

The first DNI project is underway. The coastal foothills of Papua New Guinea are the setting of the Mambare Nickel Project (MNP) which lies on a very large plateau on a low range immediately adjoining the northern coastal plain. The site offers good infrastructure with the port of Oro Bay lying 125 km by road (83 km direct) from the MNP.

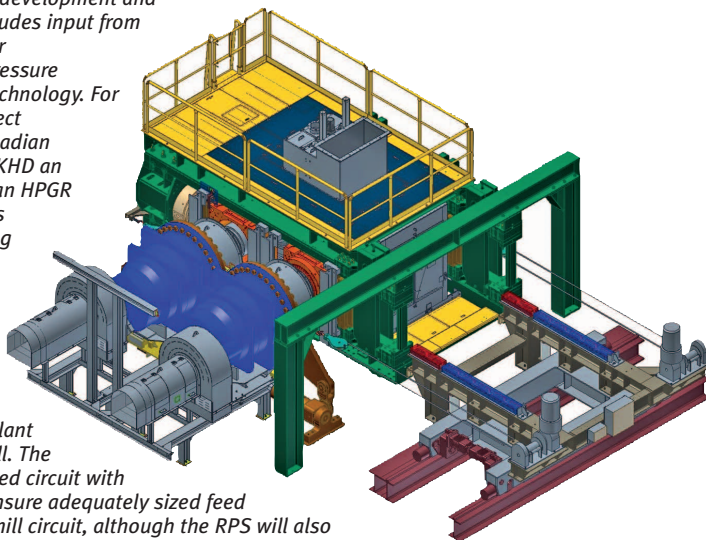
In June 2012, the MNP Joint Venture, (50:50 DNI: Regency Mines) announced an update to its maiden JORC resource, which had nearly 1 Mt of contained nickel, and is now over 1.5 Mt. An expanded drilling program is likely to identify more profitable high-grade ore to support the first decade of mining.

Total Indicated and Inferred Resource is 163 Mt at 0.94% Ni and 0.09% Co, using a 0.6% Ni cutoff. There is huge potential as only 3% of the 80 km² plateau has been explored to date.

Mambare Camp at sunrise in 2011



Next months's Process development and plant design article includes input from Weir Minerals on further development of High Pressure Grinding Roll (HPGR) technology. For the Nunavik nickel project (Northern Quebec), Canadian Royalties has awarded KHD an order for the supply of an HPGR size RPS 7-120/63 for its copper/nickel processing and treatment facilities. With its introduction, KHD's Roller Press (RPS) will increase the plant's grinding capacity by pre-grinding the ore between the crushing plant and the primary ball mill. The RPS will operate in closed circuit with a vibrating screen, to ensure adequately sized feed is provided to the ball mill circuit, although the RPS will also generate a portion of the finished product



Mambare Project Manager, Ian Warden, commented: "The increased Mineral Resource Estimate and the recent construction completion of Direct Nickel's Stage 1 Test Plant in Perth, which will test a bulk sample from Mambare, are important milestones on the path to bringing Mambare towards development."

DNI says the "with the confidence of the maiden JORC resource, plans for a sustained program over the coming years will test the extent of this great plateau deposit which has potential for up to a billion tonnes of mineralisation."

Neomet Technologies' process for nickel laterite ore converts a very high percentage of what might become tailings into marketable byproducts, such as iron ore, magnesia, and alumina, while at the same time rendering that which remains, inert. The company has published information showing:

- Metal Recoveries at > 95%
- Low capital and operating costs
- Low in volume, inert tailings
- Zero atmospheric emissions
- Zero chemical waste

- Faster permitting
- Low energy consumption
- Simple design and easy automation
- Suitable for plants of any scale
- Can treat low-grade ores profitably.

The process offers high flexibility, suitable to treat all laterite profiles economically, either separately or together (limonite, saprolite and intermediate horizons. It will recover secondary metals, including cobalt, as metal or oxide, iron as high purity, crystalline hematite, magnesium as oxide and aluminium as chloride or oxide. A further advantage of the Neomet flowsheet is that minor, rare metals such as scandium can easily be recovered.

Metals Finance Ltd (MFC) has created Nickel Developments to focus on securing a development position in the expected new wave of nickel developments, targeting the two-thirds of the world's nickel reserves that sit in laterite orebodies. Nickel Developments says it has "a portfolio of advanced projects which are capable of sustaining a long term development program, supported by:

- The lower cost nickel laterite flow sheet developed by MFC
- The capability of producing a high grade LME product from nickel laterite
- The key relationship developed with Dow Chemical
- The achievement of permitting of the Lucky Break project in Queensland, Australia
- Extensive in field testing at a purpose-built pilot plant
- The solid and accelerated progress being achieved on the Barnes Hill project in Tasmania
- The relationship established by Proto with Caterpillar Finance on the Barnes Hill project."

Detailed studies on the Barnes Hill nickel laterite project were continuing, with a view to completion of the DFS by Q3 2012. The release of an update study in June confirmed an annual production capacity of 4,100 t of nickel and 200 t of cobalt and that the Barnes Hill project was "robust even under adverse global nickel prices." The capital cost is projected at A\$70 million at this throughput, which has been achieved by identifying nearby infrastructure that can offset capital spend.

Both environmental and operating permits have now been received for the Lucky Break project. A consulting and supply agreement has been entered into with The Dow Chemical Co. As well as supporting the Lucky Break project as a commercial operation, the project will be used as the base for identifying process improvements which may be applicable to the treatment of nickel laterite projects on a global basis – the benefits of which will be available for



"DON'T WASTE ROCKS!"



Come and see us:
Electra Mining
Johannesburg, South Africa
10-14 September 2012
Stand 8D18

Don't waste time:
www.tomrasorting.com

How about putting **less effort and energy** into your process and at the same time **increase your output?**

Find out how TOMRA's sensor-based sorting systems will get you ahead of your competitors.



sensor-based ore sorting



Dr Bryn Harris (left), Neomet's Chief Science Officer, says "the Neomet Process works on all ore types, and does not have the large volumes of iron sludge to dispose of that other processes have. Neomet has run a variety of ores through our continuous mini plant, and currently we are in the process of building a larger version of our proprietary hydrochloric acid regeneration process, so that it is somewhat more than just a laboratory curiosity

use on the company's other nickel laterite projects, including Barnes Hill and Homeville.

Lucky Break is to be fast tracked, with significant related works and engineering having already been completed.

The company has also commenced studies on the Homeville project in New South Wales (NSW) in Australia.

As part of the agreement with Dow, Dow will provide expertise, technical and process engineering support for the use of its Ion Exchange Resin (IER) PLS separations technology at Lucky Break. The program may also be extended to other MFC lateritic nickel projects, including the Barnes Hill project in Tasmania.

MFC's Managing Director Tony Treasure said: "We understand the significant cost benefits that can be achieved by using Dow's IER technology compared with other traditional means of metal recovery. The technology is a key component in the flowsheet approach being taken by MFC to develop Lucky Break."

Ion exchange is the reversible interchange of ions between a solid (the IER) and a liquid. Dow says that "since they act as 'chemical sponges', IERs are ideally suited for effective removal of contaminants from water and other liquids. DOWEX™ and AMBERJET™ are among the world's leading brands of ion exchange resin

Dow chelating resins are well suited for recovering nickel from very acidic process streams. The company says it has "the widest range of worldclass IERs to meet separation requirements. Ion Exchange Resins, membrane and processing technologies from Dow Water & Process Solutions facilitate the reuse of water in mining and metallurgy."

Jervois Mining has spent some years on the Young nickel/cobalt laterite project (a resource of 92.5Mt at 0.8% Ni and 0.06% Co above a cutoff of 0.6% Ni) in NSW. Over this time it has investigated a number of process methods. The deposit is in a Tertiary-aged laterite typically comprising hematitic clay and limonitic clay overlying saprolite, which in turn overlies a weathered serpentinite unit. Scandium is concentrated in the upper layers, followed by cobalt enrichment within limonitic clay and saprolite, and then nickel enrichment within the saprolite and weathered serpentinite.

Metallurgical test work was initially based on High Pressure Acid Leach (HPAL) technology and using sulphuric acid yielded better than average recoveries for nickel and cobalt. However the company was very aware of well documented production difficulties with this process in Western Australia.

Jervois then tested a non-pressurised sulphuric acid leach process in Reno, Nevada. "This process worked for saprolite type resources but was of

HSS CUT ZONE – Precise Cuts, Better Samples!



Product
SUPPORT
★★★★★
Customer
SERVICE

Our Cut Zone System is easily integrated into any cross-belt sampler installation to improve sample collection accuracy. It can also be used to prevent fugitive material from escaping in load zone applications.

- Custom engineered for any application
- Designed to integrate with any idler

For new or existing system installation,
call our experienced design engineers at
814-695-9807

 **McLanahan**
SAMPLING SYSTEMS

Email: sales@mcclanahan.com
mcclanahan.com



limited effect on limonite/haematite resources. The process was therefore deemed too selective and in any event, the pelletising process needed prior to treatment was not consistent.”

The search for a process solution then moved to an Atmospheric Chloride Leach Process (ACLP) using hydrochloric acid (HCl). During 2004 this new process was applied to a sample with considerable success for all three lithologies tested, i.e. haematite, limonite and saprolite. More exhaustive work at Metcon Laboratories tested both agitation leaching using HCl in magnesium chloride brine, and a heap leach approach using HCl and a polymer binder. A possible extra benefit from the use of

chloride chemistry could be that, apart from nickel and cobalt recovery, by-product scandium, pure iron ore and pure magnesite (Mgo) may be recoverable.

Jervois explains that leaching of Ni/Co laterites using HCl in magnesium chloride brine is known to be effective with excellent recoveries (i.e. greater than 90%) for both nickel and cobalt. However the cost of HCl is a disadvantage, as is the amount of acid necessary to dissolve the nickel bearing minerals to release nickel. As a consequence the re-generation of the HCl is an essential step.

“Test work in Australia and Canada suggests that a breakthrough in the iron hydrolysis

Mindoro is working on the very large Agata laterite deposit and is proposing an ore treatment plant that includes separate circuits to treat crushed limonite and crushed saprolite ores. Ore is slurried with sea water to minimise fresh water consumption and improve the leaching chemistry. The limonite ore preparation circuit produces fully de-agglomerated limonite slurry for HPAL and the saprolite circuit produces three types of ground saprolite slurry for HPAL, atmospheric leaching (AL) and saprolite neutralisation (SN)

processing step is potentially in sight. Batch hydrolysis tests in a local laboratory appear to have obtained up to 95% ferric chloride hydrolysis conversion to hematite and produced correspondingly high-strength acid for recycle to leach.

“Further lab scale and future mini-plant testing are planned so that Jervois can pursue this highly encouraging development.

“The purpose of the iron hydrolysis and acid recovery step is to convert iron and other by-product metal chlorides in the leach solution to hematite and other by-product metal oxides; whilst producing concentrated HCl for recycling back to the laterite leach step and concentrated low-iron solution for impurity removal and nickel hydroxide/metal production.”

Most recently several 2-kg scale sulphuric acid bake tests were performed in Austpac Resources’ fluidised bed (FB) test rig, in Newcastle, NSW. Improvements were made to

BILFINGER BERGER
Facility Services

DIEMME FILTRATION

GHT 2500 for applications where big is not big enough

GHT 4X4 is the fully integrated pull-to-close filter press specifically designed for mines



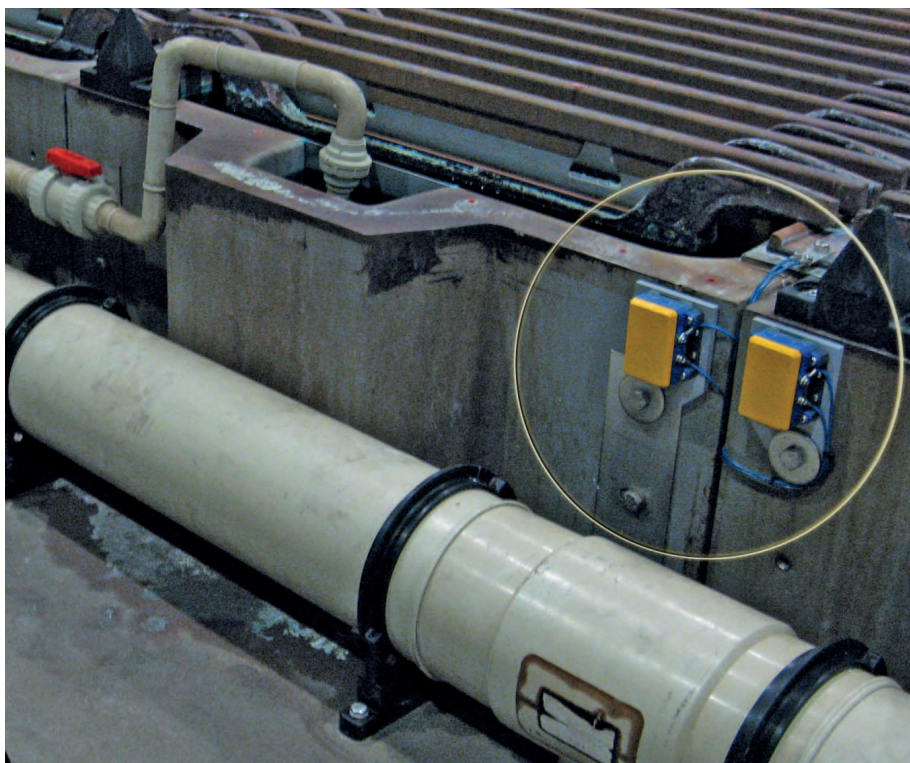
Power

The GHT 4x4 is fully automatic and designed to dewater large volumes of slurry with maximum speed and efficiency

Reliability

Four hydraulic cylinders act on the plate pack to ensure minimal structural stresses, even in the toughest working conditions

Diemme Filtration srl • Via Gessi n.16 • 48022 Lugo • Italy • info@diemmefiltration.com • www.diemmefiltration.com



the FB rig such that the exhaust gas, mainly sulphur dioxide (SO_2), was recirculated to the FB, fortifying with fresh SO_2 gas and converting to sulphur trioxide (SO_3) over a catalyst bed. Jervois reported for the March quarter this year: "The result showed up to 25% improvement in nickel recovery, from 44% (with only acid bake

and leach) to 69% (when acid bake was fortified with SO_3 gas, then leached). Further tests on less refractory Young ores will be performed in future. Based on the significant increase in nickel recovery a provisional patent has been lodged.

"Considering the refractory nature of Young

MIPAC's continuous wireless cell monitoring system, CellView®, is in demand with a second major order recently delivered to a nickel EW plant in Canada. The order is for the installation of a system of 272 voltage and temperature monitors. "This is significant because it is the first time it will be used in a nickel EW application, the order comes from a major EPCM provider and the end user is one of the world's leading mining and mineral processing companies," CellView developer Tony Mathison says.

The monitoring system realises the full potential of a refining or EW operation by detecting changes in a plant and acting as a critical first indicator of process problems including inter-electrode shorts, passivation, poor contacts, reagent control, electrolyte temperature, electrolyte flow and electrolyte contamination issues. "CellView increases production, increases fault detection capabilities in cells, reduces maintenance requirements, minimises point cost and keeps things simple," Mathison says. "It also boosts operator safety and at the same time makes it possible to increase the quality and quantity of output using the same level of input."

Ni/Co laterite, alternative processing options have been considered. The performance of HCl leach has been revisited as some new low cost technologies have been developed in the acid regeneration area. Among them are membrane distillation and Austpac Resources' Enhanced Regeneration System (EARS). These are worthy of consideration. A number of tests are planned to investigate the performance of HCl leach and new acid recycling routes."

qdos30
Metering Pumps

Join the no-valve metering revolution

- No valves, no ancillaries, no vapour lock
- Accurate, linear and repeatable flows
- Up to 5000:1 flow control to 500ml/min at 7 bar
- ReNu pumphead technology: fully sealed for safe, tool-free maintenance

See us at Electra Mining, Hall 6, Stand J16

Watson-Marlow...Innovation in Full Flow



Industrial Process Division
Watson-Marlow MasoSine Bredel

**WATSON
MARLOW**
Watson-Marlow Pumps Group

qdospumps.com
+27 11 796 2960



Autoclave isolation

Pete Smith, the MOGAS General Manager, Perth Service Centre, explains that "autoclave

isolation covers the isolation of autoclaves used in pressure leaching². This is important in HPAL for nickel laterites (250-275°C and 40-50 bar)

A recent application report³ from Applied Rigaku Technologies demonstrates an energy dispersive X-ray fluorescence (EDXRF) method for the determination of atomic elements and oxides in processing steps associated with nickel refining. Analysis of nickel concentrate, filter cake, furnace matte and furnace slag is demonstrated in Application Note #1103². Rigaku's advanced benchtop NEX CG combines indirect excitation, with secondary and polarisation targets and a high-performance silicon drift detector (SDD), to yield optimum performance for elemental analysis of ores. The method presented enables the reliable monitoring of elemental and oxide composition of the ore material throughout the entire processing cycle, including during smelting, as required for optimal process control and profitability. Analytes include: MgO, Al₂O₃, SiO₂, S, CaO, Cr₂O₃, Fe, Co, Ni, Cu, and As. The spectrometer is shown to be an ideal tool for use throughout the quality control process. Furthermore, the it can be used to monitor air filters for air quality emission control while the patented Rigaku UltraCarry sample preparation technique is well-suited for monitoring process effluents to ppb range detection limits



From Slurries to Paste Production, WesTech has the Right Thickener.

WesTech provides real-world solutions for your liquid/solids separation processes. Contact WesTech today to learn more about how our thickening solutions can help you optimize your tailings management.

- **Thickener designs for all applications**
- **Process solutions to meet new environmental standards**
- **Specialized thickeners to maximize water recovery**

Now WesTech offers multiple features in our Thickener Optimization Package (TOP™) such as the new patented EvenFlo™ Feedwell to optimize your thickener.

Contact WesTech to see how the TOP™ options will maximize your thickener performance.



Deep Bed™ Paste Thickener



TitanTraction™ Thickener



HiFlo™ CCD Thickener

and pressure oxidation of sulphide ores – HP & MP-POx (Au, Cu, Ni, U, Zn, Mo) – 180-225°C and 20-30 bar.

"Autoclave Isolation of these processes involves isolating the following severe service conditions:

- High temperature
- High pressure
- Corrosive (acidic, hyper-saline chlorides)
- Erosive (abrasive)
- Heavy solids build-up (precipitation of scale)
- Viscous.

"Autoclave Isolation is achieved with the use of severe service, metal seated ball valves. A ball valve can be considered simply as a ball with a hole in it which floats between a pair of seats contained within a body and end connect. The ball & seats are made of the same exotic material as the body and end. [It is] actuated via stem with quarter turn operation

"A severe service, metal seated ball valve used for autoclave Isolation should be considered as a piece of complex machinery consisting of numerous moving parts operating in a challenging environment.

"Autoclave isolation valves are lasting longer and performing better. On the Western Australia nickel laterite projects built during the late 1990s it wasn't uncommon for valves to last just several cycles, with valve life times limited to weeks/months. [These] valves are no longer on the critical path for campaign life with lifetimes of 6 to 12+ months available for the most severe of services and with lifetimes of thousands of cycles for some services.

"Autoclave Isolation ball valves have been tending to get bigger:

- Up to 4-6 in (DN100 – DN150) on the smaller claves

WESTECH
Process Equipment. Process Driven.

Telephone 801.265.1000
www.westech-inc.com
Salt Lake City, Utah, USA

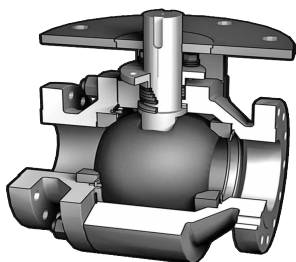


- Up to 8–10 in (DN200 – DN250)
- Up to 12–14 in (DN300 – DN350) on the current generation of valves in start-up
- Up to ...”

All such ball valves should be considered bi-directional. “The primary role of autoclave isolation is to block, or box in, pressure within the autoclave, so allowing operations and maintenance personnel to pause plant operations and to attend to equipment and plant issues without shutting down and starting up from scratch. A secondary role of autoclave isolation is to isolate the line pressure in the inlet, sparge and discharge lines. This line pressure is often higher than autoclave pressure prior to start-up.”

The valves typically have a preferred pressure end which should be orientated towards the line pressure it is intended to isolate.

“Autoclave operations involve cycling or stroking the valves open and closed. A cycle is normally regarded as an open stroke and a close stroke (or vice versa). Ball valves should be cycled regularly to confirm operation, especially in order to break scale. Where cycling of a valve is not desirable due to its impact on production then partial stroking may be used where a fully open valve is stroked 10 to 150 from its fully open position for a short duration (e.g., 5 to 10 seconds) at regular intervals (e.g., daily or weekly).”



Ni plant automation

ABB's System 800xA offers control system solutions within complex nickel mining processes. Widespread market acceptance of System 800xA has developed over recent years, demonstrating this advanced approach to automation across mineral processing, mining and other industry sectors.

Historically, DCS installations are driven to include all automation functions within a single operation and engineering environment. This provides the user with a more usable and informative interface into their processes, eliminating the need for multiple system architectures and unnecessary data.

System 800xA addresses the demanding requirements in nickel processing, including integration of power supply and power distribution systems, energy monitoring and load shedding, interfacing and integration of multi-vendor package solutions, larger and more complex installations, efficient system engineering, industry specific libraries and tools, interfacing to ERP (Enterprise Resource Planning) systems and distribution of enterprise production data to the corporate environment.

In New Caledonia, the limits of the HPAL process, by which minerals are leached from low grade ore using acid leaching and heat, are being challenged at Goro Nickel. This plant uses Vale-Inco's fourth-generation hydrometallurgical techniques to process laterites containing low nickel content at low cost and with minimal environmental impact. At Koniombo, Xstrata SAS's nickel refinery, the more traditional smelting and separation processing method will be used. Both operations are comfortable in the knowledge that the process automation system is functioning as required. **IM**

References

1. Silva R, and Olson T, Selective froth recovery (SFR) system to increase flotation recovery, SME Annual Meeting, Seattle, February 2012.
2. Smith P, A-Z of Autoclave Isolation, ALTA, May 2011
3. Best L, Ahrens M and Dos Santos M, Integrated control systems in nickel mining, New Caledonia Nickel Conference, November 2010
4. A copy may be requested at: http://www.rigakuedxrf.com/edxrf/app-notes.html?id=1103_AppNote

Customized Ion Exchange Resins for Hydrometallurgy

Highly selective ion exchange resins to improve recovery of valuable and contaminant metal

Uniform particle size (UPS) perfect for processing of clean solutions

Course particle size resins designed especially for sorption from pulps (RIP)

Effective in the remediation of tails and recycling of mine waters

Proven applications in Gold, Rhenium, Uranium, Copper, Nickel, Mercury, Iron control and other base and rare earth metals.

Need effective removal/recovery of low level metals?

Just ask Purolite.

PUROLITE
ION EXCHANGE RESINS



Download our Free Ion Exchange App. It contains useful conversion factors, resources and more. For more information please visit www.purolite.com, email info@puroliteusa.com, or call +1 610 668 9090