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ask the expert...

RFM® THIN WALL LADLE BOOSTS METAL CASTING PRODUCTIVITY

Jeff King,
Pyrotek Foundry
Sales Engineer

Pyrotek Inc. introduced standard universal mount RFM® refractory composite auto ladles in 2004. Since their introduction, RFM ladles gained wide popularity in squeeze cast, sand and permanent mold aluminium casting processes because they reduce the level of oxide-induced scrap due to their non-wetting properties, and have a longer service life compared to fiber laminate ladles. The new thin wall RFM ladles offer increased benefits for diecasters. A specialist in this field, Jeff King, Foundry Sales Engineer, Pyrotek Inc., Columbia City, Indiana, outlines the background and advantages of these ladles in responding to questions commonly posed by potential customers.

Q. What do we mean by RFM ladles?
A. Diecasters use auto ladles to deliver metal from the holding furnace to the shot sleeve. They have a choice of steel, cast iron and fiber laminate materials. Pyrotek has developed an RFM thin wall ladle designed to address the needs of the high pressure diecaster, needs that are not always addressed by the standard universal mount RFM family of ladles. The primary difference between the popular standard universal mount RFM ladles and the RFM thin wall ladles is the thickness of the ladle wall, and the underlying support structure. The thickness has been reduced from 20–25 mm to 7 mm in order to accommodate the smaller operating envelope for the diecaster.

RFM, an acronym for reinforced fiberglass material, is a composite material from Pyrotek, either calcium silicate based (RFM CS) or fused silica based (RFM FS). Material selected for use is dependent on the product application and desired properties.

RFM can be formed into complex shapes with thin walls. The material exhibits exceptional non-wetting properties against molten aluminium alloys, and because it is a composite, RFM has a high resistance to fracture.

RFM ladles greatly reduce thermal conductivity when compared to steel and cast iron. This material retains metal heat between pours—and, especially more metal heat is saved from dip to pour when compared with other materials.

Pyrotek has established that it is possible to lower the operating furnace temperature for diecasting between 10–20°F. Because RFM has better metal heat retention, the holding furnace temperature can be reduced and still deliver the same temperature metal to the shot sleeve. This reduction in furnace temperature can result in a savings of thousands of dollars each year in energy consumption. The quality of the metal can also be improved by this reduction in holding temperature.

Steel and cast iron lose heat after pouring and this cooler ladle in turn cools the molten metal rapidly when dipping the next shot. In the first 5 seconds after the ladle dips metal and raises it out of the dip well, the RFM ladle shows an average temperature drop of 10°F while the steel ladle dropped the metal temperature an average of 30°F. The most dramatic temperature drop occurs in the first few seconds after the ladle is filled. The metal temperature does not change as dramatically during the remaining time until the ladle is poured.

Q. What are the main materials and design considerations for these ladles?
A. The primary design features of the RFM thin wall ladle are to address the specific needs of the high pressure diecaster, including: an RFM composite material for the ladle body; thin walls; consistent shape, and a boron nitride coating.

Q. What is the significance of thin walls and ladle shape?
A. The diecasters' operating envelope is characterized predominantly by a small dip well in the holding furnace, and a narrow path to the opening of the shot sleeve. Other requirements are to have no interference with the auto-ladler robotic arm as the ladle traverses from the dip well to the shot sleeve and also to eliminate the contact with the diecast machine platen upon rotation when pouring metal into the shot sleeve.

The RFM thin wall ladle walls are 7 mm thick in order to accommodate the small operating environment. The side walls are reinforced to create a more robust area for the bracket attachment site.

RFM ladles are fabricated using a method developed to provide a consistent inner shape. This allows the operator to exchange one ladle for another without adjustments to the auto ladle robot program parameters.

Q. What special coatings are applied?
A. A ZYP boron nitride coating surface application prevents aluminium from sticking inside the ladle and extends the service life of the RFM material by repelling surface metal adhesion and protecting the substrate material from attack by the molten metal. The corrosion process of the molten metal gradually removes this protective coating and reapplication becomes necessary. Metal buildup in the ladle leads to a reduction in ladle volume, leading to maintenance and downtime.

Boron nitride coatings offer various process advantages. They are safe, water-based and easily applied. They are non-wetting and non-stick with molten aluminium, and they are protective to ceramics and effective in reducing maintenance.

Aluminium skim buildup, which can adhere and cause substrate damage, is removed from the base material much more easily if the material is coated with boron nitride.

Q. Are there any endorsements of the ladles in practical applications?
A. The ladles have been proven to improve operating performance with a range of benefits in many diecasting customer situations. For example, a case study was carried out at one diecaster that operates eight machines running 24 hours each day, five days each week. The cycle time was 70 seconds, or 1,234 shots per day, with two castings per shot, totaling 2,468 parts/day. The baseline comparison ladle was a 12 pound fiber laminate unit.

The results showed that the non-wetting boron nitride coating prevented aluminium from sticking inside the RFM thin wall ladle, which contributed to a reduction in downtime for ladle maintenance and cleaning. The average machine downtime for ladle maintenance for thin wall RFM ladles was 2% compared to 20% downtime for the fiber laminate ladle.

The contributing factor leading to the increased downtime for the fiber laminate ladles was aluminium buildup inside

the ladle leading to a lack of aluminium delivered to the shot sleeve and a subsequent non-fill casting.

Using the RFM ladle with all eight machines provided the customer with an annual savings of over USD$ 130,000.

Q. What overall benefits and advantages are offered?
A. The RFM thin wall ladle delivers wide-ranging benefits, including the following:

- Reduced buildup of aluminium inside the ladle—a problem that leads to non-fill scrap castings
- Reduced casting machine downtime—an expensive consequence for the diecaster
- A consistent ladle shape that reduces installation time and does not require re-programming of the auto-ladle robot, providing improved repeatability from ladle to ladle
- Reduced energy costs
- Lower holding furnace metal temperature
- Longer service life
- Less operator labor for ladle change-out, cleaning, maintenance
- Lower acquisition cost vs. service life

RFM thin wall ladles have been shown to last an average of 6 months, 4–6 times longer than the fiber laminate variant.

** Jeff King delivered a detailed presentation on this topic at the North American Die Casting Association's – 114th Metalcasting Congress, staged in parallel with CastExpo'10, March 20–23, 2010, Orlando, Florida, USA. This presentation can be viewed from the Pyrotek web site. Search for "ladle presentation."*

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