EROSION PHENOMENON IN BOILERS & REMEDIAL MEASURES

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Last two months had been a special month of erosion diagnosis for me. The cases attended include high pressure high capacity AFBC & PC fired boilers. I always preferred to have a personal inspection of the boilers designed by me at least after the first year of operation. My focus was to understand the preferential erosion pattern which comes inherently due to preferential flow in the gas path arrangement. When the designers fail to take a feedback, the users suffer. Often users try their own ideas based on their past experience which may not really extend the availability but continues to give the failures quite often.

In this article I would try my best to introduce the readers to possible erosion mechanisms that occur in boilers.

CONVECTION SUPERHEATERS / ECONOMIZER / EVAPORATOR

There are many locations possible

1. Erosion in the end coils which come closer to the waterwall / cage wall
2. Erosion in the coils inside the bank
3. Erosion at the penetrations in the roof / side wall / casing
4. Erosion in coils facing ash impingement
5. Random erosion inside the bank due to ash clogging
6. Preferential erosion near hanger supports
7. Erosion caused by soot blower
8. Preferential erosion due to layout related mechanism
9. Erosion due to ash fouling

Mode 1: Erosion Of End Coils Near To Waterwall / Cage Wall

This happens when the end coils are very close to waterwall. It is preferable to have a clear gap of 40 mm from the waterwall / cage wall. Apart from this the relative gap between the coils versus the coil to wall matters. If the gap is more then the preferential gas flow takes place. I see many designers try to maintain closer pitch than the end clearance. This makes the gas flow to take place at the end gap. This can show up in erosion of tube bends of manholes.

Use of staggered pitch inside the coils can make the gas to flow preferentially between the end tubes & casing. If the coils to cage wall / waterwall / casing space is less than 40 mm, the erosion rate increases.

Mode 2: Erosion Of Coils Inside The Bank

Case 1: when the coil spacing is non uniform due to improper erection the coil can fail due to erosion. During the erection some coils may come out of lane abnormally making it susceptible for erosion.

Case 2: Coil spacing can be non-uniform due to inadequate number of hanger tubes or coil alignment bands.

Mode 3: Erosion Of Coils At The Penetrations

Case 1: Wherever the coils penetration through the casing / side wall, there has to be sleeves to protect the tubes against erosion. There can be erosion due to the preferential flow of ash along the casing / wall.

Case 2: Inadequate sealing can cause erosion of tubes due to air ingress. The ash that comes out through the leaky location can fall back under negative draft cutting the tube.

Mode 4: Erosion In Coils Facing Ash Impingement

Case 1: There are possibilities of ash slagging in radiant SH due to fuel ash characteristics. As the ash fuses, there is slagging & recrystallisation and creation of ash with sharper edges. If there are tubes facing the ash stream, then there is erosion. The erosion rate is high if the tubes are placed in the gas lane.

Case 2: when there is pitch change / alteration in pitch from the previous bank, the trailing bank suffers erosion due to ash impingement. In sufficient space between the two banks causes erosion. The tubes are seen with ash impingement / erosion marks.

Mode 5: Random Erosion Of Bank

Case 1: when there are possibilities of ash bridging due to narrow spacing of coils, the gas streams takes a tortuous path through the free gas flow area. The ash clogging can happen due to trapping of ash lumps inside the bank. This happens in horizontal bank. Staggered pitch causes such erosion.

Mode 6: Preferential Erosion At Hanger Tube Support Points.

Case 1: when hanger tubes are pitched closer, they act as impingement separators for the dust. The dust preferentially travels along the hanger tubes. Erosion is seen in between the hangers & the coils.

Mode 7: Ash Deposition On Uncooled Supports

When the ash has fouling / slagging properties, there is deposition on uncooled supports & spacer bars / alignment bands. The ash builds over the uncooled support. Nearby areas, erosion is experienced.

Mode 8: Erosion Due To Soot Blower

Worn out soot blower nozzles, stuck lance tubes, higher soot blowing pressure, presence of condensate in the soot blowing steam, frequent operation of the soot blower can cause erosion of tubes. Soot blower can elutriate the settled ash in to gas steam and cause erosion.

Mode 9: Preferential Erosion Due To Layout

The layout of the pressure parts can matter to a great extent on preferential erosion.

Case 1: Accommodating headers inside the flue path causes reduction in apparent gas flow area. This can accelerate the gas velocity and thus erosion.

Case 2: Sharp gas turns cause preferential erosion. There is more gas flow & dust load causing erosion in certain locations.

REMDEIAL SOLUTIONS

Gas baffles: gas baffles are provided to slow down and to reduce the preferential gas flow.

Protective shields: Shields are engineered to protect the parent tubes. The shields would be replaced as per the frequency

Sleeves: Full cover on tubes are provided to avoid damage to parent tube at the penetrations in waterwall / steam cooled wall / casing