Repairing damaged refractories keeps air out, boiler performance up

Many power boilers built before 1960 were conservatively designed and built and still have steam-drum and boiler-tube wall thicknesses capable of maintaining rated pressures and loads. However, these units are not immune from other age-related deterioration that can cause poor thermal performance and higher-than-expected air emissions.

Al Brandstatter and Howard Sawatzki, Plibrico Co, Chicago, Ill, detail how advanced refractory-repair techniques can be used to solve air in-leakage—a major cause of performance degradation for aging boilers. Old refractories often deteriorate very gradually. Thus, air in-leakage also increases gradually with time and may even go unnoticed until boiler performance degrades significantly.

Air leaks can cause poor performance because a portion of the furnace's heat is absorbed by the extra air and is ultimately lost up the stack. In addition, excessive air in-leakage can lead to high CO and NO_x emissions (POWER, July 1992, p 56).

Measure excess air. To eliminate air leaks, one must first determine if excess air is above desired levels (Fig 3). For efficient operation, coal-fired boilers typically require 30-35% excess air, oil-fired units 15%, and natural-gas-fired units 10%.

After it is determined that excess air is too high, the root cause must be tracked down. The first response should be to make sure that the induced- and/or forced-draft fans and dampers are operating correctly. If excess air levels remain high after these systems are adjusted, deteriorating refractory is most likely the problem.

Detect cracks. Cracks most frequently appear in brick or tile refractories along mortar lines and expansion joints or—in rammed plastic refractories—along lamination lines between slabs of material that were not rammed thoroughly enough to unify them into a true monolithic mass. Note that cracks do more than admit air; they also allow flyash to build up behind the refractory. The buildup can eventually cause enough pressure to distort the furnace's exterior steel plate and/or collapse the refractory into the furnace.

By opening a path to the exterior steel, a crack may identify itself as a hot spot that is measurable on the furnace exterior. Such a spot not only loses valuable heat, but can also grow until it becomes a safety hazard for operating personnel.

Several different advanced repair techniques can be used to seal or replace cracked areas with a monolithic lining. The advantage of using a monolithic system is that no mortar or lamination lines are present and no expansion joints are required. Thus there is less potential for crack initiation. In addition, new installation methods require significantly less downtime compared to traditional methods of bricklaying and plastic ramming.

Advanced repair techniques. Pneumatic gunning of plastic refractories has become increasingly popular. Plastic gunning material is produced as a soft, somewhat sticky mixture of clay, aggregate, and binders—with no cement. It is available either in granulated form or as extruded slugs that are shredded at the job site.

The granular or shredded material is loaded into a gun-feed system capable of transporting the material through hose lengths up to 250 ft long to the nozzle. The material can be shot directly onto the target surface and built up to the desired thickness.

The surfaces—sometimes simply the structural steel of the furnace—are fitted with a grid of pre-fired refractory anchors spaced on 12- to 18-in. centers. Open areas behind the anchors may be backed with a temporary lattice of wood strips or a plywood sheet. The gunned material then builds up snugly around and between these anchors. Installers also use the anchors as rough guides to help achieve a uniform lining thickness.

Plastic gunning is typically the fastest means of installing a uniform monolithic refractory (Fig 4). A new mini-gun system has been developed which is particularly well-suited for spot repairs to ceilings, arches, and other contoured shapes that previously required hand-ramming.

Immediately after they are installed, gunned plastics can be cured by bringing the boiler on line at a slow, controlled rate.

Another construction and repair technique employs monolithic castable material that is mixed like concrete and poured into forms. This approach is often specified where gunned plastics cannot be used—such as replacing the lining between the waterwall tubes and the outer insulation layer or where the workspace is confined. Note, however, that if the boiler's outer steel casing and insulation are going to be replaced anyway, plastic refractories can be gunned onto the tubes from the outside before the new outer materials are installed.

After the wooden mold forms have been built and positioned, the castable material must be poured and allowed to cure for at least 24 hours. The forms are then removed and the lining is dried by slowly bringing the boiler up to load. Behind waterwalls, plywood cannot be removed from between the refractory and tubes. Instead, it simply burns away during bake-out.

Certain castable mixtures can also be applied by pneumatic gunning, which saves time for building and removing forms. Like formed castables, these materials typically require longer bake-out schedules and have lower thermal shock tolerance than do gunned plastics. With

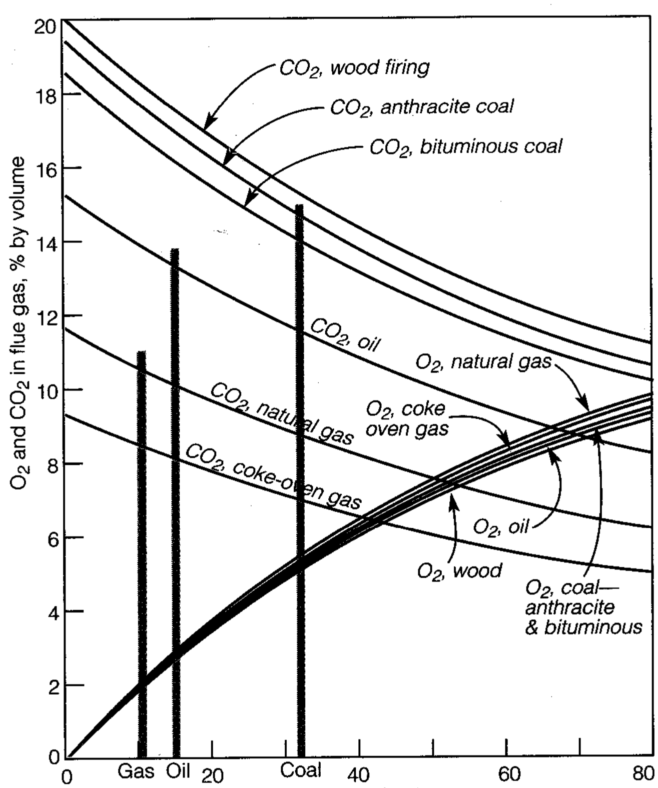

Fig 3

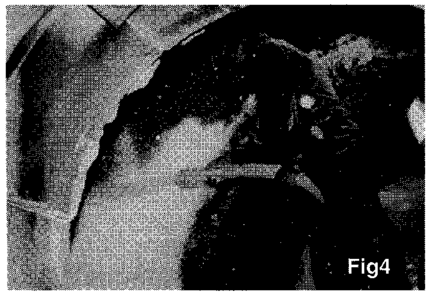
Fig4

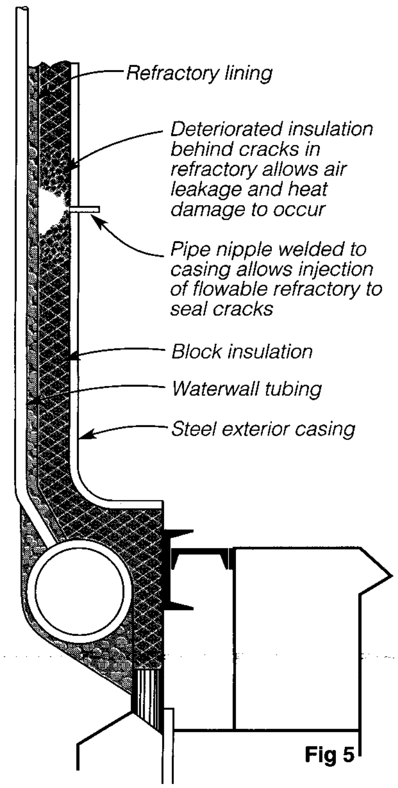

Fig 5

REPAIRING REFRACTORY ON LINE

both castables and gunned plastics, the shrinkage that occurs during bake-out is nullified by the material's thermal expansion during operation.

A relatively new, although somewhat imprecise method has been developed for fast repair and sealing of cracked, delaminated, and leaking refractory walls. This method can be performed from outside the furnace while the boiler remains on line (Fig 5). Hot spots on the outer steel are first identified by using an infrared or contact-type heat sensor. Next, pipe nipples are welded directly to the casing at the hot locations. Holes are then drilled through the casing inside each nipple. Finally, a hose attached to the nipple allows a soft, flowable refractory material to be pumped into the void behind the casing. Once inside, the soft refractory fills every crack in the vicinity of the flow and hardens to form an air-tight seal.