Seven Signs to Ensuring Reliability in your Furnace

Authored by Steve Chernack, Morgan Advanced Materials and Hyunjin Yoon, SK Energy

Refractory engineers are constantly under pressure to ensure improved reliability of fired heaters, kilns and reactors across a range of industries. Key to peak furnace performance are refractory materials and lining reliability, which, when chosen correctly, help optimize production yield and minimize energy loss and downtime.

When refractory materials fail, furnaces and heaters begin to experience problems. This can be avoided through careful collaboration between end users and refractory material suppliers. By understanding the common signs of refractory failure, engineers can carry out maintenance to both fix a problem and avoid it in the future. In this article, SK Energy and Morgan Advanced Materials highlight seven signs to look out for.

1. Fiber Modules Fallen from the Roof

This can happen for several reasons but is most often material-, design- or installation-related. When modules and support anchoring are missing, the cause is often an installation issue such as insufficient stud welding or excessive corrosion from the shell, which is caused by sulphur or rust. If most of the fiber is missing but the support anchoring is OK, the likely cause is mechanical abuse – something like water placing excess weight on the fiber. Remember that fiber is 90% porous and can absorb its own weight several times over. Engineers should always check the fiber for any signs of tears in the anchoring or water damage. Are there gaps in the fiber? Is a hot spot associated with the gaps? Always check the fiber chemistry and design to ensure you can quarantine fallen fibres before the issue spreads.

2. Failing Brick Walls: Deformation or Collapse

Insulating firebricks (IFBs) are commonplace in many fired heaters and require good materials, design, and installation for a long service life. Close examination of IFB linings can help pinpoint whether they were the root cause in the event of failure. Look for hot spots outside the unit. If the wall is in bad shape, this may indicate issues with the backup lining. To address voids, pump hot-spot repair materials in from the outside of an operating unit.

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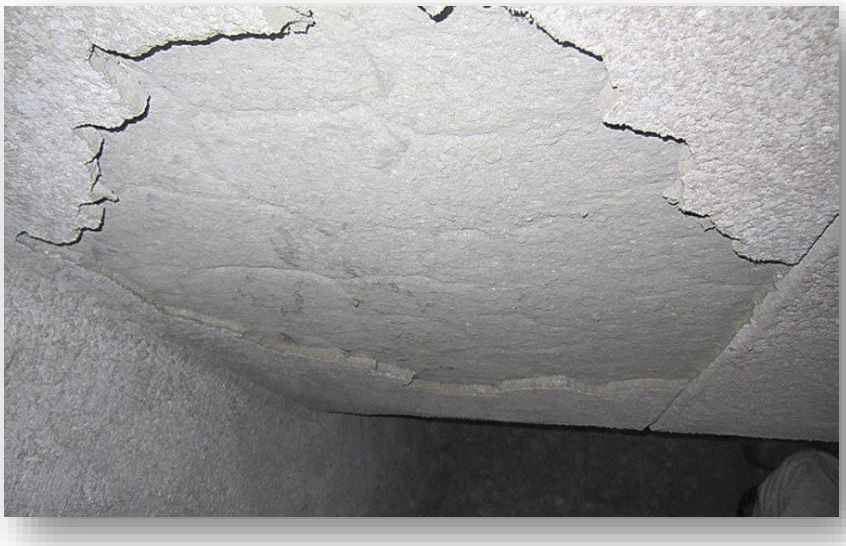
It is also important to look at the face of the brick. It may have melted or cracked, which indicates higher furnace operating temperatures, possible fuel impurities or the wrong grade brick being used. If the hot-face brick is in good shape but the wall is bowed, this could be due to inadequate thermal expansion provisions, which can also be a result of changing operating conditions and higher outputs or box temperatures.

3. Bridgewall/Tunnel Wall Leaning or Deformation

Furnace walls often lean to some extent, but failure can occur if this is excessive. This is often because the floor is not level. Some wall issues are also a result of inadequate expansion provisions in wall design. This is often a problem if operating conditions are increased to higher temperatures than first anticipated. Not all firebricks are created equal, and they all differ in formula, firing and high-temperature properties. To make the best selection, investigate both the ambient and high-temperature strength properties. Reliability is always a more important factor than price. The best products for the job are typically not the cheapest.

4. Castable Cracking



Castable linings are not in a finished state when they leave a manufacturing facility, so final quality is dependent on the installer. Materials must be mixed with clean water of the correct temperature range, installed, and cured before water is removed during the dry-out. If dry-out is not done in a slow and controlled manner, the castable can explosively spall. Shrinkage cracking should be expected, but if this becomes excessive it could be a consequence of poor installation and may indicate that too much water was used.

5. Floor Cracking/Heaving

Floor cracking occurs when temperatures surpass those accommodated in the original design. By protecting provisions for reversible thermal expansion or expansion joints in the floor, you can prevent them from being filled with debris during operation, which limits the gap's movement capacity. Get into the habit of vacuuming gaps to avoid build-up of debris.

Floor cracking is also common when dissimilar materials are used. If you have a floor-fired unit, you will have castable burner blocks of a certain material grade and a different floor material surrounding the burner. Cracks will appear at the corner of the burner blocks if adequate expansion joints are not installed.

6. Convection Castable/Corbel Damage in Convection Section

Castables are prone to damage during construction and shipping, such as cracks running through the entire thickness. There may also be some pinch spalling at the surface, which indicates directional mechanical flexure of the steel. As corbels protrude from the base lining they can also become susceptible to damage, which should be quickly repaired. Always ensure any affected portion of the lining is removed and replaced to avoid damaging surrounding materials.

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7. Mating Dissimilar Materials

Dissimilar refractory materials adjacently located are common, particularly surrounding openings such as doors (fiber and brick), peep sights (IFB, castable, fiber modules), burner blocks and pressure-relief doors. Because dissimilar materials have different refractory properties at elevated temperatures, this makes a homogenous design difficult.

In many cases outlined here, the hot effluent gases will make their way through the compromised refractory lining, resulting in hot spots on the outer casing. If these surround peep sights and door openings, it is possible that the interface designs are inadequate. In the case of the peep sight, you should use similar refractory materials to those surrounding the opening to avoid design issues and to create the best-possible seal.

Tube seals will also provide personnel protection, encouraging an influx of ambient air into the furnace. For peep sights and walls, always use a high temperature fiber expansion joint because this will avoid the issue of having to mate an expanding material (IFB) with a material that expands and shrinks differently (castable).

Closing

To highlight in-depth best-practice maintenance that should be carried out on fired heaters, kilns and reactors, Morgan Advanced Materials and SK Energy have collaborated on this white paper. This highlights some of the common signs that failure is imminent and how to determine root causes, as well as shares refractory lining best practice to improve unit reliability.