

Novel Ceramic and Refractory Components Improve Aluminum Melting and Casting

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Molten aluminum is a corrosive material that produces intense heat during smelting and casting processes, causing ceramic and refractory components to suffer thermal shock, erosion, wetting, and corrosion. These problems increase costs by degrading and destroying components, raising energy consumption, shortening component service life, and causing defects in the aluminum. To combat these effects, Pyrotek, Inc., a leading supplier of consumable products and melt treatment solutions for the aluminum industry, partnered with Oak Ridge National Laboratory (ORNL) and the University of Missouri-Rolla (UMR) to develop and validate new classes of cost-effective, low-permeability ceramic and refractory components.

The primary goal of the project was to develop materials and methods for sealing surface porosity in thermal-shock-resistant ceramic refractories, specifically for use on dense fused-silica (DFS) riser tubes (see Figure 1). Minimizing permeability and increasing pressure-holding capacity in these tubes increases their resistance to molten aluminum attack, effectively enhancing refractory performance. Benefits include reduced downtime, fewer defects, decreased scrap-rework costs, and energy savings from higher yield and productivity. The partnership successfully developed coatings as well as fused silica castables. The superior performance and durability of the castables have proven to increase the lifespan of DFS riser tubes by up to 700 percent.

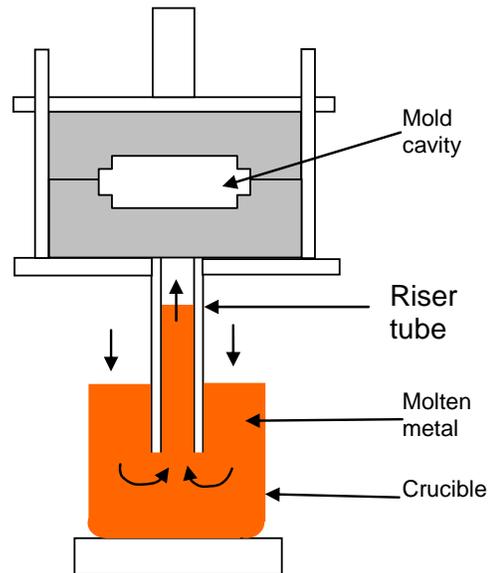


Fig 1. Schematic showing utilization of riser tube during low-pressure die-casting process.

- *XL Glaze*
“XL” glaze is a zircon-based coating material system developed at Pyrotek. Researchers faced the challenge of developing a glaze that could increase tube lifespan while matching dense fused-silica’s low coefficient of thermal expansion (CTE). Tests show that XL-coated DFS tubes last three to five weeks, in contrast to uncoated DFS tubes, which last only seven days. Pyrotek has already sold about 1,200 of its XL-coated DFS riser tubes (see Figure 2), and has reported an accelerating volume of inquiries, suggesting a growing awareness of these enhanced riser tubes within the refractory and aluminum industrial community. Pyrotek is routinely manufacturing the tubes and supplying them to its customers.
- *Fused Silica Castable*
UMR developed a computer model that suggested optimized particle packing or particle size distribution (PSD) could minimize permeability in monolithic fused silica castables. Four full-scale fused silica castables were then formulated on the basis of

this computer model. The castables are currently being manufactured at Pyrotek and are also undergoing field testing at General Aluminum in Wapakoneta, Ohio. Preliminary test results show that these silica castables last for 8 weeks during aluminum casting operations, indicating a 700% increase in the service life of riser tubes (see Figure 3). Replacing traditional riser tubes with this improved version has the potential to save 206 billion Btu per year nationwide.

Beyond the aluminum and metal casting industries, these improved ceramic and refractory components may be applied in the chemical and petrochemical industries to improve corrosion resistance and enhance the performance of several types of chemical reactors, and in the glass industry as a potentially enabling technology for oxy-fuel firing.



Fig 2. Full scale XL-glaze coated dense fused silica

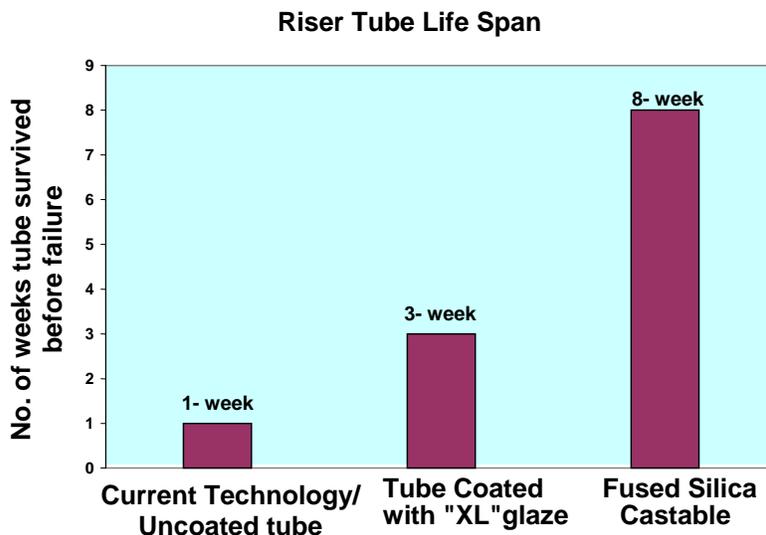


Fig 3. Life extension in riser tubes resulting from coatings and castable refractories

For additional information about XL-coated DFS riser tubes or monolithic fused silica castables, contact Greg Hodren at Pyrotek at (717) 249-2075 or grehod@pyrotek.com. Additional information about industrial materials for the future is available at www.eere.energy.gov/industry/imf/pdfs/pyrotec_tubes.pdf

References:

Development of Cost-Effective Low-Permeability Ceramic and Refractory Components for Aluminum Melting and Casting, project factsheet website:

http://www.eere.energy.gov/industry/imf/pdfs/pyrotec_tubes.pdf

Development of Cost Effective Ceramic and Refractory Components for AL Melting and Casting, Project Summary Form (CPS 1764), project report website:

<http://www.eere.energy.gov/industry/imf/pdfs/1764ceramicandrefractorycomponentssum.pdf>