Refractory solutions for high production returns

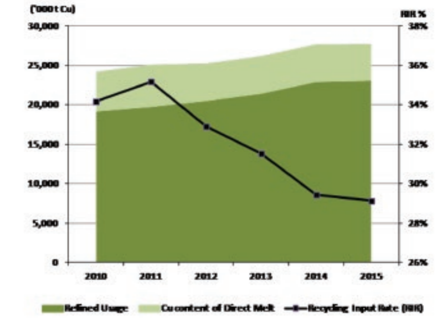
The capability to produce high quality copper wire from cheaper, dirtier scrap can improve considerably the profitability of secondary copper refining furnaces.

The global depletion of easily accessible primary copper reserves (from mined oxide/sulphide concentrates) has led to secondary copper processing assuming an ever-increasing importance within the worldwide copper industry. Secondary copper refers to all industrial wastes such as copper sheeting, bars, and pipes, to consumer wastes from brass and bronze applications, as well as used domestic wiring and plumbing fixtures. The contribution from secondary copper is a significant fraction of global copper production and is currently sitting at 29 percent.

Traditionally the treatment of secondary copper feeds at existing smelting operations was performed in a Peirce-Smith converter and/or anode furnace. However, there has been a shift towards secondary copper production units based on tilting anode refining furnaces due to their superior environmental performance and operational flexibility. These furnaces can efficiently process up to 250 tonnes of refined copper ready for use in continuous casting units and on-site drawing into electrical wire. Such companies as LAFARGA LACAMBRA have pioneered the use of secondary copper recycling for the last three decades on the production of a direct-to-copper wire process using scrap copper contaminated with increasing levels of impurities.

Impurities associated with these copper scrap materials are significantly different to those contained in primary concentrates, necessitating differing process flow sheets and operating conditions for impurity removal, along with specific gas handling/cleaning operations. These differences and variability in feed composition have implications on the design and operation of equipment and processes, presenting difficulties in the treatment of secondary copper materials within existing smelter operations. To address these factors, and the increasing availability of secondary copper feedstocks, several facilities have been established in the last decade for the dedicated processing of these materials. These operations have focused on achieving the necessary flexibility to adapt to processing and refining techniques that may vary considerably due to the variability of composition and origin of the scrap feed.

The most severe wear area occurs at the slagline on the burner wall adjacent to the tuyere line and above the tuyeres. This area is contacted by high temperature turbulent slag produced during oxidising and refining that chemically corrodes the brick lining. AUREX® 30SR mortared with SHAMROCK® 394 has been found to perform successfully in this area. In addition, flame impingement can result in rapid wear of the refractory at and adjacent to the main and auxiliary oxy-fuel burners. SHAMROCK® 493 is recommended rather than the commonly used magnesia-chrome castables in the burner areas of the furnace.



Global copper production 2010 - 2015.
Source: International Copper Study Group

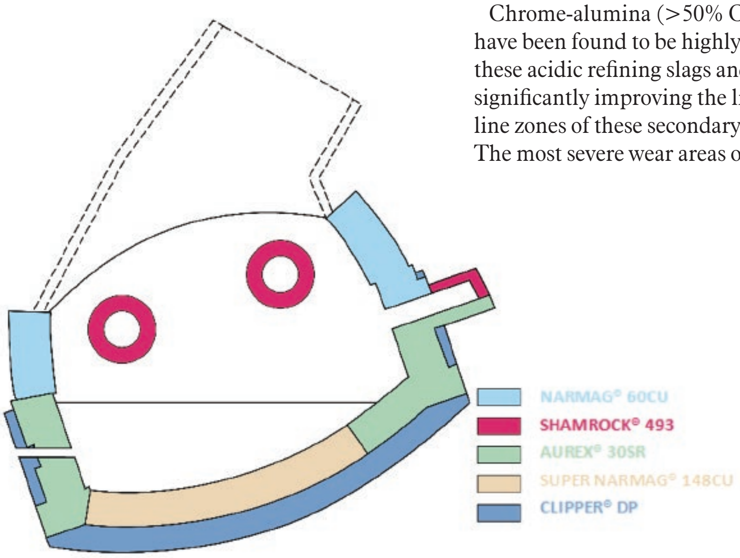
The heart of the process is the tilting reverberatory furnace. Originally these 125 t capacity furnaces were lined with magnesite-chrome bricks and castables to withstand the aggressive and turbulent copper oxide rich slags which form during refining. One oxy-fuel burner was normally installed at one end of the furnace, with additional auxiliary burners to accelerate melt-down of the charge. Charging and melting can take up to eight hours and once the initial surface slag has been removed, the oxidation of the molten bath is accomplished by injecting air. This injection is through lances (tuyeres) which are above the liquid metal level during charging and melting but are submerged by tilting the entire furnace when in the refining position. This operation can be conducted for up to three hours while the furnace is maintained at a position of 25° to the horizontal until the oxygen level reaches 10,000 to 12,000 ppm.

Photo of AUREX® 30SR lance port area after 200 heats with 6-8" remaining lining thickness

Refining techniques must be adjusted each time to match the composition of a given melt. Some impurities are relatively easy to remove such as iron, aluminium and zinc which oxidise rapidly and can be skimmed off the surface of the melt as a slag. However, lead, tin and especially nickel, which all have an adverse effect on copper rod electrical conductivity, 30will require the use of multiple refining cycles to be completely removed. At this point, after up to six hours of refining, a final slag skim is conducted and the injection of steam/natural gas drastically reduces the oxygen to 250-300 ppm before casting can begin.

The latest high production units of up to 250 t capacity, using two oxy-fuel burners in excess of 12 million BTU and oxygen-enriched injection for refining, are generating significant quantities of higher temperature corrosive slag, compounding the refractory wear issues. Direct-bonded magnesia-chrome linings, normally used in these furnaces, were found to be inadequate to deal with the increasing severity of the operation, and even up-graded brick formulations using fused magnesia-chrome components provided little or no improvement.

Chrome-alumina (>50% Cr_2O_3) refractories have been found to be highly resistant to these acidic refining slags and have aided in significantly improving the lining life in the slag line zones of these secondary refining furnaces. The most severe wear areas occur at the slag



Schematic of the lining of a furnace in tilted refining position line on the burner wall adjacent to the tuyere line and above the tuyeres. Initial slag line trials increased the lining life by up to 300% and the problem areas of the furnaces shifted to where flame impingement can result in rapid wear of the refractory in the roof and adjacent to the main and auxiliary oxy-fuel burners. The improved resistance of chrome-alumina refractory lining to the refining slags has allowed the increased use of more contaminated scrap, which can have a significant positive effect on the economics of the process and the bottom line.

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Author: Joe Rigby is presently the Senior Applications Specialist in the Industrial Metals Group of Harbison Walker International. He has been actively involved in the development of refractories and furnace design specifically in the copper/nickel industry for over thirty years. He has published several papers on the refractory selection, design and installation methods of linings for non-ferrous smelters, converters and refining vessels in the COPPER 1999, COPPER 2007 and COPPER 2013 global conferences.

Compact e-scrap plant ordered in Russia

A jointly developed process involving pre-treatments, pyrometallurgical processing, refining, casting and other integrated steps is now available.

Aurus, a company based in Moscow, Russia, has placed an order with SMS group for the supply of an innovative UrbanGold Compact plant. The plant will be located near Moscow. Around 6,000 tonnes of printed circuit boards will be processed by the plant each year. It will be used to produce LME grade metals such as copper, nickel, gold, silver and platinum. The process was jointly developed by SMS group GmbH and UrbanGold GmbH, Austria, as part of a cooperation agreement between the two companies. Aurus was founded by the Pik Group, a construction company, and IC VAP, a manufacturer of ferrous and nonferrous products.

The scope of supply of SMS group includes the supply of all components, i.e. facility for mechanical preparation of the raw materials, top blown rotary converter (TBRC), refining furnace (PolyRefine), casting wheel, electrolysis, gas cleaning plants, and the automation. SMS group will provide the engineering, supervise the erection and commissioning, and train the customer's personnel. UrbanGold, a spin-off of the SMS group joint venture partner Mettop in Austria, is responsible for the design of the equipment and for the metallurgical process. Commissioning of the plant is scheduled for 2018. With this, the first plant of its kind worldwide, SMS group and UrbanGold are demonstrating their expertise in electronic scrap recycling technology. Both companies together also offer a profitable integrated concept for smaller volumes of electronic scrap, with which valuable precious metals can be recovered cost-efficiently.

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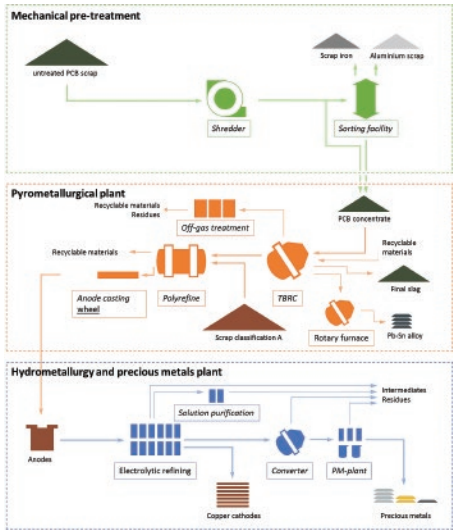

UrbanGold Compact flow diagram

Signing the contract in Moscow are: Dr. Rolf Degel (left), Vice President Nonferrous Metallurgy, and Dr. Guido Kleinschmidt (3rd from right), Member of the Managing Board, both from SMS group GmbH; Vladislav Sviblov, Vice President Development Pik Group, Russia (centre); Alexander Sharuda, General Director, (4th from right), and Vladimir Zotov, Development Director, (2nd from right), IC VAP, Russia.