

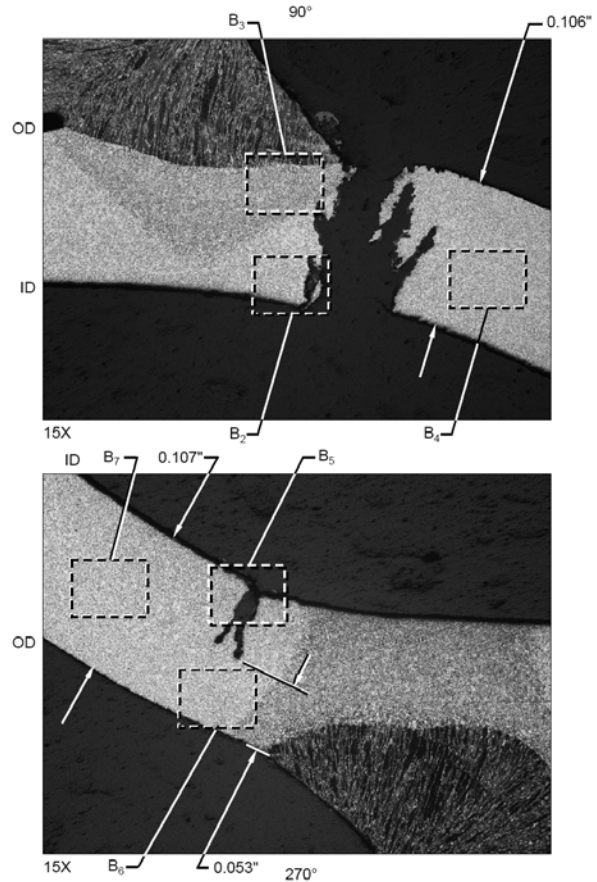
TECHNICAL BULLETIN

SUBJECT: Boiler Tubing - Corrosion Fatigue Failures

Thielsch Engineering has provided a summary document on the power /paper industries approach in managing corrosion fatigue cracking within the water circuit tubing of high-pressure boilers which include our own experiences within these industries as it relates to this failure mechanism.

Leak type failures of water circuit tubing resulting from corrosion fatigue can be expected in boilers; historically, the power and paper industries had recognized this condition as an availability issue not a safety issue. However, that has changed since the late 1990's.

Since 1999, Thielsch Engineering has been involved in the failure analysis and inspection of more than five (5) catastrophic failures of water circuit tubing resulting from corrosion fatigue. Three (3) of these instances had resulted in significant injury and death to plant and contractor personnel. In the preceding twenty years of business Thielsch Engineering had no similar catastrophic assignments. This increase is directly related to the power industries trend towards more cyclic and peaking operation of their aging boilers to meet new market demands. The thermal swings associated with the increased cyclic/peaking operation is the primary driver for the fatigue element of "corrosion fatigue" failures.



For the sake of this document, a catastrophic failure is defined as a rupture of the high-pressure water circuit tubing that releases a sufficient quantity of fluid into a low-pressure area in which rapid expansion (flashing) and large pressure surges result. If the release is of sufficient magnitude, it will have a similar effect to an explosion. In the assignments that Thielsch Engineering has been involved with since 1999, the ruptures were great enough to breach the outer boiler casings.

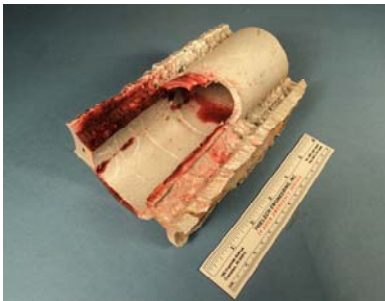
As a result of these catastrophic failures, Thielsch Engineering has witnessed:

- Regulatory authorities withholding operating permits due to corrosion fatigue failures resulting in near miss safety concerns. This resulted in the boiler operator submitting a force majeure claim for business interruption.

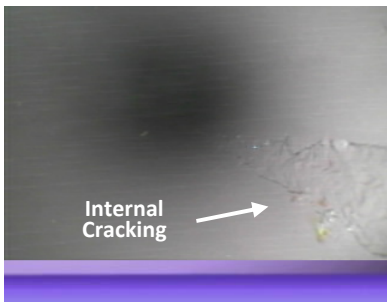
January 2010

- Power companies decommissioning 180 MW boilers as a result of catastrophic corrosion fatigue failures.
- Power companies removing 100% of external boiler casing and performing inspections of the cold side of the tubing for corrosion fatigue to satisfy insurance underwriters.
- Power companies completely re-tubing furnace waterwalls with different tube specification to eliminate chronic catastrophic corrosion fatigue failures of Electric Resistance Welded (ERW) tubing.

Significant efforts have been expended by boiler OEM's and engineering firms to develop design modifications and inspection technologies to first eliminate the potential and second to identify the incipient conditions prior to failure.



What the industries have found is that there is no easy or expedient way to resolve corrosion fatigue cracking within water circuit tubing. The most commonly recognized methods involve significant modifications to the boiler structure strong backs, door openings, and corner restraints. On the inspection side, costly destructive work is required to gain access to the areas for inspection, i.e. cutting away the boiler casings to perform specialized ultrasonic examinations or cutting "pigeon holes" in the tubing to conduct internal borescopic inspections.



Thielsch Engineering has seen a marked increase in the number of bid projects specifically geared towards the inspection of corrosion fatigue in water circuit tubing. The fact the boiler operators are specifying and implementing such costly projects speaks to the level of importance placed on the issue.

If you would like more information on failures associated with corrosion fatigue or would like Thielsch Engineering develop a scope of work for an engineering inspection and evaluation, please feel free to call 401-467-6454 or you can e-mail me at Pkenefick@thielsch.com.

Very truly yours,

THIELSCH ENGINEERING, INC.



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