CASE STUDY: WAMBO BACKFILL PLANT

Mobile backfill plant for Wambo provides cost effective yet flexible solution ...

To manage this risk Peabody engaged Outotec to refill the “board and pillar” workings. These workings consisted of approximately 15km of largely horizontal roadway over a 3 hectare area, with a total volume of approximately 250,000m³.

Scope
The scope of Outotec’s materials management team was to develop a reliable, cost effective strategy that would deliver fill with adequate properties for maintaining stability during undermining.

Background
Peabody’s Wambo coal mine, in NSW, Australia, includes a longwall mining operation in the “Wambo” seam at a depth of 70-100m. Some sections of the Wambo longwall operation are overlaid by historic “board and pillar” workings. These workings exist approximately 40-50m above the Wambo longwall operation. During historic mining of the “board and pillar” workings, problematic ground conditions were encountered and Peabody identified a risk of sinkhole formation during underlaying longwall extraction. Sinkhole formation was considered to pose a considerable risk to both underground mining operations and the sustainability of an environmentally important alluvial channel that ran across the surface.

Mobile paste plant in operation.
Outotec was tasked by Peabody with delivery of a lumpsum turnkey backfill solution for Wambo. To address this:

- Outotec worked closely with Peabody’s rock mechanics consultants to derive the mechanical resistance required.
- Outotec undertook extensive laboratory studies to ensure that the requirements were satisfied.
- Outotec developed a flexible backfill operating strategy to ensure the fill was placed most cost effectively even when the feed source varied.

Cost effective material selection

Various materials were analysed in a comprehensive testwork programme. These included mine rejects (with high clay content), very fine crushed sandstone and natural alluvial soils. Based on extensive testwork, it was shown that the natural alluvial soils provided the most cost effective solution for Peabody. However, the problem with adopting this natural material was its highly variable nature. Consequently, in order to utilise this cost effective material source, a flexible fill and mix design strategy was required.

Flexible paste solution

To assess the fill flow properties, rheological testing was carried out on alluvial soil samples from the different locations across the available borrow pit area. These results showed highly variable rheological characteristics, indicating that maintaining consistent rheological properties during operation would be challenging. Furthermore, flowability was shown to be highly sensitive to changes in solids content.

Based on the perceived difficulty in maintaining consistent rheological properties and the likelihood of significant coarse aggregate content, control of hydraulic delivery system (positive displacement pumping) from a fixed plant location was considered unmanageable. The only sustainable solution for this project was a mobile paste plant that could be placed directly above each borehole when filling.

To enable drilling of the fill holes, a roadway grid was required directly above the workings. This would allow the mobile paste plant, a twin-trailer, to move around the grid safely and be quickly re-established at each borehole. The plant consisted of a front trailer which housed the tailings feed hopper, main conveyor system with weightometer, mixer and hopper; and second trailer containing a generator and cement silo. The mobile paste plant achieved production rates in excess of 150m³ per hour.

Comprehensive testwork programme - Mix design

Outotec implemented a comprehensive testwork programme to ensure a flexible, robust and cost effective fill mix design. A paper “Fill design and implementation with challenging material - Wambo fill project” (Helinski and Revell, 2014), presented at ACG’s MineFill 2014 in Perth, outlines this programme in detail. Testwork undertaken included direct shear and consolidated undrained triaxial testing - on both cemented and uncemented paste. The objective of this work was to:

1. Define the fill mix and mechanical properties to maintain rock mass stability.
2. Ensure that the fill itself did not pose a risk to underlying mining activities, specifically through “flow” liquefaction.
3. Ensure that the implemented design was sufficiently flexible to manage variability across the source material stockpile area.

In order to prevent sinkhole formation, the paste required sufficient stiffness and bearing capacity to support any roof failures. During the fill process, the fill would be exposed to a range of different stress paths. Should the fill material remain in a saturated state, it could potentially liquefy and remobilise into the underlying workings during this stage. Therefore, in addition to the rock support requirements, it was also necessary to ensure that the fill material could not remobilise.

Results of testwork showed that paste batched in excess...
of 81% solids strain-hardened upon undrained shearing. This showed that this material would not be prone to "flow" liquefaction. At this solids content the in situ fill material was shown to possess adequate strength and stiffness to prevent any sinkhole formation. Consequently, if placed at a solids content in excess of 81% solids, the paste could be deposited without any binder addition.

Below 81% solids the paste was shown to strain-soften upon undrained shearing, leading to "flow" liquefaction. Over the range of mix solids contents tested, the results showed that all paste with a UCS in excess of 30kPa strain-hardened upon undrained shearing. Paste of this strength was also shown to have sufficient bearing capacity and stiffness to prevent sinkhole formation. Consequently, if placed at a solids content in excess of 81% solids, the paste could be deposited without any binder addition.

Testwork showed a unique relationship between the binder addition (required to achieve this target strength and behaviour) and the mix solids content (for samples taken from across the alluvial soil stockpile area). The required binder addition increased as the mix solids content reduced.

**Challenges**

Both underground and open pit mining operate at the Wambo site and immediately prior to beginning of backfill operations, a modification to surface mining resulted in the preferred source of alluvial material being unavailable for extraction. Due to ongoing underground mining and the necessity to commence filling as soon as possible, a less favourable alluvial source [within the borrow pit area] was used. This material had a high clay content and consequently could only be batched at low solids contents. In addition the "sticky" nature of this material reduced production rates.

During Paste 1 of the filling program this problem was overcome by the Outotec team through "working" the material with earthworks equipment. In addition, the screening method was changed from MISU screening to conventional screening. This removed a significant amount of the clayey material by rejecting the clay lumps as oversize.

Atterberg limit testing was also undertaken on a number alluvial soil feed samples during Phase 1. This testwork showed a clear relationship between paste production rates and increasing magnitude negative liquid limit values. During Phase 2 of operations, this relationship was used to confirm the preferred material source. This preferred material source significantly increased production rates during Phase 2. Also, during a significant portion of the operation, the mix solids content was sufficiently high to eliminate the need for binder addition.

**Results**

Outotec will deliver approximately 250,000m$^3$ of mine backfill by Q4 of 2014 through more than 100 boreholes on the Wambo project. The boreholes, lined with 125mm NB PVC casing, extended approximately 25-50m vertically into the old board and pillar workings. The project was executed such that both open pit and underground operations were able to continue throughout the fill process. Due to the robust fill strategy, the rigorous manner in which the fill mix was derived and the flexible operating philosophy:

- Filling operations continued without compromising the quality of the placed material when operational restrictions drove the need to utilise unfavorable fill material during Phase 1 of the project.
- When the preferred alluvial material was accessed, during Phase 2, a considerable portion of the fill was placed without binder at very high fill rates, delivering significant economic and production benefits to Peabody.

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BUSINESS NEWS: INNOVATIVE SORTING JOINS OUTOTEC COMMINUTION PORTFOLIO

In April this year Outotec agreed with Tomra Sorting GmbH to cooperate in the supply of Outotec-branded sorting solutions for the mining and metallurgical industry. Tomra Sorting is a global leader in sorting technology, setting the bar for sensor-based solutions. Through this new cooperation, customers can access energy-efficient process solutions which help them increase productivity, decrease costs and thereby extend the life of their mining operations.

Sorting is used to separate ore from waste rock at mine sites. Tomra’s sensor-based sorters can reduce specific energy consumption by 15%, as well as reduce the amount of water by 3 to 4 cubic meters per tonne of ore. Although sorting is quite a new technology in the metal mining industry, it is a proven concept in industrial minerals processing, recycling and the demanding food industry. Tomra has already sold approximately 10,000 devices for these industries worldwide.

Declining ore grades, high energy and production costs, water shortages and increasing environmental regulations require innovative process solutions, and thus the agreement with Tomra was a logical opportunity for Outotec.

"Tomra’s sorting equipment will complement our comminution product portfolio and strengthen our market position. We work hard to ensure that our offering is the best in the industry when it comes to resource efficiency and minimizing emissions. The cooperation with Tomra will support us in addressing our customers’ challenges in the energy-intensive mineral processing industry. Our sustainable solutions differentiate us from the competition”, says Kalle Harkki, Head of Outotec’s Minerals Processing business area.

BUSINESS NEWS: DEWATERING WEBINAR!

Find out more about Outotec’s new dewatering concept which is a full scope solution for concentrate, tailings and water management. This flexible dewatering plant solution can be modularized and is also scalable. Apart from a seamless plant design, fast track delivery and complete life cycle solutions with this new concept, customers can access improved efficiency, reliability and safety as well as decreased total cost of ownership.

This concept is discussed via a webinar on this link...

Further information on dewatering is on our website...
CASE STUDY: CARMEN COPPER

Significant brownfield upgrade delivers state-of-the-art solution...

Carmen Copper Corporation (“Carmen Copper”), a wholly-owned subsidiary of Atlas Consolidated Mining and Development Corporation (“Atlas Mining”), practices sustainable and responsible mining by adhering to the highest standards in health, safety and environmental performance in its operations and by leading the industry in community contributions and relations.

Sustainability and operational excellence form the cornerstones of Carmen Copper’s mining enterprise. It is currently working towards achieving higher cost efficiency and being in the lowest quartile of mining companies worldwide in terms of production costs.

Atlas Mining’s operation of the Toledo copper mine, located in Cebu in the Philippines, began in 1955, but was suspended in 1994 due to market surplus and the decline in the global copper market price. Operation of the mine was resumed by facilitating its rehabilitation in 2007

Scope

In 2012, Carmen Copper engaged Outotec as its principal technology partner for the upgrade and modernization of its processing plant. This first phase of the upgrade project was designed to increase throughput from 40,000 to 60,000 tonnes per day. Outotec, renowned for innovative solutions and technology, was engaged on an EPS basis (Engineering, Procurement and Services). Alongside full engineering expertise, including high level concentrator process capabilities, Outotec’s proprietary minerals processing equipment would also be a key component in delivering the targeted expansion of Carmen Copper’s processing capacity. The delivery schedule was extremely ambitious, with Carmen Copper and Outotec working in close partnership toward completion.

Innovative engineering

Outotec’s cost-effective engineering approach engaged a multi-disciplinary team of technical personnel for civil, structural and mechanical works, engineering design, instrumentation and process engineering. The team worked well with the Filipino engineers of Carmen Copper to meet demanding schedules. The upgrade was engineered for both greenfield and brownfield stages to allow continuous plant operation. Allowances were also incorporated for future expansion and sustainable, value-adding by-product recovery.

Point Cloud 3D laser scanning was employed to provide a complete and accurate survey of the vast site. This technology, from a detailed engineering perspective, not only delivered the fastest and safest means of surveying this complex brownfield plant, but is also the most accurate in the world, providing a complete up-to-date picture of the site. The extremely precise 3D scanned data considerably reduced time associated with processing data and images in more ‘traditional’ ways.

“This is a step change in recovery for us” Mr Serge Serdzeff, Expansion Project Manager
Partnership approach
The close partnership between Carmen Copper and Outotec ensured meticulous planning and enabled site to be fully operational at all times. Tie-in points for new equipment and rerouting of pipework, for example, were planned upfront and all disruptive work was completed during shutdowns, ensuring minimal interruption to production. Procurement was also carried out on a collaborative basis with Carmen Copper to deliver the most cost effective and timely result.

State-of-the-art concentrator technology
Designed to cope with projected increases in throughput and recovery, Carmen Copper’s new concentrator technologies comprise comminution, flotation, thickening, on-stream analyser, particle size indicator and DCS systems. Considerably more operator friendly, the state-of-the-art circuit offers easier and safer access. The new system delivers advanced analysis and automation for up-to-the-minute process stability, providing maximum availability and optimized recovery. Commissioning of this significant expansion was completed by March 2014, a mere 20 months after Outotec was engaged on the project.

Commissioning
Comments Mr Serge Serdzeff, Expansion Project Manager for Carmen Copper, “Outotec’s presence offered substantial value adding during commissioning. Challenges encountered during this phase were resolved quickly and Outotec was committed to delivering what was promised. Outotec looks after the customer” added Mr Serdzeff.

Results
Following commissioning, the plant is now focused on optimising the equipment. Although still early days, results from the new equipment are pleasing. “We are recovering more than we ever expected” explains Mr Serdzeff, “we are getting 80%-82% across the TankCell 300s on rougher duty and 70%-75% was anticipated.

This is a step change in recovery for us”. Site’s focus on equipment optimisation will help deliver further process stability and maximised recovery.

Life cycle solutions
In July 2014, Carmen Copper subsequently awarded Outotec a life cycle solution package. This three-year agreement comprises the provision of site services including maintenance and spares programs, as well as one-off training. This specialised support is designed to maximise the equipment availability and longevity.

Training package
As part of Carmen Copper’s focus on safety and professional development, the site has also commissioned a one-off training package to ensure local staff are comprehensively trained in optimised operation of equipment. Additionally, with Carmen Copper’s Life Cycle Solutions agreement, the site will also have access to regular local on-the-job training.

Future development
The Carmen Copper expansion project has afforded Outotec a unique opportunity to work closely on a significant brownfield concentrator expansion project. This project required very close onsite liaison with the client, who has been responsible for construction. Through collaboration, Filipino subcontractors and partners were utilized for detailed engineering and the Carmen Copper project as a whole has facilitated development of concentrator engineering, procurement and project management. Carmen Copper’s subsequent three-year site services contract with Outotec further underlines Carmen Copper’s commitment to sustainable, responsible mining. It also reflects their goal of achieving higher cost efficiencies and being in the lowest quartile of terms of production costs. With forward planning, Carmen Copper also has the flexibility to undertake further expansions in the future.

Two Outotec 6MW ball mills and trommels.
Outotec has been developing chloride hydrometallurgy-based processes since the 1980s, when the technique was originally developed for copper recovery. It has since been extended to nickel, zinc, and gold processing. This latest solution, the Outotec Nickel Matte Chloride Leaching Process, is suitable for nickel refining and is a highly flexible, calcium chloride based processing route for nickel matte and other nickel-containing raw materials. It incorporates two-stage leaching and iron precipitation stages that make the recovery of precious metals such as gold and silver possible.

This new approach incorporates multiple leaching steps in Outotec OKTOP reactors and uses hydrochloric acid and oxygen. The heart of the process is the regeneration of ammonia and hydrochloric acid, which decreases the operational expenses while maintaining excellent metal recovery. As a closed process, it also minimizes waste and by-products, and therefore has minimal environmental impact.

The process
Because the Outotec process is based on a calcium chloride solution, it enables easy acid and base regeneration. Base metals are leached in oxidative conditions at atmospheric pressure, iron is precipitated with limestone, and base metals are purified by solvent extraction, using ammonia as the neutralization agent. Organic reagent entrainment and dissolved reagents are removed from the aqueous solution with copper, cobalt, and nickel solvent extractions, and ammonium chloride is regenerated into ammonia. The water balance is controlled by evaporation after the ammonia regeneration. Calcium chloride is regenerated into hydrochloric acid and the solution is returned to leaching. In total, the leaching process takes about 10 to 15 hours to complete. The leaching residue weight is about 25 percent of that of the matte fed into the process.

Iron precipitation
Iron is precipitated using slaked lime or limestone at around pH2 while oxygen is fed to the reactors. Under these conditions iron precipitates as goethite. Controlled sulfur removal at this stage significantly decreases scaling in the downstream process.

TEXT KAARLO HAAVANLAMMI
Despite current modest growth in the nickel market due to unfavourable economic conditions, analysts expect an upturn in the future. Additionally, although nickel raw materials are increasingly from laterite sources, the continuing treatment of sulfide ore in smelters means that nickel matte production will continue far into the future. An innovative new approach for nickel intermediates has recently been launched which produces good overall metal recovery, enables the regeneration of expensive chemicals using cheaper chemicals, and also minimizes waste and by-product output. Particularly suitable for small-capacity standalone refineries, it brings the benefits of low capital expenditure and reduced operating costs.

An innovative new process for nickel intermediates delivers cost-effective, sustainable benefits

NICKEL MATTE CHLORIDE LEACHING
About five hours of residence time is sufficient for good removal of iron and sulfur. Both iron and sulfur can be precipitated to a very low concentration without significant loss of valuable metals.

**Solvent extraction and electrowinning**

Copper is purified from the process solution by solvent extraction, using conventional hydroxyoxime-based copper extractants, with ammonia being used to control pH in order to improve extraction. Impurities are removed from the organic phase in scrubbing stages before the copper is stripped to a copper sulfate electrolyte, while electrowinning is done by conventional means. Cobalt is also extracted by solvent extraction. Impurities are scrubbed with diluted hydrochloric acid before stripping and the cobalt is then precipitated from the rich stripping solution.

Nickel is recovered from the process solution by solvent extraction, using the reagent Versatic 10, with ammonia again being used to maintain a pH of 5 to 5.3. Unlike sulfate-based extraction processes, there is no significant gypsum precipitation since most of the sulfates have already been precipitated as part of the iron removal stage and the process solution has been diluted slightly due to the pH control. The loaded organic is scrubbed with the diluted anolyte from nickel electrowinning to reduce calcium loading and, in turn, gypsum precipitation. Nickel is recovered by electrowinning.

**Ammonia and hydrochloric acid regeneration**

After nickel solvent extraction the raffinate is a concentrated calcium chloride solution containing a significant amount of ammonium chloride. Ammonium is regenerated into ammonia by adding calcium hydroxide. Because sulfates are not present in the Outotec process, there is no significant gypsum precipitation during ammonia regeneration. The solution and stream are fed to a stripping column, where ammonia is recovered in the gas phase. The ammonia gas is condensed back to an ammonia solution, which is recycled for use as a neutralization chemical in solvent extractions. This helps to produce a more concentrated ammonia solution and enables better overall water-balance control.

The final process step is hydrochloric acid regeneration, where calcium chloride solution is reacted with sulfuric acid to produce pure gypsum precipitate. Hydrochloric acid stays in the solution and is returned to the leaching stage. The typical hydrochloric acid concentration in the solution is between 120 and 150 g/L. Acid regeneration takes place in multiple reactors, with a total residence time of four to five hours.

**Comprehensive solution**

The atmospheric operating environment helps to minimize initial capital investment, and Outotec can supply the majority of the key equipment. The Outotec PROSCON automation solution enables fast plant ramp-up, smooth operation, and high-quality end products. The comprehensive offering of proprietary equipment and ongoing services and support maximizes the operational availability of the solution, increases profitable operations, and provides customers with a faster return on investment.
In summary
In summary, the Outotec nickel matte leaching process is an extremely flexible method that can be used for treating a wide variety of raw material feeds. In addition to nickel matte, the process can easily be modified for treating different concentrates and intermediates. Other key benefits include:

- Tailored and optimized technology solutions for the entire production chain, from raw materials to end products
- Production of high-quality nickel end products, saleable by-products, and stable residues
- Fast, smooth plant ramp-up and operation
- Advanced automation minimizes operating costs
- Testing, engineering, process design, and equipment and automation solutions from a single provider
- Closed process circuit minimizes waste production and optimizes water usage

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HCl regeneration
RESOURCE EFFICIENCY BLOG
FOCUS ON COPPER

Have you heard the statement that metals are eternal? Well, they have been around since the start of the universe, but they are not all always easily accessible for our applications.

‘Copper is actually a backbone of a modern sustainable society’ Prof. Markus Reuter.

The blog’s focus this time is on copper. Find out why copper is so important and unique by following this link...

BUSINESS NEWS: OUTOTEC PROVIDES SMELTING TECHNOLOGY FOR NYRSTAR’S PORT PIRIE

Outotec has agreed with Nyrstar, a global integrated mining and metals company, to provide Outotec Ausmelt technology to the Port Pirie redevelopment in South Australia. Outotec will provide a technology licence, engineering, proprietary equipment and advisory services. The Nyrstar Port Pirie is being redeveloped into an advanced metals recovery and refining facility.

Nyrstar’s Port Pirie smelter has been in continuous operation since 1889, with many of the core production assets in service for up to 60 years. While considered the best practice at the time, these assets are no longer capable of meeting the increasingly stringent environmental and operational standards expected of a modern base metals facility. Outotec Ausmelt technology will be used to upgrade the facility to an advanced poly-metallic processing and recovery facility – capable of processing a wide range of high value, high margin raw materials with improved environmental footprint and reduced airborne metal and dust emissions. Specifically, Outotec technology will replace the outdated sinter plant with a state-of-the-art oxygen enriched bath smelting furnace.

The redeveloped facility will produce the current range of metals including lead, zinc oxide, gold, silver, and copper. However, the application of Outotec’s high temperature top submerged lance (TSL) bath smelting technology will allow a wider range of raw materials to be processed. The increased furnace flexibility will allow Nyrstar Port Pirie to process a wider range of high value and high margin concentrates and residues from Nyrstar’s existing smelters.

More information is available here....

BUSINESS NEWS: ADDITIONAL SCOPE AT ONE OF WORLD’S LARGEST SINTER PLANTS

Outotec has agreed a three-year operation and maintenance contract with South African Kalagadi Manganese Pty Ltd for the new manganese sinter plant located in Hotazel in the country’s Northern Cape province. The contract value is approximately EUR 17 million, which has been booked in Outotec’s 2014 second quarter order intake.

The operation and maintenance contract follows Outotec’s earlier EUR 119 million delivery of the one of the world’s largest manganese sinter plants on a turnkey basis, including technology, engineering, project management, supply of all equipment and structural steel, construction, commissioning as well as advisory services for civil works.

More information is available here....
TECHNICAL SEMINARS

Our series of technical seminars continue to prove popular in 2014! These seminars, which are complimentary, often count towards professional development hours...

The seminars provide information on all facets of a technology from a general overview, to in-depth discussion of operation, control, applications and new technologies. These one and two day seminars are delivered by some of the most knowledgeable and experienced personnel in the industry.

We have four upcoming seminars for the remainder of 2014:
- Jakarta (Indonesia) - Metals processing, 8 October (1 day)
- Perth (Australia) - Grinding, 16 October (1 day)
- Port Moresby (PNG) - Minerals Processing, 22-23 October (2 day)
- Baguio (Philippines) - Minerals processing, 10-11 November (2 day)

If you would like to attend or require any more information, please contact krystle.king@outotec.com

CONFERENCES 2014

For the remainder of 2014, Outotec will be at the following industry conferences in South East Asia Pacific. Drop by and meet our technology experts who will be on hand to answer your questions...

12th AusIMM Mill Operators’ Conference
1-3 September 2014, Jupiters Townsville Hotel, QLD
Booth # 21 & 22
Papers from Outotec industry specialists will be presented throughout the conference including:
- “Maximising value through maintaining your flotation equipment” by Jason Heath
- “A case study on Carmen Copper brownfield upgrade” by Sherwin Morgan
- “Advanced flotation control at Kevitsa” by Ari Rantala
- “Flotation plant commissioning” by Jason Heath
- “Concentrators, past, present and future trends” by Tom Hunter (keynote)

15th ACPS
14-18 September, Jupiters Gold Coast, QLD
Booth # 6
- “A commentary on design of mechanical flotation circuits for coal applications” - Presented by Jason Heath

61st Annual National Mine Safety and Environment Conference
11-14 November, John Hay Trade and Cultural Centre, Baguio, the Philippines.
SUSTAINABLE USE OF EARTH’S NATURAL RESOURCES

The Outotec stripe and its colours represent a journey from the Earth’s core to the outer reaches of its atmosphere. Each stage of this journey stands for a key part of the Outotec story, locating us within our own ecosystem, and within the world at large.

Outotec’s customers in the minerals and metals processing, renewable energy production and industrial water treatment industries need technologies that allow them to make the best possible use of increasingly limited raw materials.

By making prudent choices today, we can ensure the prosperous growth of businesses and societies worldwide, while preserving the planet for the benefit of future generations. This is our mission: sustainable use of Earth’s natural resources.

For the whole story, please visit our YouTube channel.