



Measurement, Punishment, and Red Wine

Good engineers need to be punished, and they know it. Their job is to relentlessly improve the efficiency of operations – to collect and act on the right numbers, not the popular numbers. But this often conflicts with organisation structure and kpi's. Accounting systems don't cope well with mineralogical variability and measurement uncertainty. So our kpi's are set on the things we can measure. As a result our organisations miss huge efficiency gains because we don't optimise things that are hard to measure. We have all heard of the miner who chased tonnes at the expense of ore quality. Or the mill manager rewarded for recovery, but penalised for increasing unit cost to increase concentrate grade – even though 1 kW to remove an impurity in the mill can save 10 kW in smelting. We know this, but our kpi's don't. Our search for efficiency can be lonely, poorly rewarded, and often punished.

But before we blame the organisation, process engineers need to look at what we can influence. Sadly, our record isn't perfect either. For example, we studied the energy efficiency of regrinding in concentrators by an extensive review of independent research, publications and plant data. We compared actual performance with the owner's design and the manufacturer's claims.

To our dismay, most regrind circuits are about half as efficient as design! Worse, the process engineers often don't even know. Everyone knows if primary grinding isn't performing because we don't get the tonnes. But regrinding is hard to measure – so often we simply don't measure it. Even when we do collect the data – feed and product size distribution, feed tonnage, gross and net energy consumption – we rarely compare it with design. Because the engineers who operate the circuit aren't the engineers who designed the circuit, it is very rare to 'close the loop' with design. Since we don't learn that the scale-up method was wrong we keep making the same mistake.

At Xstrata Technology, we make it our business to get our numbers right. Often we lose jobs because our numbers 'sound too high', but we are proud of our accurate scale up record, and we always 'close the loop'.

So here's a challenge. Measure the actual energy efficiency of your plant regrinding circuit and compare it with design. If it matches manufacturer's design – what the heck, if it is within 75% of their design – I will buy you a bottle of good red wine! You can contact me at: jpease@xstratatech.com

Joe Pease, Chief Executive, Xstrata Technology

IsaMills™ at Waterval Retrofit Upgrade Project

One of the biggest projects the IsaMill™ team worked on during 2009 was Anglo Platinum's Waterval Retrofit upgrade project, that uses 5 x M10,000 IsaMills™ to treat various streams in the concentrator to improve PGM recovery and grade. The mills are powered by 3MW (4000 hp) motors, and use ceramic media to improve downstream flotation performance. The mills were commissioned in July and September 2009 by XT teams working together with Anglo Platinum staff.

Four of the mills are located in 2 modules on mainstream inert grinding (MIG), a coarse grinding application treating rougher tails at F80 size of 75 microns. The other mill is used for regrinding of combined intermediate concentrate streams from F80 of 40 to 45 microns to product size of 20 microns before final cleaning.



Jameson Cell Applications – Its not just Coal and Copper

Jameson Cell technology is playing an important role in new Potash and Phosphate projects around the world. The high demand for good quality fertilizers is putting pressure on the industry, with operators turning to lower grade resources with higher impurity levels to meet the demand. In turn, the Jameson cell technology is able to make high quality concentrate grade products and has been selected in flowsheets of new projects. It is also making its way into a number of plant upgrades and expansions.

While Jameson Cells are common in coal and base metal circuits, they are not yet as familiar in the industrial minerals sector. A cell was installed in the UK's only potash operation in 1994 and is still operating after 15 years with minimal maintenance and high availability.

Potash and phosphate plants use flotation in various configurations which are sometimes similar to base metal flotation circuits but can also be very specific to the industry. However, the aim is always the same: to produce final product at high quality and yield in the simplest circuit with the least number of cells. Le Huynh, Senior Process Engineer for Xstrata Technology has been managing a number of potash and phosphate pilot plant projects. Le says the Jameson cell meets these objectives because of its high intensity, consistent generation of small bubbles, froth washing of product and its ability to treat high volumes in a single cell. This means a single Jameson cell can treat high volumes to produce final grade concentrates in a single cell. For example a single Jameson Cell can replace two stages of potash cleaning with multiple banks of mechanicals cells.

Another industry that is adopting the benefits of the Jameson Cell technology is oil sands. This huge industry treats millions of tonnes per year of oil sands to recover crude oil. The extraction process initially uses hot water to separate bitumen from the sand, with flotation of middlings streams. Mechanical cells have been used as the standard technology for several decades but the industry needs more efficient technology with high volume, improved recovery, low wear and low maintenance needs. Jameson Cell pilot plant rigs at various Canadian sites have shown an excellent ability to recover and upgrade bitumen. The small footprint and absence of moving parts means minimal maintenance and spares needs – important in an industry which operates in tough remote locations, with hot pulps in freezing winters. The first full scale Jameson installation in Canadian oil sands has just been commissioned.



Jameson Cell lab scale flotation test of oil sands (top), and phosphate (below)



IsaMills™ in Europe

XT's partner, Netzsch Feinmahltechnik, have provided high quality stirred grinding mills to a wide range of manufacturing applications in Europe for 60 years. The IsaMill™ now follows in these steps with the first M3000 IsaMill™ being recently commissioned at the Neves-Corvo copper zinc mine in Portugal.

The Neves-Corvo mine is situated on the Iberian Pyrite Belt, and is operated by the Lundin Mining Corporation. Copper tailings from an upstream operation are retreated to produce a poly metallic concentrate which is ground in the 1.5 MW (2000 hp) M3000 IsaMill™ before further cleaning. Unlike many of the recent IsaMill™ installations that have been in coarse grinding duties, this mill is in an ultra-fine grinding duty, grinding a 40µm feed stream to 8 µm, to enable sequential flotation of copper and zinc in downstream cleaning.

The ultra fine sizing requires a fine media size for efficient grinding; in this case Magotteaux 2mm Keramax® MT1™ ceramic. As well as high energy efficiency, the inert grinding environment improves downstream sequential flotation, which would be adversely affected by ferric ions released by conventional steel grinding media.

Xstrata Technology provided a packaged solution with the mill, including general layout, design of feed and discharge slurry handling systems, media addition system, installation and commissioning support.

While the Neves-Corvo mill is the first IsaMill™ in Europe, it will soon be joined by other sites. This includes European Goldfields Limited Certej project using a 3MW (4000 hp) M10,000 IsaMill™ in an Albion Process atmospheric leach circuit treating refractory gold, as well as the Eldorado Gold Tuprag Efemçukuru gold project in western Turkey, installing a 200 kW (260 hp) M500 in another gold application.



BREAKING NEWS

XT has just received an order from Somincor for another IsaMill™, a 500 kW (670 hp) M1000 for a regrind duty in their zinc expansion project.

XT Wins Third Order for Sterlite Site

XT was confirmed as the technology provider of choice when Sterlite Industries (India) Limited, a subsidiary of Vedanta Resources plc, recently selected XT's smelting and tankhouse technologies for its next major copper smelter/refinery upgrade at its Tuticorin site, in southern India. Having worked with Xstrata Technology for over 15 years using ISASMELT™ TSL and ISA PROCESS™ tankhouse technology, Sterlite are now constructing their third ISASMELT™ and ISA PROCESS™ copper facility next to the existing facilities at Tuticorin. These repeat orders confirm the successful application of the technologies at Sterlite, regarded as the one of the worlds lowest cost copper smelting and refining sites.

The new smelter/refinery will produce an additional 400,000 tonnes of copper cathodes per year and will include the world's largest TSL smelter. Xstrata Technology will provide a technology licence, engineering design services, proprietary equipment and commissioning services.

The Sterlite metallurgical complex, situated in Tamil Nadu state at the southern tip of India, started operations with its first ISASMELT™ in 1996. This furnace was designed to treat 450,000 tonnes of concentrate. Its success led to a second plant commissioned in 2005 to treat 1,300,000 tonnes of concentrate, in an operation regarded as one of the most cost efficient in the world. The combination of Sterlite's business and operating expertise with



XT's technology and support has enabled Sterlite to grow from a new copper producer 10 years ago to a major producer today. The XT technology package assists in fast start up times and low cost operations through its emphasis on the entire package, including design of ancillary equipment, gas handling, refractories, process control, operating techniques, on-plant training, technology transfer and extensive commissioning assistance.

The Sterlite upgrade is planned for start up in 2012.

The ISASMELT™ TSL – Blast Furnace Process A Cleaner Way to Produce Lead

The lead smelting industry needs to meet the challenge for cleaner lead production and improved energy efficiency. Fortunately new proven technologies are available to meet these needs. Often the best innovations result from combining old proven ideas with modern developments, and this has occurred with the combined ISASMELT™ TSL – Blast Furnace Process for lead bullion production. This flowsheet combines the advantages of top submerged lance technology for oxidation with the fuel efficiency of counter-current reduction in blast furnace technology.

The latest project to adopt this flowsheet is the Huize project, a 'green-field' smelter in Yunnan Province in China which will treat lead concentrate and zinc leach plant residues. The smelter will be operated by Yunnan Chihong Zn and Ge Co. Ltd, a subsidiary of Yunnan Metallurgical Group (YMG). YMG first partnered with Xstrata Technology to install this flowsheet at YMG's Chihong's Qujing smelter in Yunnan Province, which has been successfully operating for over 4 years. XT is also working with Kazzinc to install the combined ISASMELT™ TSL-Blast Furnace Process in their operations in Ust-Kamenogorsk, Kazakhstan.

XT's pyrometallurgy General Manager, Philip Arthur, explains that the combination of new with traditional technologies provides the most efficient flowsheet. The high intensity and mixing in an ISASMELT™ TSL is ideal for rapid oxidation of feed. Using oxygen enriched air in a small stationary furnace produces a low volume of high strength gas ideal for acid production, with low fugitive emissions and dust generation. Further, the TSL stage typically places 30 to 70% (depending on feed grade) of the lead and most of the precious metals direct into bullion. The remaining metals report

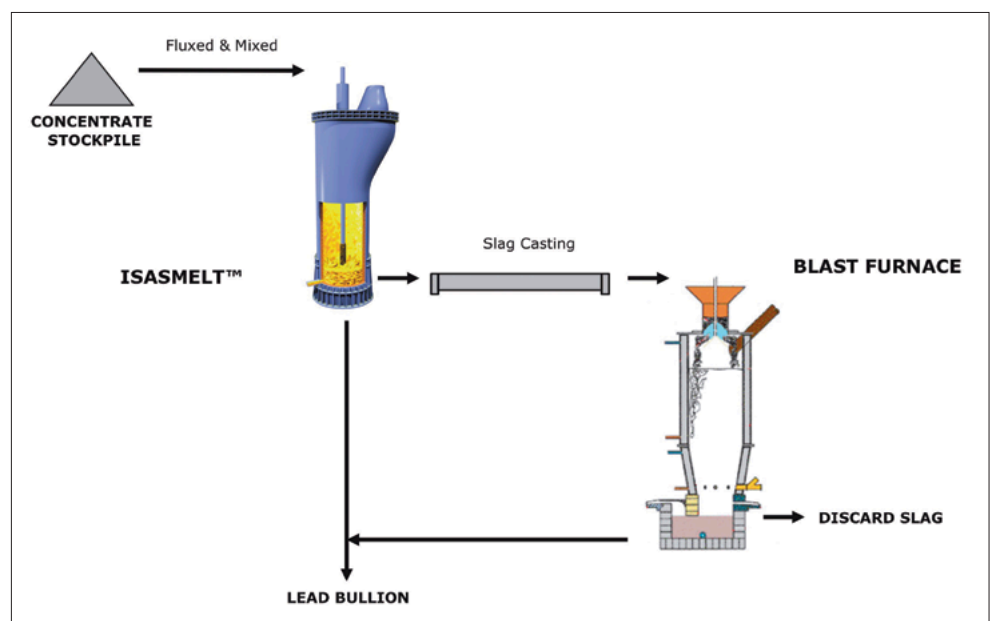
to a high-lead slag which is tapped and cast to feed a modified blast furnace. The high-lead slag consists of a lead silicate matrix with crystals of zinc ferrite, which creates a protective lining of the ISASMELT™ lance and refractories resulting in long campaign life. While the TSL is highly efficient for oxidation, a blast furnace is ideal for reduction because of the counter-current flows of gases and feed – the final bullion is contacted by the most reducing gases, and depleted fuel heats the charge and initiates reduction at the top of the shaft. These effects can't be replicated in a bath furnace.

The breakthrough was the discovery that 'glassy' slag performs well in a (modified) blast furnace. This is in contrast to the conventional understanding that a porous sinter structure was required for blast furnace feed. Field work at both YMG and theoretical and laboratory studies at the University of Queensland showed that a cast lead slag performs well in blast furnaces. Limestone is added direct to the blast furnace rather than through sinter. The high degree of control over ISASMELT™ and slag casting means slag with a consistent quality and feed size is added to the blast furnace, eliminating the biggest source of variability in blast furnace feed. Unlike sinter, the cast slag can be stockpiled with minimal degradation. Combined with the high strength gases, low fugitive emissions, elimination of high sinter plant recycles, and reduction in blast furnace energy due to direct bullion production in ISASMELT™, it is easy to see how this combination of technologies results in a major reduction in emissions and increase in efficiency.

The Huize lead smelter will start up in 2011, and will be the third smelter using this process, joining YMG's Qujing and Kazzinc's Ust-Kamenogorsk smelter, all provided by XT.



YMG's Chihong's Qujing smelter in Yunnan Province, China



ISASMELT™ TSL – Blast Furnace Process

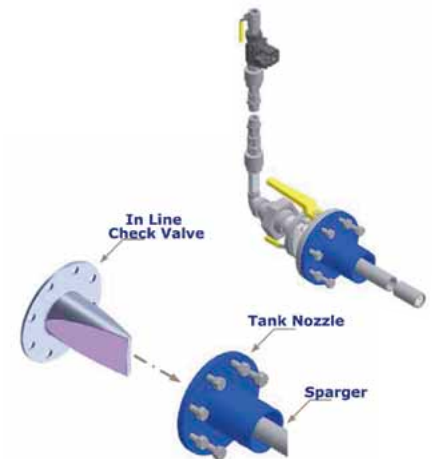
HyperSparge™ The New Generation in Sparging

Xstrata Technology has developed and successfully trialed a new gas sparging technology that improves the efficiency of air or oxygen injection into reaction vessels. Originally developed for the Albion Process, it is well suited for other mineral processing duties, leaching processes and other industrial duties.

The HyperSparge™ system allows for increased reaction rates and reduced reagent consumptions when compared with conventional sparging systems. Safety is central to the design of the HyperSparge™, with all materials fully compatible with oxygen injection. The system is designed with fail-safe protection to allow live insertion and removal of the sparger from the process vessel without any downtime.

The key to the technology is the injection of oxygen into slurries or solutions at supersonic velocities. This results in regions of very high local shear and when combined with the fine mist of bubbles generated by the sparger, provides the most efficient method of transfer of oxygen into the slurry phase.

The HyperSparge™ incorporates a hard wearing ceramic nozzle to accelerate the gas stream and maximise turbulence at the injection point. The sparger is designed for easy maintenance, and can be inserted into the side of the reactor without the need for internal supports, simplifying reaction vessel construction. Sealing of the sparger around the insertion point is achieved through a robust system incorporating a non return valve, block and bleed and dual seals.



HyperSparge™ can be used in a wide range of applications, including:

- Oxidative leaching of sulphide ores
- CIP/CIL processing of gold ores
- Pre-aeration of flotation pulps
- Wastewater treatment
- Reagent preparation
- Fermentation
- Pharmaceutical and Chemical production

Introducing ZipaTank™ – Modular Slurry Tank System

The ZipaTank™ is an innovative, fully modular, storage tank for slurry applications, using a novel locking mechanism to provide water tight sealing of pre-fabricated vertical panels, eliminating the need for welding or bolting to assemble the tank panel walls.

The ZipaTank™ system can reduce the capital cost of conventional welded slurry tanks by up to 35%, with installation of large ZipaTanks™ being 1 – 2 weeks compared with upwards of 6 weeks for welded tanks. The system is also very simple to use, with no welding required in the construction of the tank, so minimal skilled labour is required.

The ZipaTank™ consists of vertical panels that are locked together to form the tank shell using a compression joint. The cylinder is then bolted to the base. Each vertical panel is manufactured from a single cold rolled section of mild or alloy steel to the total height of the tank. The width of the panel is rolled to match the tank diameter, with all panels designed to fit in a standard shipping container, reducing the transport costs to site.

The key to joining the panels together is the proprietary Joinlox™ joining system, which consists of two interlocking sinusoidal sections fabricated on each edge of the tank panel, which are brought together and then locked with a tensioning key, resulting in a spring-loaded joint. As the tensioning key is pushed into place, it wedges the two panels together and locks the joint. The mating surfaces of the joint are rubber lined, providing a water tight seal between the panels. This enables high quality lining systems to be applied to the panels under controlled factory conditions, eliminating any need to line at site. This reduces the cost of the lining, and allows lower cost lined panels to be used in the place of more expensive alloy steels. A large range of rubber and GRP/FRP lining systems can be used.

The ZipaTank™ can be used for a wide range of applications, such as storing concentrates, reagents, repulping and conditioning duties, flotation tanks, thickeners and clarifiers as well as all types of leaching applications.

ZipaTank™





Jameson Cell 20 Year Anniversary Dinner – Guest of Honour, Professor Jameson centre, alongside Dr Emmy Manlapig – JKMRRC (left), and Rakan Rahbani – Xstrata Technology (right)

20 Years of Jameson Cells and Still Getting Stronger

2009 marked the 20 year anniversary since the Jameson Cell was first developed by Professor Graeme Jameson of the University of Newcastle. What started as a simple idea for the fast flotation of fine particles without the need for blowers and compressors, has resulted in a robust flotation technology, with nearly 300 Jameson Cells installed in base metals, coal, solvent extraction, oil sands and industrial mineral applications.

In late November, a Celebratory Dinner was held in Brisbane, with many of the people involved in the development and the commercialisation of the technology attending. Professor Jameson was the Guest of Honour and he entertained the crowd describing the inspiration for the technology, his travels to mines world wide, and his use of perspex models to perfect the downcomer before the first prototype cells were tested in the lead zinc concentrator at Mount Isa.

Steve Smith, Global Marketing Manager for Mineral Processing at Xstrata Technology said the ongoing development of Jameson Cell technology was impressive. Having started in base metals,

it established a strong reputation in coal, all the time improving the robustness and operability of materials and designs. The current 'Mark IV' Cell represents the state-of-the-art, combining enhancements from many different applications, in coal, base metals, organic solvents, flash flotation, cleaning and preflotation. The modern cells are virtually maintenance-free and extremely robust to operate. As a result, the new Jameson Cell is making a 'comeback' in base metals, often in combination with conventional cells. They are being adopted in new applications like oil sands, potash and phosphate which treat high volumes and need froth washing to produce high grade concentrate.

A highlight of the dinner was when Joe Pease, CEO of Xstrata Technology awarded Professor Jameson a watch to celebrate the milestone. Joe said the range of people who travelled to attend the dinner – early developers, operators, researchers, design engineers and process experts – demonstrated both the high regard for Professor Jameson, and the diverse effort required to make a new technology successful over the long term.

CIM Distinguished Service Award

Greg Rasmussen, Principal Metallurgist with the Mineral Processing group, based in XT's Vancouver office, has won the esteemed Canadian Institute of Mining, Metallurgy and Petroleum (CIM) Distinguished Service Award for British Columbia and Yukon Territories for 2010. This prestigious Canadian award recognises CIM members who have greatly contributed to the development

of the mining industry and the CIM at their local branch level. Greg will be presented this award at the CIM Annual Awards Gala in Vancouver this year.

Greg, along with the rest of the Canadian team, have been instrumental in establishing XT's Vancouver office and have generated a lot of interest and business for IsaMill™ and Jameson Cell technology in the Americas, including the recent order for 3 x M1000 IsaMills™ with complete grinding plant circuit design and supply for Endako Molybdenum Project in British Columbia, Canada.

Robotics – New Developments in Copper Stripping Technology

The ISA 2000 refining technology has been extremely successful since it was developed in the late 1990's, eliminating the need for wax in electro winning and refining of copper. The ISA Cathode Stripping machine was upgraded to handle the two separate copper sheets that were produced. Now the stripping process has been further improved by XT's developmental program to develop a single sheet stripping system using robotics.

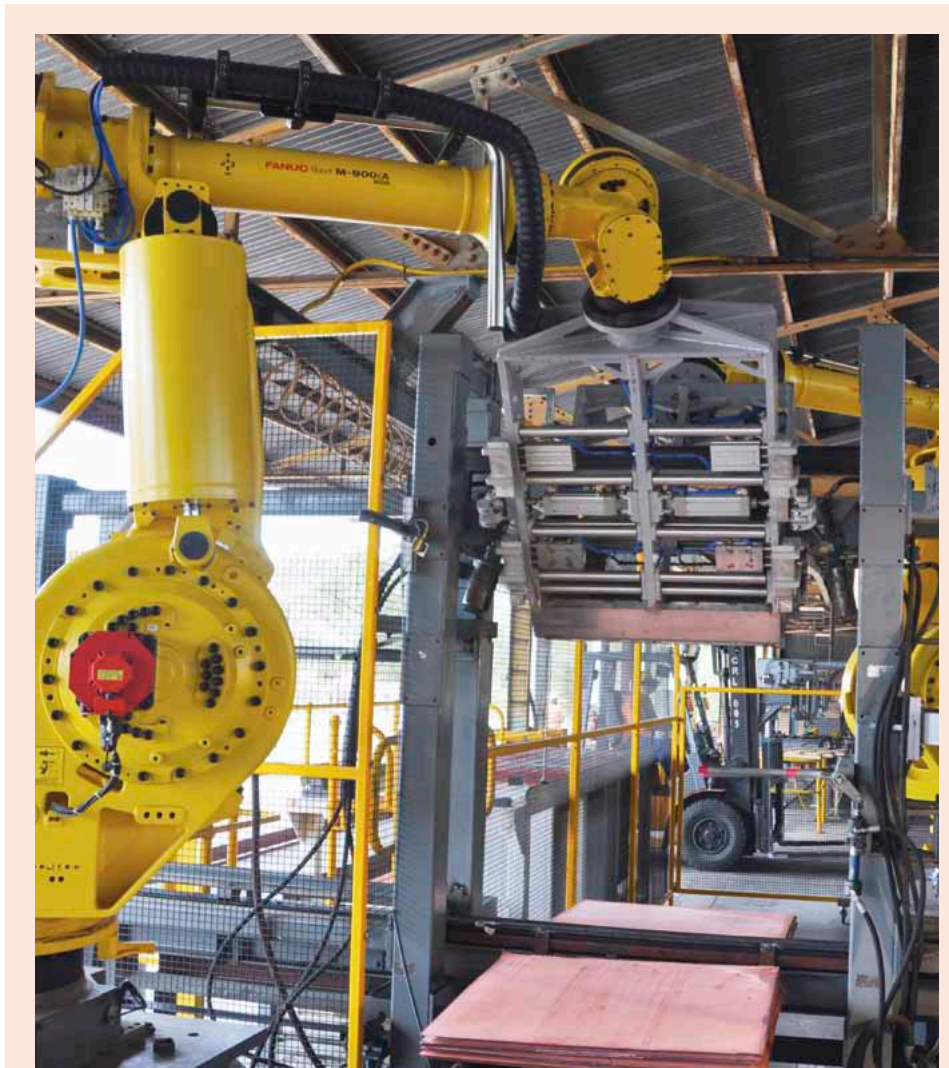
The objective was to overcome one of the biggest disruptions to tankhouse operation, 'laminated' copper deposits. These occur when power outages interrupt current to the electrolytic cells forming irregular copper deposits which are difficult to strip.

XT combined the operational know-how from both the KIDD and ISA PROCESS™ to solve this problem. A fundamentally new stripping concept was developed and a prototype mechanism was tested manually for an extensive period. The final stage in development was to automate the new concept, and robotics proved to be ideal.

Robot technology is not new to Xstrata Technology. The KIDD PROCESS introduced robotics in 2003 for handling copper sheets and cathodes. The machines have demonstrated high reliability and very good operational flexibility. The new XT robot stripping machine extends the use of robotics from material handling to the stripping function as well. A prototype has been installed at the CRL refinery in Townsville with excellent results. The challenge for XT's engineers and robotics suppliers was to develop and program robots to accommodate the many and varied forms of copper cathode that can be expected in tankhouse operations. As any operator knows, it isn't the 'average' cathode that determines the stripping rate, it is the rare 'problem' that needs to be handled efficiently.

Machine concept:

The new machine combines the successful functions of existing XT machines with new features to improve stripping. Flexing rams are still used to release the copper deposits from the stainless steel cathode, but now a 'pre opening' device is used to ensure



The prototype Robotic Stripping Machine in action using the new wedge tool developed for efficient stripping without damaging the stainless steel cathode

separation of the copper and the mother blank. The stripping function is now performed by robots designed with a proprietary wedge tool at the end of the robot arm. The wedge tool has been designed to slide between the released copper deposit and the mother blank to prevent scratching of the stainless steel mother plate, and then 'down ends' the copper to produce individual sheets of copper. This combination greatly improves splitting and separation with minimal deformation of copper sheets, even where lamination has occurred.

The prototype continues to be used at CRL in Townsville, especially to strip copper that can not be handled by the conventional down ender stripping machines. The new robotic stripping technology is efficient, reliable and robust, and can be designed for low and high capacity automatic operation.

Upcoming Tankhouse Technology Users Conference

Tankhouse Technology will be hosting its biennial Users Conference in San Pedro de Atacama in the north of Chile, in November 2010. The theme of the conference will be 'The Next Generation of Copper Refining with Xstrata Technology'.

San Pedro de Atacama is located in the 2nd region of Chile, in the most arid desert in the world, the Atacama Desert, which boast some of the most impressive scenery in Chile

Invitees to the Users Conference will participate in 3 days of formal presentation sessions, informal technical discussions and a day for tours to nearby copper operations. Also scheduled for the conference will be scenic tours including archaeological sites, sand boarding and horseback riding, as well as the farewell dinner planned at the end of the conference hosted under the Atacama stars – some of the best in the world!



Contacts for IsaMill™ Testwork

G&T Metallurgical Services <i>Canada</i>	www.gtmet.com
SGS Lakefield <i>Canada and Chile</i>	www.met.sgs.com
JKTech <i>Australia</i>	www.jktech.com.au
Ammtec <i>Australia</i>	www.ammtec.com.au
HRLtesting <i>Australia</i>	www.hrltesting.com
CSIRO <i>Australia</i>	www.csiro.com

Contacts for Jameson Cell Testwork

Xstrata Technology – jamesoncell@xstratatech.com.au

Contacts for Albion Process Testwork

HRLtesting – www.hrltesting.com

TMS Award Success for Stanko Nikolic



Dr. Stanko Nikolic joined the XT team in 2008, after submitting his Ph.D. thesis at the University of Queensland (UQ). His thesis was part of an XT sponsored co-operative research project that was investigating slag systems for use in the copper ISACONVERT™ process. At the start of 2008 a series of Stanko's papers were published in Metallurgical Transactions B, entitled:

'Phase Equilibria in Ferrous Calcium Silicate Slags, Parts I-IV'. These were co-authored with UQ researchers Prof. Peter C. Hayes, Dr. Hector Henao, and Prof. Evgueni Jak. This series of papers led to Stanko and his co-authors being awarded the TMS 2010 EXTRACTION & PROCESSING SCIENCE AWARD (www.tms.org/society/Honors/EPDScience.html)

The TMS, The Minerals, Metals and Materials Society, is an

international society, based in the USA, and promotes the advancement of materials and engineering, from minerals processing and primary metals production to basic research and the advanced applications of materials. Each year the TMS organizes a series of awards and honours, awarding those related papers which it believes represent a notable contribution to the scientific understanding of extraction and processing metallurgy.

This series of papers, and a second series recently published, have direct relevance to the copper converting industry, and in particular, to the copper ISACONVERT™ process. The research as a whole mapped out previously unknown areas of the two continuous converting phase diagrams and characterized the effects of temperature, oxygen content and silica on the system. It has allowed XT to better understand the relationship between product blister copper quality and copper in slag, as well as identify how the operating window of the ISACONVERT™ process is altered at different conditions.

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