# Care and Maintenance of Circulating Fluidized Bed Boilers
# Refractory Failure

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Among the numerous maintenance items encountered with the operation of circulating fluidized bed boilers refractory failure may be the most problematic, time consuming, and costly. Refractory used in circulating fluidized bed boilers includes brick, block, tile, plastic rammed, castable and “gunned” refractory.

Two of the most prevalent refractory failures are *Thermally Induced* failures and *Anchoring System* failures.

## ***Thermally induced failures:***

Thermally induced failures in rammed, castable or gunned refractory (and to a lesser degree in brick, block or tile refractory) include minor cracking and spalling up to complete failure of sections of refractory which may require shutting down the unit to repair.

Thermally induced failures generally result from rapid or erratic heating/cooling of the refractory experienced while taking the unit in and out of service and to some degree during load changes. This leads to uneven expansion and contraction of the refractory resulting in cracking or spalling. These failures can result from uneven refractory thickness, inadequate application of expansion joints or misapplication of refractory layering. Brick, block, or tile failure may also result from rapid heating/cooling which will also result in uneven expansion/contraction rates between the “hot side” and “cold side”, resulting in spalling and cracking.

Although some degree of thermally induced cracking and spalling is inevitable the severity of the these can be greatly reduced by following acceptable heat up and cool down curves. These curves are generally supplied by the original equipment manufacturer (OEM) but may be obtained from a reputable refractory vendor. Adequate provision for uninhibited expansion and contraction must be considered prior to installation of any significant refractory repairs or new installations. Proper consideration for expansion joints is a must during installation of refractory.

Figure 1

General cracking in “gunned” material
in cyclone above cyclone inlet.
Typical thermally induced cracking.

Figure 2

Spalling of refractory from water wall tubes
in combustor bed area.
Typical thermally induced Spalling.

## *Anchor System Induced Failures:*

Anchor System induced failures may be the leading cause of refractory failures. These occur when the anchoring system holding the refractory to walls, roofs, tubes, etc., fail resulting in the refractory not having any support strength. The refractory needs a means to keep it tight against walls, roof, floors, etc., to keep ash or other material from getting between the refractory and the wall, floor, etc. If ash or other material is allowed to get between the refractory and the wall, floor, etc., the ash will build up and force the refractory away from the wall, floor, etc. resulting in cracking, collapse, or other modes of failure. Anchor system failure on walls and roofs will result in the weight of the refractory to pull itself away and result ultimately in cracking and collapse.

Anchor system failures can be due to in adequate anchor density for the application (not enough anchors per square foot of refractory, bricks, etc.

Poor anchor design (material choice, configuration, etc.) for the application may also lead to failure of the anchors. Anchoring system in CFB units can be subjected to upwards of 1800oF during operation of the units. If an improper material is selected for high temperature service, such as carbon steel, is used for the anchor material, the anchor is sure to fail due to detrimental microstructure changes and accelerated corrosion at the high temperatures. Anchor system must be fabricated from heat and corrosion resistant materials based on the application.

Improper attachment welds may also lead to anchor system failure. Poor electrode selection, improper weld procedure selection, or improper welding technique may lead to detachment of the anchor from the wall, roof, etc. resulting in refractory failure. Anchoring systems must be attached to roofs, walls, etc., with sound weldments.

Figure 3

Failure of Stud to Water Wall Tube Weldment
Resulted in failure of refractory at this site.

Figure 4

Failure of “Pant legs” on “Dancing Lady” Anchors. Failure resulted in significant refractory failure. Anchors shown after refractory removed.

Figures 5 & 6

Severe cracking in cyclone “bull nose” refractory due to failure of anchoring system. Improper anchors standoff material used (carbon steel).

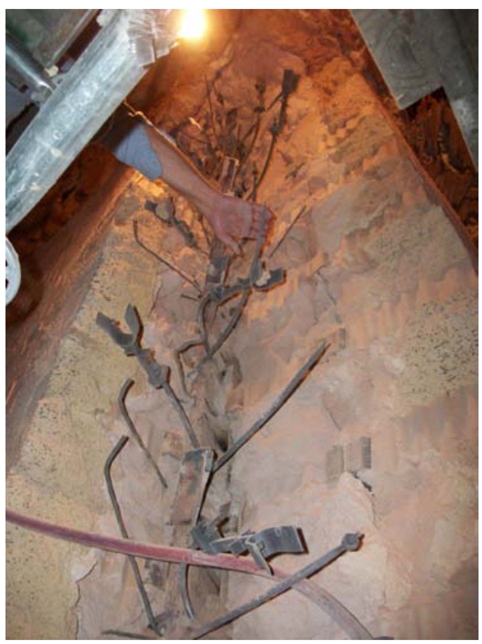

Figure 7

Entire “Bullnose” had to be removed and replaced.

Figure 8

Cyclone inlet “long wall” shifted out of plane approximately 4”
due to failure of brick anchors. Entire wall will have to be replaced.

In conclusion, to avoid major refractory failures, proper operating procedures must be followed, especially heat up and cool down rates. Also, attention must be paid to provide adequate anchoring for the refractory, including material selection, anchor density, and anchor design. Provisions must also be made in the overall design of the repair for adequate expansion and contraction of the refractory including inclusion of expansion joints if required. Thorough inspections of all unit refractory should be made during normal maintenance outages so that conditions can be assessed and repairs made during scheduled maintenance outages. There will always be some degree of “discovery” related repairs that will require immediate attention, but these can be kept to a minimum with proper operation of the unit and a proactive inspection and repairs program.