Dear Reader,

This year is well on its way, and while the northern hemisphere is moving towards summertime, the southern parts of the world are approaching wintertime. One of the highlights to look forward to in 2013 will be Copper 2013 on 1-4 December returning back to its country of origin, Chile (http://www.cobre2013.cl/index.php/en/). The Copper International Conference will be a good opportunity to meet and get together with leading research and development specialists in the art of copper making from all around the world.

Outotec has provided several publications to this conference. Brief summaries have been provided for your review in advance here. We also hope to see many of you in person at the conference in Santiago, where you can hear and learn more about our new product launches and campaigns.

Outotec will host a get-together on Monday 2 December starting at 7pm. We would like to invite our customers to join us for the Outotec after-dinner party. You can receive a personal invitation card to the party from smeltingnews@outotec.com or from the Outotec booth at the conference.

We look forward to seeing you at the conference and also at the Outotec after-dinner party!

» Kim Fagerlund
Vice President - Smelting
Recent experiences with implementing dynamic process control and monitoring in the flash smelting process

*Peter Björklund, Tiina Ranki, Elli Miettinen*

Introduction

Outotec has long experience with flash furnace process control. In recent years the emphasis has been on developing easy-to-use process control and monitoring software referred to as Expert Systems. The Outotec® Process Advisor is an online dynamic process control model with an operator-user interface, while the Outotec® Sentinel system is an online furnace integrity monitoring system for cooling elements. These software systems have been integrated into the Outotec Proscon® automation system, forming a complete process automation platform for smelter operations. This article focuses on actual experiences from a recent startup of this system.

**Outotec® Process Advisor**

The basic principle layout of the Outotec® Process Advisor is shown on the right.

The Process Advisor is a web-based software system linked to the Proscon automation system through an OPC (Object linking and embedding for Process Control) link.

The operator simply feeds the feed material analysis and target product grade into the Process Advisor. The Process Advisor then calculates the operating parameters taking into consideration the composition of the feed material and the current condition of the furnace. The parameters calculated by the Process Advisor are transferred automatically as new setpoints for process control after operator approval.

Online flow diagrams and liquidus slag diagrams are available for the operator. They also include history browsing.
Outotec® Sentinel

Outotec® Sentinel enhances furnace integrity by monitoring the process conditions and furnace wear based on information measured from the cooling waters. It protects the furnace by notifying about water flow drops, heat load peaks and excessive return temperatures. It can indicate abnormal process conditions, such as buildup, and estimate the condition of the furnace refractory lining. The Outotec® Sentinel solution improves operational safety and helps to reduce water consumption.

New automated cooling water headers are used to measure the heat loss of each individual cooling water circuit cost-effectively. The heat load pattern and analysis is graphically displayed in the Outotec® Sentinel’s operation display.

Startup feedback

Outotec’s Process Advisor, Sentinel and Proscon systems were started up together with the rest of the delivered equipment at the Parapanema S.A. smelter in August 2012. Hands-on training for engineers and operators was held on site, and everybody learned remarkably fast. The startup went smoothly, and all products were in use from the start.

One way of estimating the performance of the Process Advisor is to compare the matte grade (control target) before and after the startup. With the kind permission and help of the Parapananema S.A. smelter, we could put together graphs showing the situation before and after for a typical stable operational month for both cases. The standard deviation for one typical month of data dropped from 2.5 to 1.6 percent, showing that the process control is now on a very good level. The results are shown in the following pictures.
The Process Advisor is connected to the Outotec® Proscon system through an OPC (Object linking and embedding for Process Control) link. The Proscon system includes the start, stop and change sequences required for safe and easy process operation. Since all the main operating parameters are calculated with the Process Advisor, it is sufficient to operate the smelter with one screen if everything is running smoothly. The main screen includes the link between the Process Advisor setpoints and the Proscon system, as well as the detailed statuses of the automatic start, stop and change sequences. The main screen is shown in the following picture.

The Sentinel system was used for the new electric furnace’s roof cooling elements. The following picture shows a screenshot of the roof, with the blue selection showing a selected element with the details on the left-hand side of the screen. The graph on the bottom of the picture shows the trend for roof heat losses. The variations are related to the operational phase of the batch.

Through the integrated remote connection feature, it has also been possible to assist the client online with any issues after the startup.

**Summary**

New expert systems can result in significant improvements in process control. Equipment integrity and personnel safety can be maximized thanks to the constant monitoring and alarm capabilities of these expert systems. The Outotec solution combines all of these into a complete package.

Direct economic benefits can be achieved by stabilizing the process conditions, enabling lower copper losses, higher oxygen efficiency, lower energy costs and optimized shut-down scheduling for equipment replacement, which in turn can lead to improved furnace lifetime.
Environmental improvements for PS converters with Outotec’s Converter Hood Technology for primary and secondary gas capture

Per Brännström, Lennart Hedlund

Most smelters have changed their primary smelting technology. Reverberatory furnaces have been replaced by more environmentally friendly and energy-efficient furnaces, such as Outotec® FSF or TSL units. Once environmental performance has been improved for the primary smelting furnace, the focus switches to the acid plant (if single absorption) and later the converter aisle.

Converter hood technology from the beginning was designed for high false air to ensure that the converter hoods and gas outlet did not get to warm. (Picture 1)

A later attempt in converter hood technology was fitting converter hoods with water cooled jackets. Although environmental performance was increased due to closer fitting to the converter, still the converter hood was not close enough to the converter and there were other drawbacks, such as build-ups and intensive piping. (Picture 2)

Today, Outotec’s Converter Hood Technology has solved all of these past problems. The Outotec® Converter Hood is self-cleaned; Picture 3 shows how clean an Outotec® Converter Hood is after 10 weeks of production. Outotec’s water-cooled primary converter hoods enable sulphur and dust capture in excess of 95 percent. Outotec’s converter hoods for primary gas capture are designed for low false air inlet and high production without \( SO_2 \) leakage during production. (Picture 3)
Outotec® Smelting – Integrated, sustainable plant solutions

Kim Fagerlund

Outotec offers a very unique and exceptional combination of smelting process technologies together with state-of-the-art products and continuous development in our research laboratories and pilot-plants. The world’s leading smelting technologies are all now within the Outotec family: Outotec® Flash Smelting, Kennecott-Outotec® Flash Converting, Outotec® Direct Blister Flash Smelting, Outotec® Ausmelt TSL, Outotec® Kaldo, Outotec® TROF, Outotec® Electric Furnace, Outotec® Fire-refining and Outotec® Anode Casting. Outotec is not only able to evaluate the various complex raw materials that are available but also to provide the best available solution for the specific project. In addition, enhanced social responsibility and increasing governmental regulatory requirements are placing new demands on copper producers, and environmental approvals for new and existing smelting plants are increasingly more difficult to acquire.

Outotec® Copper Plant Solution

Primary copper smelting has long been the dominant processing route for copper production. In the past decade the proportion of global copper production derived from copper secondaries has been around 35%. However, certain trends are currently reshaping the industry, so some of these aspects need to be taken into consideration while also trying to predict the future. This paper looks at some of these industry shaping trends and provides examples of how different technologies and process knowledge can be combined in order to be able to respond to these challenges.

Figure 1 illustrates how the selection and combination of different process technologies can address certain trends and introduces the Outotec “Super-Smelter”. The process plant flow sheet in Figure 1 illustrates a high- capacity, continuous converting (can also be a direct-to-blister single unit) primary copper circuit, including precious metals recovery and a separate secondary e-scrap smelting facility.

Primary copper production in high production rates can be most efficiently treated in continuous copper smelting and converting facilities in combination with the treatment of high SO2-containing gases. The recovery of valuable metals can be ensured.
using Kaldo-based precious metals facilities. The treatment of secondary copper scrap and recycling of e-scrap using TSL Ausmelt in the same location would provide the best value for the investment and also generate savings. In addition, it would allow the optimal use of the same personnel, equipment, materials, transportation, infrastructural facilities and environmental approvals in the same carefully selected location. This type of super-smelter would also generate considerable employment and economic benefits outside the immediate industrial complex, making it attractive to the local business community and region.

Good examples of the flexibility and innovative use of one solution to achieve a more integrated and widely applied application comes from the combination of Outotec’s expert system, Sentinel cooling monitoring and cooling elements. Figure 2 outlines some of the new applications that are already in use, not only in flash smelting, but also in slag cleaning electric furnaces – and not only for copper, but also soon for other metals. These applications are not limited to a specific furnace and/or metal but can and have been tailored to suit different kinds of operations and metals.

Figure 2. Outotec’s expert system, Sentinel cooling monitoring, new continuous cast tap hole and ICE-design
Start-up & operation of the Daye Non-Ferrous Metals Company’s Outotec® Ausmelt Copper Smelter

Gavin Swayn, Jacob Wood, Stefanie Creedy

Executive Summary

In 2008, the Daye Nonferrous Metals Company (DNMC) signed an agreement to build what is to date the largest Outotec® Ausmelt TSL Furnace for the treatment of more than 1,500,000 dry tonnes of low grade copper concentrates. This formed part of a plant modernization project aimed at creating an “Energy Saving, Environmentally Efficient” (ESEE) Copper Smelter at the DNMC metallurgical complex near the city of Daye in Hubei Province, China. The overall project included the replacement of reverberatory and Noranda smelting furnaces with a single Ausmelt furnace and an ENFI designed and supplied Electric Settling Furnace (ESF). Other notable inclusions in the project were the construction of a new 700kt/a double-contact acid plant, a 28kNm3/h oxygen plant, a new Pierce Smith converter and an Outotec® Twin M18 Anode casting system.

During the initial stages of the plant commissioning and operation, concentrate feed rates were maintained at between 80 and 100 t/h, after which a step-wise increase in production to the design capacity was achieved following construction of the new oxygen and acid plants. Matte and slag grades from the ESF have been well controlled since start-up and are currently achieving the design targets of 55 wt. % Cu in matte and less than 0.75 wt. % Cu in slag.

The paper “Design And Commissioning Of An Outotec® Ausmelt Copper Smelter For Daye Non-Ferrous Metals Company Ltd” to be presented at Copper 2013 presents further information regarding this stepwise increase in production from commissioning to design capacity, in addition to details about operations over the following two years.

History of the design, construction, commissioning and start-up of the Daye ESEE Copper Smelter

In 2008, Outotec (previously Ausmelt) reached an agreement with DNMC to provide basic engineering services and equipment for core components of the Ausmelt furnace. Design information was provided over the following years, and construction of the plant commenced in 2008.

In early November 2010, cold commissioning of the Outotec® Ausmelt furnace and its ancillary systems was carried out by a team of Outotec engineers from Australia and China working alongside the DNMC and ENFI...
teams to finalize construction and cold commission the furnace, lance services, feed system, product handling system and Outotec designed and supplied Yokogawa process control system. Shutdown and demolition of the existing reverberatory copper smelting furnace also commenced at this time.

Heat up of the Outotec® Ausmelt furnace and ESF commenced in early December 2010 following the arrival of the Outotec hot commissioning team on site. DNMC continued to operate their existing Noranda furnace during the initial stages of the hot commissioning until the Ausmelt furnace operations were settled. At this time, insufficient oxygen plant capacity to meet the Ausmelt furnace design requirements necessitated modification of the lance valve train to allow for furnace operation at a significant turndown to design (40%) until construction of the new oxygen plant was completed.

On 28 December 2010, the first concentrates were fed to the furnace and a matte product produced. On 31 December, a continuous flow of matte and slag was achieved using the Outotec designed underflow weir, commonly installed on many larger scale Ausmelt copper smelting furnaces.

In late January 2011, following six weeks of onsite Outotec support, DNMC personnel were fully maintaining and controlling the Ausmelt furnace operations, and the hot commissioning team demobilised from site. In April 2011, a large jump in concentrate feed rates was achieved under the direction of Outotec personnel following the completion of construction and commissioning activities for the new oxygen plant. A further step change in throughput was achieved in August/September 2011 with Outotec’s site assistance after the new acid plant became available. Figure 1 illustrates this stepwise increase in smelter capacity during the first 12 months of operation.

Conclusion

The DNMC ESEE project is still today one of the largest Outotec® Ausmelt Furnaces in operation, both in terms of concentrate throughput and physical dimensions. The furnace is currently treating more than 1.0 million dry tonnes of concentrate per year to produce matte and a low copper content discard slag. During the last 2 years of operation, the combined resources of Outotec Ausmelt have provided ongoing support and technology to Daye in other areas of the plant and expansion upgrades. The Ausmelt TSL furnace forms one part of the technology packages available to clients offered by Outotec for lifecycle treatment of Earth’s resources.
Environmental footprinting of metallurgical copper processing technology: Linking GaBi to HSC Sim

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PE-International, Germany: Johannes Gediga, Harald Florin

This paper discusses the use of HSC Sim (www.outotec.com/hsc) and GaBi (www.pe-international.de) software for footprinting process technology and complete solutions. In a recent development together with PE-International, HSC Sim’s simulation functionality has been expanded to create files that can be exported in a format that can be loaded directly into GaBi to create a GaBi-plan (i.e. GaBi-model) from a complete HSC Sim flowsheet and subsequently produce an environmental assessment locally positioned wherever the plant is situated. This is very useful for evaluating existing industrial plants represented by suitable HSC Sim flowsheets, as well as for evaluating various scenarios to estimate the impact of newly designed solutions based on the rigor of metallurgical flowsheeting and associated process models.

Life cycle analysis (LCA) software generally relies on average process data for the various metals to assess their impact when used in products and applications. Environmental impacts can vary significantly from the average due to the variations in flowsheets and the application of best available techniques, in addition to processes being situated at different locations globally, impacts due to changing energy mixes, resource impacts, transport and other factors. It is therefore useful to evaluate the impact of specific processes at specific locations to assess their real impact.

Examples in this paper illustrate the benefits of connecting HSC-Sim™ and GaBi in order to perform an LCA as described in Figure 1 (next page). Such a connection enables highly detailed process information to be accessed through HSC, providing a rigorous basis on which to perform an environmental impact assessment. This in turn makes it possible to identify the best process options for each site based on the local conditions and energy footprints.
In addition to this LCA analysis, HSC Sim has also been expanded to include exergy analysis, which is useful for understanding the entropy flows in systems and permitting evaluating systems on a more fundamental basis. Combining detailed, plant specific, simulation-aided exergy analysis with LCA (Exergetic Life Cycle Analysis - ELCA) enables the identification of the most significant waste streams, exergy losses and potentials for environmental and process improvements.

This is illustrated by various brief cases in copper extraction, metallurgy, refining and recycling.

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, Outotec has developed over decades many breakthrough technologies. The company also provides innovative solutions for industrial water treatment, the utilization of alternative energy sources and the chemical industry. Outotec shares are listed on NASDAQ OMX Helsinki.