STEAMING GENERATED DURING

REFRACTORY DRYOUTS

A DISCUSSION

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The topic of observing steam during a refractory dryout has been an ongoing one for many years.

After over 10,000 projects in over 40 years, we have come to the conclusion that in the several dozen jobs where a portion of the lining experienced steam spalling, THE STEAM WE SAW ON THE OUTSIDE OF THE FURNACE OR VESSEL IS NOT THE STEAM THAT CAUSED THE BLOWOUT!

Some points:

1. Initially we advocated having weep holes in shells or metal claddings to vent steam generated during dryouts. After observing <u>many</u> furnaces in the process of steaming, the location and amounts of steam being generated did not make technical sense. Steaming would first be observed at the intersection of a runner with the furnace rather than at a massive sidewall with a considerable larger amount of water due to heat penetrating the thinner refractory lining first.

2. Steaming can only be seen where the refractory is exposed to the atmosphere. Obviously, where you have a metal shell you can't see steam. If an aluminum furnace would not be encased in steel you would not see <u>any</u> steam. Because steam can only be observed when it condenses in sufficient quantities, and will be considerably more visible in colder temperatures than in warmer temperatures. Usually this develops after several shifts.

3. After a few years of serving a number of industries, we started working in the petrochemical industry. There, large pressure vessels with refractory up to three feet thick, were heated with Hotwork burners. Suggesting installing weep holes was obviously out of the question. The refractory was as prone to spalling as other industries, but the incident rate was no greater. Mike Crowley observed that even though the refractory is cast directly against the shell, the interface effect is formidable and acts as a channel. The moisture travels between the shell and the refractory and escapes as water or vapor or steam at available openings in the vessel, even in large spheres with remote vent points.

4. Internal steam generated during the first several hundred degrees vents through the hot face of the refractory. This phenomenon is documented by technical data and is further supported by the "wetness" of the exhaust stream which can be easily felt at the beginning of the dryout. However, after several hundred degrees the process reverses and the moisture travels towards the cold face of the material. The internal vapor pressure near the hot face has become higher than that near the cold face, making it easier for the moisture to travel towards the cold face. It travels a long way through the lining during which time it condenses and is ultimately visible as water and/or vapor when it emerges.

5. Most refractory failures caused by steam spalls occur within two to four inches of the hot face and not near the shell. It is the steam which is trapped in this high pressure region within the refractory that causes the problem. Obviously it cannot be seen.

6. Should we, therefore, ignore steaming when we observe it? We don't believe so. We should be keenly aware when the whisks of steam develop into pressure steam. Pressure steaming is defined by the inability to hold your hand in the stream at a distance of four inches from the source for more than ten seconds. Whisks of steam are not a problem and is a positive indication that the Hotwork burners are doing their job.....driving the water out of the refractory. Most refractory manufacturers have revised their statements regarding steam and now refer to "pressure steam" in their dryout instructions.

7. Research on drying and heating of refractory linings has been ongoing within a number of technical groups. A major research project is presently being conducted at the University of Missouri - Rolla in which we as a company participate and financially support. Predictions are that permeability and network strengths to tolerate internal vapor pressures will dictate heating rates. What is emerging is the understanding that in heating a monolith from one side, a very complex heat and mass transfer phenomenon exists which includes many and constant chemical reactions, changes in conductivity, internal pressure changes, and mechanical stresses.
