Gunite Refractory Installations

by Ted W. Sofis

Refractory gunning, like any other gunite/shotcrete work, has much in common with the practices and procedures that one would typically use in any other good installation. There are, however, some other things that differ and need to be given the proper attention.

Predampening

Refractory materials are typically packaged in a premixed state in 75 and 100 lb (34 and 45 kg) bags or in 3000 lb (1361 kg) super sacks that can be handled with a forklift. The aggregates are kiln dried so there is no moisture in the prepackaged refractory materials. For this reason, it is advantageous to predampen the refractory material by adding a moisture content of 3 to 6% to the dry mixture. The dampened material has several benefits. First and foremost, there will be less airborne dust in the work area which, depending on the ventilation, could be a major health concern. There is less separation of the dry aggregates and cement binders as the predampened material moves through the hose, which will result in a better finished product in place. Also, the dampened material accepts the water better when the entire amount does not have to be introduced at the nozzle. Therefore, the hydration of the refractory material is better and, because of this, there is less rebound. Predampening is most effectively achieved by using an auger-type predamper where the material is continuously fed into a rotary gun providing an uninterrupted flow of moistened material. Other effective methods are using the paddle-type mixer conveyor rigs with an overhead holding hopper where one can predampen the refractory material batch by batch. On smaller jobs where production is not an issue, a paddle mixer can be used. A prewetting nozzle can also be used where there is a second water ring several feet back from the nozzle, but this is less effective than the auger or paddle mixers. It is also beneficial to use a Spirolet nozzle which has a rifled spiral in the nozzle where the water and material will more thoroughly mix at the nozzle.

Anchoring

Unlike conventional shotcrete installations where wire mesh and reinforcing bars are placed in horizontal and vertical patterns in the center of the sprayed material, refractory anchors typically extend directly out from the gunning surface almost to the surface of the gunned lining. The reason for this, in high temperature applications, is that as the temperatures increase, the metal expands, creating horizontal shear planes in the refractory which in turn can cause delamination and spalling. The most commonly used anchors are the V-Type refractory anchors which are usually made of 304 stainless steel rods. The point of the V-anchor is typically welded to the steel shell and the two legs reaching toward the surface. These anchors can be installed on regular centers depending on the thickness of

Predampener feeding material to a rotary gun

The ungunned area to the left shows the V-Type refractory anchors with monolithically gunned refractory

Ash hopper sidewall (left) with the refractory gunned to full 9 in. (229 mm) depth and V-anchors (right)

Completed opposite wall section of the ash hopper reline, October 2007

the lining. Because they are vertical to the lining, there is no shear plane. The advantage of using a V-anchor is that it creates an inverted wedge and the shortcrete can be applied to its full thickness in one application on overhead and vertical installations. On burners or on boiler tubes where only a 1 or 2 in. (25 or 50 mm) lining is necessary, a straight stainless steel stud is often used.

Refractory Gunning

When installing refractory, it's important to follow good gunning practices. This means keeping the nozzle as close to a 90-degree angle to the gunning surface as possible. Try to maintain a circular gunning pattern and never shoot over rebound. Rebound is expended or improperly hydrated material that bounces off the gunning surface. Gunning over rebound in high-temperature applications will ultimately lead to failure. So care should be taken to ensure that any rebound that collects is properly cleaned out. This can be easily achieved by shutting off the material at the nozzle and turning up the air pressure air to blow out the corner or area where the rebound has collected. While gunning refractory, it's important to bring the refractory material out the full thickness in one pass rather than in layers. A monolithic lining with no laminations will provide a superior result. When the refractory is gunned to the full thickness, vent holes should be poked in the green material with a straight steel rod to the full depth of the lining, on approximately at 12 in. (305 mm) centers. Venting the refractory is extremely important because it provides a place for the steam to escape during the heat up. During a heat up, it is not uncommon to see steam coming out of all vent holes. Entrapped steam has a tremendous amount of power and if the unit is heated too quickly, it can cause an explosion. This occurred 25 years ago on a project at the U.S. Steel Edgar Thompson Works when the temperatures were brought up too quickly. As a furnace is heated, the chemically combined moisture in the new refractory material migrates away from the hot face toward the steel shell, and when it reaches the steel, the steam escapes back toward the heat source through the vent holes. Therefore, taking the time to properly vent the shotcreted refractory is essential. Quick fire fibers are now common in refractory installations. The quick fire fibers are typically made of polypropylene and burn out quickly when the temperature increases, creating fissures and avenues for the steam to escape. Even with quick fire fibers, it remains a good practice to vent the gunned refractory. Also when cutting down the shotcrete, it is recommended to use the edge of the trowel to leave a textured finish, which will facilitate drying, rather than a slick trowel finish, which tends to seal moisture in the shotcrete and can lead to surface spalling.

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