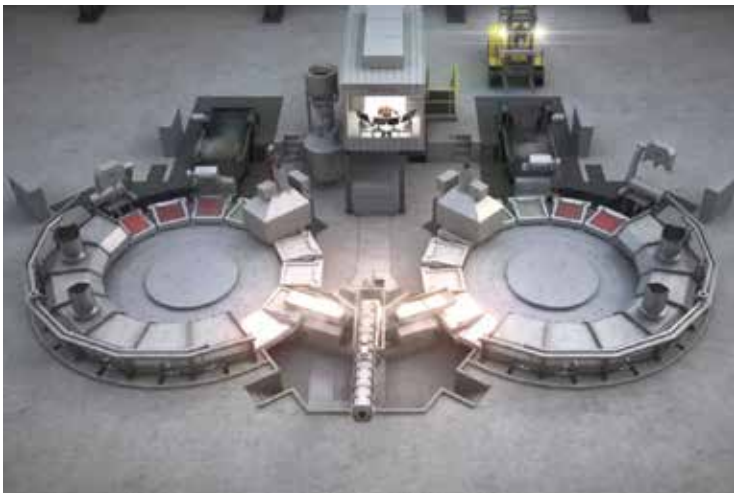
SMELTING NEWSLETTER #1 2014



GREETINGS FROM OUTOTEC SMELTING!

TEXT **KIM FAGERLUND, VICE PRESIDENT - SMELTING**

At the beginning of each new year, some time is always spent reflecting on the previous year. In this issue we have summaries of some of the important start-ups in 2013. New Flash Smelting and Flash Converting facilities were successfully started by Jinchuan Non-Ferrous Metals Group Co. (JNMG) in Fangchenggang, China. This is now the 4th continuous Flash Smelting and Flash Converting operation in the world and shows the trend towards efficient and sustainable process technologies becoming more important selection criteria. In addition, this newsletter contains an article about the renovation and modernization shutdown in La Caridad, Mexico. This is an example how current operating facilities can upgrade their processes to meet ever-increasing environmental and efficiency requirements. Grupo Mexico has kindly promised to host a visit to the recently renovated premises during the 14th International Flash Smelting Congress.

This year will mark an important milestone for smelting with 20 years of continuous Kennecott-Outotec® Flash Converting at Kennecott, Salt Lake City, and 40 years of Outotec® Anode casting technology. The 14th International Flash Smelting Congress will be organized in Las Vegas on 16-21 November 2014. All delegates will have the opportunity to visit the recently renovated La Caridad smelter in Mexico and Kennecott smelter in Salt Lake City. Do not miss this event.

More information is available from Congress Secretary Ms Mirja Lager (mirja.lager@outotec.com).

Looking forward seeing you there! ■

NEW OUTOTEC® FLASH SMELTING AND KENNECOTT-OUTOTEC® FLASH CONVERTING FACILITIES STARTED IN FANGCHENGGANG, CHINA

TEXT **KARI PIENIMÄKI**

New Flash Smelting and Flash Converting facilities have now been successfully started up by Jinchuan Non-Ferrous Metals Group Co. (JNMG) in Fangchenggang, China. This is the fourth continuous Flash Smelting and Flash Converting operation in the world and the third in China. The smelter is located in the Guangxi Zhuang Autonomous Region of the People's Republic of China.

Outotec delivered basic engineering for the facilities. The supplied equipment package included four loss-in-weight feeders, a concentrate burner, a matte burner, four air-slides, all the taphole and melt area ICE cooling elements for the flash converting furnace, a Sentinel furnace monitoring system with 30 headers, process advisors for the Flash Smelting Furnace (FSF) and Flash Converting Furnace (FCF), granulation nozzles and Twin M18 Anode Casting equipment.

The average design feed mixture feed to the Flash Smelting Furnace is 292 t/h and to the Flash Converting Furnace 115 t/h. The smelter is designed to produce 400 ktpa of copper in the first stage.

The furnaces were heated up carefully in a long heat-up period of more than 30 days. There was not much expansion in the furnaces during the heat-up. The mechanical completion certificate was undersigned for the flash furnaces on 28 November and for anode casting on 3 December 2013.

The first FSF feed took place on 30 November 2013 at 15:16. The furnace was started smoothly, and there was a lot of noise in the air when thousands of firecrackers were set off in the smelter yard to celebrate. TV cameras were also present to record the historic moment.

Initially the matte grade produced was 62% Cu in order to achieve a high heat value for the feed mixture for the start- up of the Flash Converting Furnace. The feed rate in the beginning was 80 t/h and increased gradually to 150 t/h once the concentrate conveyors and -dryers were capable of supplying more concentrate. Also the matte grade was increased to 64% Cu.

Approximately 10,000 tons of matte was produced to the dome before the Flash Converting Furnace was started 33 days later on 2 January 2014 at 11:38 since the number 8 is considered lucky in China. Before the start-up the furnace was inspected and it seemed to be ready for matte. Initially the matte feed rate was 40 t/h and was increased gradually to 50 t/h.

The first blister tapping took place on 3 January. The furnace was designed to be operated with a continuous high blister level to prevent slag contact with the skew-brick area in the furnace. After the first anode furnace was filled with good quality blister, which was produced from the very beginning, the first anode casting successfully took place on 7 January.

The Outotec Smelting start-up team consisted of: site manager Kari Pienimäki, shift metallurgists Markku Lahtinen, Satu Jyrkönen, Päivi Suikkanen, Harri Talvensaari and Stefanie Creedy, process advisor specialist Peter Björklund, automation specialists Jouni Heikkinen, Juha Karttunen and Sauli Salomaa, instrumentation specialist Pekka Rihu and mechanical specialist Juhani Asikainen. Shanghai office services and interpretation were provided by Jimmy Du Jin, Charlie Guo Chao and Lyon Wang Cailiang.

Stefanie Creedy expressed her experience as follows: "I was invited to join the commissioning team as part of the efforts to strengthen the relationships between the various smelting technologies. I am one of the younger process engineers predominately working with the Ausmelt group. I have been involved in many Ausmelt commissioning, but this was the first time I had seen a flash furnace, so it was nice to put into perspective some of the stories from my Ausmelt colleagues with flash smelting backgrounds.

When I arrived the smelting furnace had already been operating for approximately one month, and the converting furnace was in the final stage of the heat-up. After resolving a few outstanding issues the converter was started up just after the New Year, and the first anode casting was performed a few days later.

It was comforting that my experience with Ausmelt projects had provided me with a solid basis for this commissioning. Many of the problems that cropped up were similar to those experienced during Ausmelt commissionings. Overall the approach was very familiar, even if the equipment, terminology and target conditions were somewhat different.

I was warmly welcomed by the team, and although I only spent a few weeks with them, it is amazing how much quicker you get to know people during a commissioning than in the office. Everyone was full of information and more than willing to answer all my questions. We are commonly faced with similar challenges as we strive to better understand and optimize our plants. It is always interesting to discuss the differences in the design and operation of the furnaces and share experiences and ideas on the ways we could do things better. I look forward to working together more closely and seeing the improvements as we incorporate aspects into our Ausmelt furnaces and vice versa.

Overall the plant was very impressive with a relatively smooth commissioning, and I believe this is largely a credit to all the parties involved." ■

MR. GUO WANSHU, PROJECT DIRECTOR FOR THE JINCHUAN NON-FERROUS METALS GROUP'S NEW FANGCHENGGANG SMELTER

TEXT **LARS HELLE**

According to Mr. Guo, the new smelter project proceeded very smoothly. A particularly reason for this is no doubt that the whole project has been under his management, from purchasing and contracts to erection and commissioning. This has been possible due to his personal character and his "never give up" attitude towards all the challenges in this kind of huge project.

Mr. Guo elaborated also the challenges in the copper industry in China as a whole. Partly these are connected to the expeditious and even too fast progress of the copper industry combined with a lack of raw material resources in the home country. This has forced producers to go and seek these outside of China. In this context the available sea port in Fangchenggang offers a major benefit, but at the same time, the area's peculiar climate has its own part to play and has to be taken into account in the project and in the future operation.

Reflecting on the future, Mr. Guo revealed that the future end products of the Fangchenggang plant will be ready-made copper products, such as pipes, rods and strips for customers throughout Southeast Asia. This will entail further investments in final product manufacturing and will mark the third phase of the Fangchenggang site development in the not too distant future.

At the moment JNMG is concentrating on phase one, which includes production of 400,000 tons per annum of cathode copper with the double flash smelter, as well as 200,000 tons per annum of ferro-nickel. The second phase will involve increased production of ferro-nickel and also smelting of copper scrap to cathodes. There are also plans for stainless steel production.

Mr. Guo confirms that he has been very happy with the cooperation with Outotec in the past and in this project. Of course he has generated some new and different ideas that he feels might have helped to simplify the selected design considering his and JNMG's long and solid experience in the field and their independent problem solving capability stemming from the existing Jinchuan smelter in Jinchang, which surely is only logical.

"Combining local Chinese and foreign technologies is always challenging, but with good and open communication and cooperation these can and have been overcome to the benefit of all," concludes Mr. Guo. ■

Q&A

Why did Jinchuan Non-Ferrous Metals Group Co. (JNMG) decide to build the new smelter on the shoreline of the BeiBu Gulf on the South China Sea?

There are completely logical reasons. First of all, JNMG has always been at the top of the smelter business in China, both in terms of technology and the economy, and we want to retain this position.

Furthermore, one of the key factors in selecting the smelter location was the available site at the seashore, which will be cost effective in terms of lowering overall transportation and other costs. The Chinese government's tax incentives and the government's general plan to develop this southern part of China were also important considerations. At the existing location of JNMG's facilities in Jinchang in Gansu Province, the limits have been reached in many respects. The location is for example remote in terms of transportation.

What made you select Outotec's double flash (flash smelting – flash converting) process?

JNMG compared different process alternatives, but ultimately it was easy to come to the decision. The key arguments in the final selection were environmental sustainability, the biggest available production capacity of all the processes, and surely last but not least the operating cost benefits.

MODERNIZATION OF OUTOTEC® FLASH SMELTING FURNACE AT THE LA CARIDAD COPPER SMELTER

TEXT **IINA VAAJAMO, HEIKKI HEINONEN**

The Outotec® Flash Smelting furnace modernization project at the La Caridad Smelter of Mexicana de Cobre S.A. de C.V in Sonora, Mexico, has been successfully completed. The old furnace with Outotec® Flash Smelting technology was built in the 1980s and had served the customer for nearly 30 years. The new furnace was a turnkey project that included engineering, equipment and installation, as well as the shut-down execution. The service part of the project was done together by Outotec personnel from Mexico, Canada and Finland, who supervised the local contractors during the construction stage.

The new equipment consisted of loss-in-weight feeders for the feed mixture, a dust conveyor, two air-slide conveyors, process air fans, a concentrate burner, field instruments for the new equipment, cooling elements and copper pipes with Outotec® Sentinel cooling water headers, furnace steel structures and springs and brick lining. On the process control side the delivery included Outotec process control system Proscon® with integrated Outotec® Process Advisor and Outotec® Sentinel that form a complete process automation platform for smelter

operations. In addition, complete spare parts supplies were included in the delivery together with shut-down planning and management services, as well as supervision of the installation, commissioning and start-up.

After the shut-down, installation and commissioning, in which more than 55 Outotec personnel were involved, the start-up team arrived at the site. Starting the furnace was a pleasure due to the good work that the installation and commissioning teams had done. Special thanks go to the Grupo México employees for the wonderful working atmosphere; it was really a pleasure to work in cooperation with you!

Following the modernization the renovated smelter will be capable of higher production capacities and energy-efficient metals recovery without any increase in emission levels. Outotec is pleased to work with Grupo México and will continue to support the client. We wish all the best for the plant with the new Outotec® Flash Smelting furnace and all the best for La Caridad smelter's employees. ■

COPPER MARKET AND TC/RCs

TEXT **HEIKKI PUUSTJÄRVI**

World copper mine production in 2013 is estimated to have increased by 5.5% to 17.66 Mt. Concentrate production increased by 6.4% and SX-EW production by 2%. Smelter capacity utilization rose to 83.6%, resulting in 4% growth in smelter production and final tonnage of 16.4 Mt. Refining grew by 3.7% to 20.9 Mt and with a corresponding consumption growth of 5.6% to 20.7 Mt led to a slightly positive balance.

Commodity price performances in 2013 were in general poor. Copper was one of the survivors. The average annual price was 7318 USD/t indicating a decline of 8% y-o-y.

The outlook for 2014 is that mine production capability will continue the upward trend of 2013. Whereas last year's rise was attributable to improved performance at existing mines, the anticipated increase for 2014 will be largely due to production from new greenfield projects.

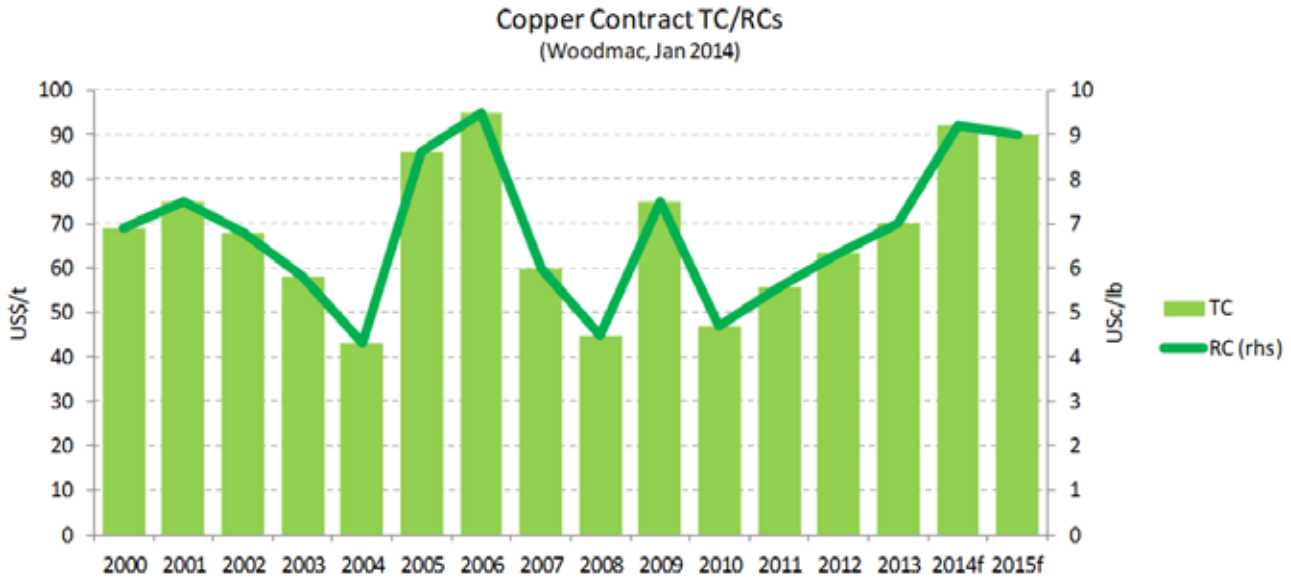
Although the mine supply of concentrate is expected to continue increasing during 2014, smelter utilization and installed capacity is also forecast to rise. The upward pressure on TC/RCs is therefore expected to ease during this year.

Concerning smelter production growth, there are some potential constraints especially for the Chinese production. These could include a lack of storage capacity for sulfuric acid, delays in commissioning new capacity and new legislation to decrease air pollution, or at the very least increased costs at the smelters due to the above.

According to trade statistics, imports of copper concentrate into China during December totaled 1.04Mt, exceeding the previous monthly record of 1.02Mt recorded in September. December's figure took the full year total to 10.08Mt, an increase of 28.7% on 2012.

The increasing importance of China to the global copper concentrate market is highlighted by the fact that annual imports have risen by 58% since 2011 and doubled since 2007. China now purchases more than twice its closest rival, Japan, in the internationally traded market.

In late November 2013 Freeport-McMoRan and Jiangxi Copper agreed to 2014 copper contracts of $92/mt and $0.092/lb. The agreement with the Chinese smelter is



a 31% increase over the $70/mt-$0.07/lb benchmark agreed in 2013 and is widely expected to be the benchmark for other contracts. BHPB subsequently signed a contract with Chinese smelters for the first half of 2014 at $99/mt and $0.099/lb – higher than the benchmark but well below spot contracts.

Spot TC/RCs in Asia rose to $130/mt and $0.13/lb in December as the market moved in favor of smelters in line with the concentrate oversupply and smelters slowing purchases to decrease year-end inventories.

In a slow market ahead of the Chinese Lunar New Year holiday, spot terms eased during January. Spot TC/RCs accepted by miners from traders were marginally below December's level with $100/t &10c/lb being a representative average. Spot buying terms from Chinese smelters also fell slightly with $110/t &11c/lb being typical. ■

SOURCES:

- Woodmac Q4 2013 Copper LTO and January 2014 Metals Market Service reports.
- Metals Economics Group Nov-Dec 2013 Strategic report.

COMMISSIONING OF THE ZIJIN PRECIOUS METALS PLANT IN CHINA

TEXT **MIKHAIL MALIARIK, BJÖRN LUDVIGSSON**

Zijin Copper is a new copper smelter located in the green hills of southeast China, about a two-hour drive from the city of Xiamen, or Amoy as it is also known. A new "two plus two" lane motorway with 23 tunnels has been built between Amoy and Zijin, as well as a new railroad to serve the smelter with the transportation of imported concentrates and ready-made products. The smelter has been built on flat land made by knocking down the hill and putting it down in the valley, so to speak.

Outotec has contributed to the smelter with an Outotec® Flash Smelting Furnace (FSF) and Precious Metals Plant (PMP) for the recovery of silver, gold and selenium contained in the copper concentrates. The FSF was installed before the PMP. The PMP consists of a smelting process with an Outotec® Kaldo Furnace and an Outotec® Wet Gas Cleaning System at the heart of the process.

Tapping of the first silver doré from the Kaldo Furnace

Zijin Precious Metals Plant

Temporary casting of the first silver doré

Mikhail Maliarik technology manager, Outotec, describes his first days in Zijin and the start-up project at the Precious Metals Plant:

"I was about to exit the plane in Xiamen airport when I receive a telephone call from Mr. Johnson, the Zijin company's "foreign minister". He asks me how the flight from Beijing was and informs me that a car is already waiting and where the driver would stop for a meal pause.

Mr. Johnson takes care of all foreigners coming to work for the company. He does his very best to make us feel comfortable during several weeks of commissioning. His responsibilities cover everything from planning transportation and meals to any possible technical issues and problems that we might encounter at the plant. He has also arranged various social events for us.

The next morning at the plant I met Mr. Liu. We have known each other since 2008. At that time Mr. Liu was an engineer employed by another company, Yanggu. We commissioned their PM plant in 2009. He has recently started at the Zijin Precious Metals Plant as production manager. After a couple of hours at the plant it's absolutely clear that Mr. Liu is a key person for the project. Having good experience with the commissioning of a similar installation, as well as several years of practice with plant operations, he coordinates all actions required anywhere, including civil, mechanical, electrical, automation and process issues."

Altogether ten people from Outotec in Sweden took part in the commissioning during different stages of the project, as well as two people from Boliden Rönnskär PMP in Sweden led by Gunnar Berg and Clas Ericsson. One Outotec team member was Lyon Wang from Shanghai, the only non-Swedish speaking member. Lyon is a very qualified electrical engineer and he was involved in almost everything during the commissioning. He was also an excellent English to Chinese communicator, which we of course took advantage of.

The commissioning took place during April and May 2013. The first doré silver was produced on 6 May. Everything went very smoothly thanks to good cooperation with the customer. The team left Zijin once the performance guarantees had been successfully demonstrated on 11 May.

One interest of our commissioning team was to watch the final games in the Swedish Hockey League where our home team, Skellefteå AIK, became champion on 24 April. Even some of the local Chinese became interested in ice hockey and enjoyed watching and celebrating with us. ■

The commissioning team celebrates the success of Skellefteå AIK along with our Chinese colleagues. Lyon and Mikhail are kneeling in the front row next to the flag.

OUTOTEC® AUSMELT TECHNOLOGY TO BE INTRODUCED IN CHINA FOR ZINC RESIDUE TREATMENT

TEXT **PAUL ABBOTT**

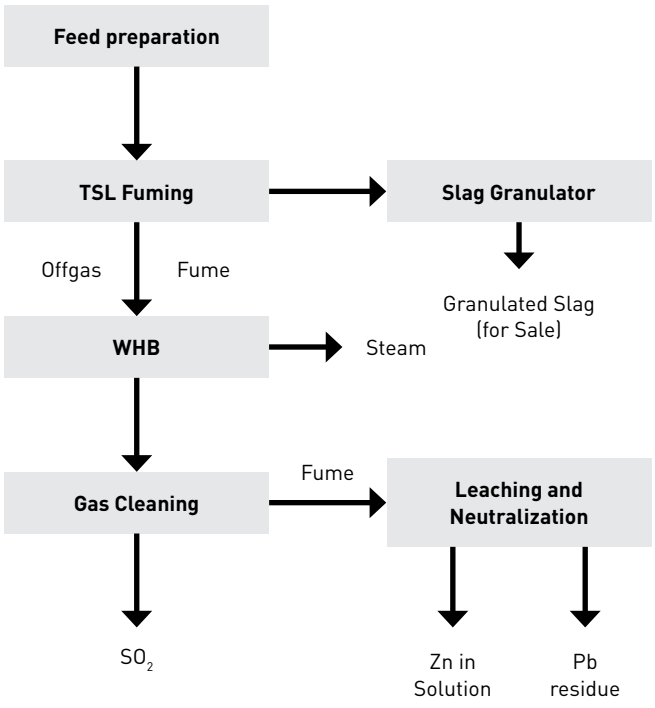
Outotec has an on-going project with Inner Mongolia XingAn Copper and Zinc Smelting Limited (XingAn) to supply the Outotec® Ausmelt technology for a new zinc residue smelter project in Inner Mongolia in China. This marks the first zinc residue fuming project for Outotec in China.

The new XingAn project will treat 160,000 tons per annum of zinc-bearing feed materials, comprising a mix of hot leach residues, electric furnace residues, zinc dross and fume leach residues, to produce a zinc-lead fume product and a slag.

The zinc-bearing residues together with silica flux and reductant lump coal will be continuously fed into a single Ausmelt furnace and smelted under reducing conditions at ~1300°C to produce a non-hazardous slag with an average zinc content of < 3% by weight and an oxide fume product. The fume and dust generated will be further processed in a hydrometallurgical circuit to recover zinc, lead and other valuables, and slag will be removed from the furnace as required.

The process air will be oxygen enriched to a level of ~40%, and the off-gases from the Ausmelt furnace will be cooled and cleaned before discharge to an acid making plant. The Ausmelt furnace system will have an internal diameter of 4.4 meters and an overall height of ~15 meters. The furnace will be designed with an insulated refractory hearth, above which will be copper panels and a membrane top to enable the maximum campaign life and heat recovery.

A simplified schematic of the proposed process flow sheet for the XingAn project is shown below.



World zinc production has been steadily increasing by 4% per annum to 13 million tons in 2012. The majority of this zinc production is produced via the Roast-Leach-Electrowinning (RLE) process, which eliminates iron from the circuit in the form of leach residues such as goethite, paragoethite or jarosite. For every ton of zinc metal produced using the RLE process, usually 0.5 to 0.9 tons of zinc residues is generated.

Methods for treating zinc bearing residues

These residues are classified as a hazardous waste due to the leaching of elements such as cadmium, arsenic and lead. Traditionally these residues had been disposed of in hazardous waste facilities or in on-site residue areas or tailings dams. Due to ongoing environmental concerns, there have been increasing restrictions on the construction and management of zinc residue storage facilities. As such, governments are strengthening environmental legislation to force companies to find commercially and environmentally viable solutions by modifying their flow sheets or implementing processes to further treat the residues.

There are three broad approaches to treat zinc-bearing residues:

- Pyrometallurgical – High temperature processes generally involving conversion of the residue into an inert slag but also offering the recovery of zinc, lead, silver and other valuable metals that would otherwise be lost with the residue.

- Stabilization – Chemical processes that involve blending the residue with other materials to alter its physical and chemical properties without metals recovery.

- Hydrometallurgical – Aqueous chemical processes whereby the residues are leached, purified and then re-precipitating in more stable form.

Of these three approaches, the pyrometallurgical solution is most commonly employed due to its ability to recover the valuable metal content and produce a disposable slag. Although the underlying reactions in these processes are similar, the way in which the different technologies utilize them varies.

For stabilization processes the final products are reclassified as a non-hazardous waste; however, finding an alternative use for them can be challenging, so they are usually still stockpiled. The stabilization processes also fail to recover any of the metal content, and the reagents required for the process can be expensive.

The hydrometallurgical solution is largely unproven. These processes primarily focus on recovering the contained metal value as opposed to producing an inert material suitable for safe disposal. Often iron and many of the impurities are re-leached into solutions together with zinc. Accordingly, these processes do not provide residue-free solutions and are mainly targeted on improving zinc recovery.

Outotec® Ausmelt technology process

The versatility and flexibility of Outotec® Ausmelt technology enables conditions within the furnace to be easily adjusted according to the specific application. Valuable metals such as zinc, lead, silver, indium and cadmium are recovered to a fume product. The benign slag produced as a byproduct of the process can be safely discarded or used as a construction material. Additional benefits can be derived from large-scale operations if the surplus heat generated is exploited to produce steam and electricity.

The feed materials, reductant coal and fluxes are added through a feed port in the furnace roof. In most circumstances minimal fluxing is required, as the natural slag chemistry of the system can be utilized. In the bath the feed decomposes and the lead and zinc are reduced and volatize as metallic species. The zinc and lead and other volatilized components are then post-combusted above the molten bath to form oxides products.

Depending on the throughput, feed grade, sulfur and halide content, this is performed as either a two-stage batch process in a single furnace, a continuous process in a single furnace, or a continuous process with two furnaces in series. The zinc is recovered in the form of zinc oxide fume and can easily be treated in an existing zinc RLE, as only a neutral leach step is required.

Advantages of Outotec® Ausmelt technology

The advantages of using an Outotec® Ausmelt Furnace for the treatment of zinc residues over other technologies include:

- Well understood and proven technology
- Ability to process a wide range of secondary feed materials
- High lead, zinc, silver and indium recovery
- Slag is non-hazardous and can be discarded or used for construction applications
- Energy can be recovered from off-gas as steam or electricity
- Small footprint allows plant to be easily incorporated into brownfield sites
- Ability to operate the process continuously or in batch mode
- Flexible slag chemistry requirements

Ever-increasing concerns about the environmental impact and past failures due to improper handling or solid waste mismanagement are strong drivers to treat zinc residues. As such, residue stockpiles are often viewed as an ongoing liability as opposed to a permanent solution. The scarcity of land and cost of residue deposition have also been strong arguments in favor of the implementation of processes that do not generate residues but valuable products. Outotec® Ausmelt technology offers an economically and technologically superior solution to treat these residues.

With the return of the Outotec® Ausmelt technology for the fuming of zinc-bearing residues to Outotec's portfolio of solutions, Outotec can now provide tailored solutions

integrating its hydrometallurgical, pyrometallurgical and gas cleaning expertise such as has not been possible in the past. This range of solutions allows Outotec to tailor a well integrated process to specific client needs, ensuring cost efficiency and maintaining high environmental standards.

The success of the implementation of Outotec® Ausmelt technology for the treatment of zinc residues at Korea Zinc is a clear example of the technological benefits and opportunities now available to the wider zinc industry. The implementation of the XingAn zinc residue fuming project in China will establish another important milestone in the development of Outotec® Ausmelt Technology applications. ■

SERVICES FOR ANODE CASTING EQUIPMENT

TEXT **ANTTI AIRAKSINEN, TERO KOLHINEN**

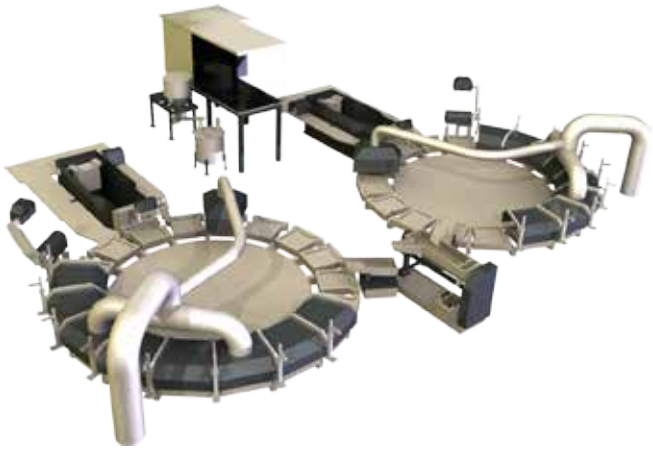
Challenges in maintenance planning

Regularly and proactively scheduled maintenance is critical for ensuring the production process performance of the anode casting shop. Unplanned equipment downtime can cause severe financial losses. Equipment failures, anodes of poor quality, degrading process efficiency – these are all indications that the equipment may be in need of routine maintenance.

Solution

Outotec® Maintenance Inspection for Anode Casting equipment allows the customer to identify proactively the need for repairs and spare parts for short- and long-term planning. In addition, potential bottlenecks in the production capacity can be further identified and avoided by taking the recommended actions.

The modular setup of Outotec's maintenance services is designed to meet customer needs flexibly. The services include regular inspections, equipment-specific maintenance planning, and maintenance service agreements covering maintenance execution. ■



BENEFITS:

- Extended equipment lifetime
- Reduced downtime
- Less quality losses
- Lower operating and maintenance costs
- Enhanced safety
- Support for the maintenance program

Condition Monitoring
- Maintenance Inspection
- Equipment condition information collection for Maintenance planning and execution

Maintenance Planning
- Equipment level planning of maintenance activities
- Customer specific maintenance plans for execution

Maintenance Execution
- Preventive Maintenance
- Spare Parts

Outotec provides leading technologies and services for the sustainable use of Earth's natural resources. As the global leader in minerals and metals processing technology, we have developed many breakthrough technologies over the decades for our customers in metals and mining industry. We also provide innovative solutions for industrial water treatment, the utilization of alternative energy sources and the chemical industry. Outotec shares are listed on NASDAQ OMX Helsinki. **www.outotec.com**

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