

Ladle Shell Insulation

Question

Shell temperatures on steel casting ladles have been exceeding design standards for the steel structure in our operation. The steel shells of the ladles are warping and several breakouts have occurred that may be related to overheating of the shell. Attempts to insulate the lining have resulted in minimal benefit in reducing shell temperature and in some cases breakouts have occurred. How can the shell be protected?

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Answer

As the use of high density, high conductivity refractories increases due to the longer life that can be achieved, more heat is conducted through the lining to the ladle shell. This coupled with the reduced lining thickness at many mills (to increase heat size), and longer hold times, to allow more post treatment of the product, can significantly raise the temperature loading of the shell. The effects of this high shell temperature can be increased fatigue of the metal, deformation of the structure, and even loss of containment of the liquid steel. Costs of increased maintenance on the ladles shell, shortening the life of the ladle shell and the danger and costs associated with a breakout make this condition unacceptable for operation of the meltshop.

Use of traditional insulation materials in the application have led to problems. Traditional insulation products are usually low density to provide for low thermal conductivity. This also tends to make the materials low in strength and therefore compressible or crushable in service. When insulation is placed between the shell and the refractory lining, it is subject to high compressive stresses as the lining expands from the operating heat load. This crushes or compresses the insulation yielding two results, 1) the insulation becomes thinner and more dense, losing effectiveness, and 2) because the insulation is not strong enough to resist the expansion of the lining, the working lining loses compression and joints in the lining open, allowing steel penetration and ultimately breakout.

High strength insulation is now available that is strong enough to prevent crushing of the insulation layer of the lining. When this material is used between the shell and the lining of the ladle, shell temperatures can be safely reduced.

The lining is maintained in a stable, compressed condition. This keeps joints tight and prevents breakouts. High strength insulation is available in calcium based and magnesite based materials. It is important to know the temperatures the insulation will be subject to in service because the calcium based materials will begin to shrink at a much lower temperature than the magnesite based materials. This shrinkage can destabilize the lining as well and allow breakouts.

Answer provided courtesy of Mike Maupin of Maupin Enterprises - Refractory Consulting and Insulation Materials Agent for Pyrotek
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