Product Spotlight...

Indalco Increases Furnace Capacity and Reduces Energy Costs by Changing Refractories

Indalco Alloys, a division of Lincoln Electric Company, produces aluminum weld wire and redraw rod. The plant in Mississauga, Ontario, Canada, operates a melting furnace and two holding furnaces that feed a continuous casting machine through a trough system. In the past, the company experienced problems with spinel growth that reduced the working volume of its furnaces and made them difficult to clean when switching alloys. Other problems in the furnaces included refractory wear on hearths and cracking in walls. Les Thoms, rod mill manager for Indalco Alloys, tried Stellar Materials' Thermbond refractory to repair a few areas of the melting furnace walls. Thoms noted that the spinel growth and difficulty in cleaning disappeared in the area where the new refractory was used. Over a few years, he replaced the walls and hearths of all three furnaces with Thermbond. The refractory provided superior resistance to penetration, which made it possible to reduce the thickness of the walls and hearths. This increased the capacity of the melting furnace by 18% and the holding furnaces by 25%. The new roof refractory material also provided superior insulating capabilities, which reduced the natural gas consumption by greater than 15%, saving almost $7,500 in fuel per month, based on an average 2015 unit cost of $0.2509/$m^3$.

Casting its own aluminum rod enables Lincoln Electric to hold extremely tight tolerances in the chemical composition of its aluminum metal inert gas (MIG) wire and tungsten inert gas (TIG) welding products. The company makes both 4000 and 5000 series wires, predominately 4043, 5356, and 5183 alloys.

Eliminating Spinel Growth

When Thoms first arrived at Indalco in 1999, the foundry had problems with spinel growth on its furnace refractories. Spinel, which is a crystalline form of magnesium aluminum oxide, reduced the capacity of the furnaces and made them difficult to clean efficiently. The company changes alloys as frequently as once per day and the furnaces had to be scraped clean each time. Washing out the furnace between alloys typically took 60-90 minutes per washout. "When we were having spinel problems, we frequently had to perform a second and sometimes even a third washout to fully remove the previous alloy," Thoms said. "This was very time-consuming. Another issue with the previous refractory was that repairs required ripping out and replacing a section of old material. Then we had to dry out the repair, which took about a week."

Stellar provided Indalco with samples of its Thermbond refractory and Indalco tried it out in spots on the furnace that needed repair. The areas that were patched with the refractory did not show any signs of spinel growth. Indalco used the refractory for additional repairs over the next year and decided that the areas that had been patched performed so much better that it could justify replacing the walls of all three furnaces with the new refractory. Jim Scott, Ontario sales director for Stellar Materials, suggested that the greater ability of the new refractory to resist penetration combined with the high insulating properties of the microporous insulation would make it possible to reduce the thickness of the refractory walls from 11.5 to 10 inches. This increased the capacity of the two holding furnaces by about 10% from 32,000 to 35,000 lbs.

Thermbond is a family of engineered refractories that consist of a two-part system including dry formulation and liquid activator. These materials are supplied as pre-measured components that are added together to form a unique, chemically bonded refractory. One advantage of this refractory is that it is considerably more resistant to cracking than conventional refractories. Another advantage of this material in aluminum foundry applications is that it is completely and naturally non-wetting to aluminum without the use of additives. This means that oxides don't penetrate the lining and can easily be removed during nightly cleaning operations without damaging the underlying refractory, ultimately resulting in a longer lining life. Other refractories typically use additives to achieve non-wetting characteristics, which eventually oxidize out of the products causing them to lose their effectiveness.

The new refractories have been in place on the walls for about 15 years. Spinel is no longer an issue. The elimination of spinel growth saves considerable time in cleaning the furnace when changing alloys. In some cases Indalco can now completely clean the furnace with a single washout. Indalco has also seen reductions in maintenance costs with the new refractories. These refractories have required only minor repairs during the biannual shutdowns in some years and in other years no repairs at all have been needed. "With our new refractory we don't have to tear anything out, we simply add a patch," Thoms said. "Then we do a small dry-out based on the size of the patch. The typical time required for the dry-out is only about 30 hours. So we get the furnace back into production 5 or 6 days sooner than in the past."

Thinner Hearth Tiles Without Defects

These improvements spurred Indalco to look for other areas where refractories could be upgraded. A number of issues were previously experienced with the furnace hearths. When changing alloys, it was necessary to drag a rake across the hearth. When T-bars are dropped into the melting furnace or scrap into the holding furnaces, they often hit the hearth, which in the past frequently created dents or chips. Over time, the hearths developed crevices and potholes that increased the time required for cleaning. These defects in the surface also made it necessary to use a relatively thick refractory in order to avoid damage to the lining.

Installing Stellar's engineered precast tiles on the hearth made it possible to reduce the hearth thickness from 12 to 8 inches (Figure 1). These cast and fired shapes were ordered to fit the specific dimensions of the three hearths. The tiles are formulated to yield high abrasive wear resistance, excellent mechanical strength, resistance to temperatures up to 2,700°F (1,482°C), and thermal shock conditions. Indalco installed the first hearth tiles in a furnace in 2004. Four years later, the hearth was in such good condition that the company put the tiles into

its other two furnaces. To date, these refractories are all still in use and have required only minor repairs.

Changing the walls and the hearths of the three furnaces has provided a substantial increase in production. In the past, each cast produced 32,000 lbs while today each cast generates 40,000 lbs of product without requiring capital investment or additional labor costs.

New Roof Lining Reduces Energy Costs

Indalco was also able to substantially reduce fuel costs by changing the dense roof lining of all three furnaces to Stellar's Maftec® insulating fiber (Figure 2). Designed for continuous use applications up to 1,600°C, Maftec is a polycrystalline alumina fiber that does not change molecularly through the temperature range until it melts at 1,850°C. Comprised of a pure mullite chemistry, Maftec demonstrates exceptional chemical resiliency to the fluxes and other chemistries present within aluminum furnaces.

Figure 1. Installation of ceramic tiles in a furnace hearth at Indalco.

Figure 2. New panel for installation in roof lining of furnaces.

An added benefit of Maftec technology is that the fiber diameters range between 5 and 7 microns, effectively preventing Maftec fiber from being respirated.

"After switching to the Maftec roofs, we saw substantial improvements in fuel efficiency," Thoms said. Historically, 0.1532 m^3 of gas was required per pound of rod produced by the foundry. After installing the new roofs, the amount of gas required per pound was reduced by 20% to 0.1224 m^3.

"Switching to new refractories has helped us substantially improve the operation of our aluminum casting operations," Thoms concluded. "The higher performance of the new refractories helped us increase the capacity of our furnaces by 33%. We have saved considerable additional time, both during washout for alloy change and by greatly shortening the dry-out time required after repairs. This means we have more time for melting and casting. Finally, we have achieved substantial cost reductions through the superior insulating properties of the new furnace roofs. All in all, by substantially improving our refractories, we have made a considerable improvement in our competitive position."