

Magnetec Monthly Chronicle

Issue No.11 " FROM THE FIELD " November 2005

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Magnetec Inspection, Inc.

Excellence in Eddy Current Inspection Technology & Failure Analysis

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Reported Failure Was Unexpected and not Confirmed Prior to Bundle Dismantle

Subject: The Erosive Power of Steam!

The exchanger is found in a major northern paper mill which produces raw product and finished goods. The bundle was inspected to determine active failures and corrosion mechanisms.

The bundle has been reported with failures in the past 2 months and bundle replacement is expected. Due to tight time frame constraints the bundle would have to be put in service for 18 months and all questionable and active tube failures will need to be plugged. The exchanger operates with a 4 sister/parallel bundles and acts as a temperator spray condenser for the main waste heat recovery boiler which supplies steam for paper production and in-plant electrical power production. A temperator spray nozzle

condensate into the main steam line to control/moderate the steam heat characteristics. The tubing consists of 260 U-tubes – .625" X .049 wall X Monel 400 X 10 Foot long. The exchanger was reported with failures during service by flooding of the shell side and relief valve cycling. There was no previous inspection history as this was the 1st internal inspection performed in the bundles 36 year history. Based on service (Steam/Steam -Condensate) the bundle was not expected to have any corrosion problems

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and the reported failure was unexpected and not confirmed prior to bundle dismantle. The inspection scheme was performed on 100% of the tubing across the entire bundle matrix with the bundle being in the shell and the inspection performed from the open channel head. In addition a U-bend inspection was performed to verify the condition of this section of tubing. Based from the inspection the tubing was found to contain I.D. wall loss in the form of erosion in the U-bends of the center row of tubes adjacent to the pass partition plate. This row contains tubes with the tightest U-bend radius (2.625") and is in direct line with the tube side steam inlet piping. The steam inlet tends to concentrate the inlet steam flow first towards the pass partition plate and then upward through the tubing. The detected failure(s) was found in the apex of the U-bend with fish mouth type failures being noted which is indicative and consistent with a over-pressure rupture from a thinned tube wall. After analysis of the inspection data it was determined that only tubes in the first center row were found with the severe erosion damage and tubes outward from this row showed limited to no erosion damage. The failures are a combination of the age of the bundle, erosive qualities of steam, and tight U-bend radius which forces flow reversal and concentrates the erosion environment within the U-bends. Failures that occur at flow changes in both tubing and piping systems (elbows,

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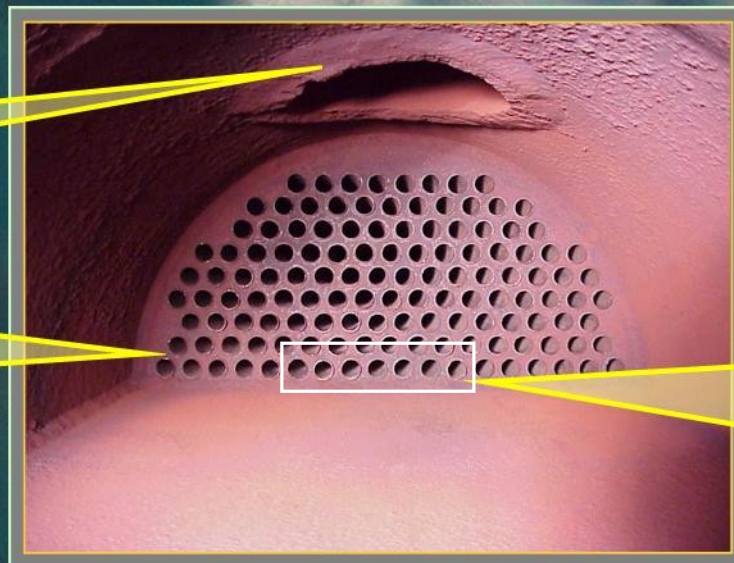
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Y's, Tee's, etc.) are in much higher concentration than straight flow runs. Erosion can occur with any process feed and is found in the highest concentration when the laminar flow is disrupted. Based on Eddy current and Video probe visual inspection, the failures noted were very large, and correct operation of the bundle could not be attained. The bundle, while seemingly insignificant in size and process, caused many problems in keeping the main steam supply at the correct limits and characteristics. Based on the inspection results there were 7 tubes plugged due to active failures and/or preventative plugging. With the severely eroded tubes removed from service, the bundle should provide many years of service and replacement could be held off. The tubes were plugged by the Magnetec using Pop-a-plug type plugs.

Inlet Steam Pass

**Erosion Affected
Center Row**



**Tubes
with
Severe
Erosion &
Failures**

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View Looking through Tube to Adjacent Tubing



View from Straight Tube Section to U-bend



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