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## **Melting and Refining Technology for Copper Produced from Scrap Charge**

### **An Innovative Approach for Refining Scrap Copper**

Air Products copper refining technology can refine copper scrap more economically than traditional methods. This technology replaces and surpasses conventional "fire-refining" of scrap-derived copper melts in large reverberatory furnaces.

With our technology, scrap copper is charged nearly continuously into a combination shaft/reverb furnace where oxy-fuel burners accomplish scrap melting and impurity oxidation at a near continuous rate. Oxidized and superheated molten copper is then periodically tapped (e.g., once every 2 hours) from the primary melter into a tuyere-equipped, rotatable, refining furnace. Here the copper is further refined through the submerged injection of gas mixtures involving oxygen, hydrogen and nitrogen.

This combination of technology and operating equipment provides the following advantages:

- Very high productivity from compact pieces of capital equipment.
- An ability to melt lower-priced, lower-quality scrap charge materials while surpassing the quality requirements for traditional fire-refined copper from scrap.
- A production method that enables air pollution emissions to be more tightly and easily controlled.
- The ability to achieve very specific and controlled low levels of dissolved oxygen in the final copper [e.g.,  $\leq 20$  parts per million (ppm) O.]

### **Insightful development**

Our basic copper refining technology was co-developed by Air Products and our customer, UCA, located in Liege, Belgium. Cooperative development began in 1980 and we first implemented the technology in three of UCA's modified and repositioned "sklenar" furnaces, or small tilting reverberatory furnaces.

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Together, we modified one of the larger sklenar furnaces [20 metric ton (MT) capacity] to be a three-burner, oxy-fuel fired melter, with a charge "chimney". Periodically, molten copper was tapped from this melting furnace, through a runner, to one of two smaller (12 MT capacity) sklenar furnaces, which were equipped with tuyeres for submerged gas injection for both oxidation and reduction. A process controller managed the flows of the tuyere-injected gases and switched the gases from oxidizing to reducing mixtures. This compact system, with a crew of three, produced molten refined copper at a rate of 8.8 metric tons per hour—a higher production rate than traditional operations achieve using a 200 ton reverberatory furnace. This equipment re-arrangement, modifications and processing system enabled UCA to produce refined copper with <20 ppm final dissolved oxygen. Plus they used much cheaper charge materials while maintaining a rate of 5.5 MT per hour.

This operating scheme yielded a higher quality product at a high rate. After a few years operating with the modified sklenar furnaces, the technology was implemented at a larger scale at UCA using newer and improved furnace equipment. In this configuration, baled and loose scrap copper is charged into the "chimney", or shaft portion, of a 35 MT capacity, modified tilting reverb furnace. This furnace has:

- Four oxy-fuel burners located in the lower portion of the ~3.5 meter tall shaft (2 burners on each side)
- Two air/gas burners on the downstream endwall of the furnace which can melt a 12 MT/hour

Once every 2.5 hours, the launder taps molten copper from the tilting reverb furnace and then it directs the flow of molten copper into one of two cylindrical-shaped, rotatable refining furnaces. Each refining furnace can hold 25 MT of molten copper and it requires 10 minutes to transfer the 25 MT of molten copper from the reverb to the rotary. During transfer, the copper loses some of its superheat.

The refining furnace maintains melt temperature at 1180°C (2156°F) by using a single air-fuel burner positioned in the upstream endwall of the furnace. Next, the submerged injection of gas mixtures refines (oxidizes and reduces) the molten copper. Then, gas is injected into the molten copper through four double-walled tuyeres located along a line in the side of the rotatable refining furnace. The tuyeres operate in one of four possible modes:

- a) Repose (i.e. "at-rest") - when no metal is covering the tuyeres
- b) Mixing - to simply keep the melt stirred
- c) Reduction
- d) Oxidation

Depending on the degree of oxidation, the reduction step typically takes 40-50 minutes for the 25 MT of melt in the rotary furnace to bring the dissolved oxygen down to less than 100 ppm. This is more favorable than traditional "poling" which only brings dissolved oxygen levels to the 200 to 300 ppm range. It is also more favorable than the injection of straight natural gas which cannot reduce dissolved oxygen lower than about 1000 ppm.

With our technology, we demonstrated that unwanted impurities of lead and tin can be oxidized from levels as high as 0.10 wt.% to below their specification of 0.020 wt.% maximum (the goal is 0.013 wt.%). The molten copper can then be deoxidized to very low levels of dissolved oxygen (e.g., 20 ppm).

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Our copper refining technology allows the use of higher-impurity charge materials, and still produce premium quality refined copper. In some applications, copper produced by this method may compete with copper that underwent electrolytic refining.

Off-gases from both the reverb-melter and the rotary-refiners are ducted to a cyclone dust separator and then to a baghouse. The entire melting and refining operation is very labor efficient, requiring only three operators: one to handle charging of the reverb, one on the reverb, and one overseeing both rotary refiners.

### **Summary**

Air Products copper refining technology can offer numerous benefits, including:

- Premium quality refined copper from lower cost charge materials.
- A highly efficient, compact and flexible melting system to replace massive and sluggish reverb furnaces with high operating costs.
- Quality levels (low dissolved oxygen) previously unavailable to fire-refiners.
- Higher productivity from modifying existing equipment.
- Reduced pollution and environmental concerns.
- High productivity per labor man-hour.

Through Air Products' participation and experience in the development of this technology, we can:

- Advise on the design of the furnaces and combustion equipment.
- Define operating parameters and flow control equipment to help achieve defined results through the appropriate gas injection.
- Apply knowledge based on development, technology transfer and operating experience.
- Provide start-up assistance and operator training.
- Arrange for observation and demonstration of the technology.

### **Contact us today**

For more information on how to produce superior refined copper for less, please contact us at 800-654-4567.

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