PROCESS CHANGES AND CORROSION OF MATERIALS IN RECOVERY BOILERS

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Recovery boiler evolution: leading cause of corrosion?

1934* ~1990* *Steam, B&W (1992)
Adapting materials solutions to process problems began with Windsor # 2

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Corrosion problems are seldom anticipated – solutions are reactive
How to build a recovery boiler with predictable corrosion problems?

- Boiler design
- **Process understanding**
- Materials selection
- Manufacturing practices
- Fuel variability

**Case histories**

- Near drum thinning of generating bank tubes

- Cracking of composite tubes on floors and at primary air port openings

- Corrosion of lower furnace carbon steel waterwall tubes
Near-drum tube thinning affected many two drum boilers in mid-1980’s

- Moderate rate of corrosion on tubes at interface with mud drum
- Differences in boiler design reflected in location of corrosion
- Change in process operation was shown to mitigate the problem
The most effective solution to near-drum thinning lay in process change

Corrosion of carbon steel wall tubes precipitated a change to higher cost materials

- Need for increased energy efficiency raised boiler operating pressures
- Result was the gradual acceptance of composite tubes as new standard
- Burning liquor on walls found to be detrimental
Corrosion rates increase with higher pressure operation

Pyrolysis gases can be very corrosive to carbon steel, but not stainless steel
Release of pyrolysis gases against wall probably overshadows most other causes

Alloys with greater nickel content can corrode more quickly when exposed to H$_2$S
Very localized corrosion has been observed on alloy 625 weld overlay openings.

Laboratory corrosion tests have identified environments corrosive to 625.
Cracks in composite wall and floor tubes pose different risks to boiler operation

- Several mechanisms are responsible for cracking
- 304L SS readily cracks in-service, alternative alloys may be more resistant
- Process changes can reduce risk of cracking

Cracks in air port openings are more likely to grow into carbon steel
A 600°C excursion with steam blanketing on the ID can cause tensile stresses in carbon steel.

Stresses in the carbon steel are compressive in normal operation. Stresses in carbon steel are tensile after the temperature excursion.

Metallurgical condition of an alloy influences resistance to cracking.

The graph shows the maximum crack depth for different alloys and their metallurgical conditions:

- 304L
- A825
- A625

- 50% Cold Worked
- 50% Cold Worked & Solution Annealed
Operating practices that direct liquor away from the walls reduce thermal activity on air port surfaces

Additional materials issues

- Waterside problems
  - scaling
  - circulation
  - flow induced corrosion
  - stress assisted corrosion

- Mechanical design and fabrication
  - Fatigue at headers, tube ties

- Sootblower-related problems
  - Thinning of tubes at intersection with drums and headers
Conclusions

- Corrosion in recovery boilers occurs in micro-climates
- Compatibility of composite tube alloys with boiler environment is unresolved
- Burning and pyrolysis on surfaces should be avoided to minimize corrosion

Challenges for the future

- Process changes have profound effect on corrosion – how do we anticipate the consequences in advance?
- Recovery boilers are amongst the few chemical reactors in the world to be built largely from carbon steel. Can the industry afford an all-alloy boiler?