Magnetec Monthly Chronicle

Issue No.13 " FROM THE FIELD " March 2006

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Magnetec Inspection, Inc.

Brass Crude Overhead Condenser

High Heat Gradient across Top Row of Tubes

Excellence in Eddy Current Inspection Technology & Failure Analysis

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Subject: Pitting in Brass Crude Overhead Condenser

Low Heat Levels for Long Periods of Time Have the Same Net Effect as High Heat Levels for Short Time Frames

The Tube and shell exchanger was found in a major North Western refinery. The bundles were inspected as part of a planned turnaround work scope as a routine cursory type inspection to determine bundle condition. The exchanger operates as a 3 bundle parallel feed, series flow, through the stacked exchangers with crude OVHD on shell side flow and Cooling water on the tube side. The shell side feed enters the Middle shell nozzle of the bundle and splits into a divided flow across the tube matrix. The cooling water enters the bottom channel nozzle and makes two passes through the tubing. This condition makes the middle shell side inlet a high temperature area and would tend to layout cooling water deposits at a much higher rate than other parts of the bundle. The tubing consists of 1050 straight tubes – .750 O.D. X .065 min wall X SB-111-443 X 20 Foot long and are 12 years old. Upon visual inspection there were numerous holes noted near/adjacent to the deflection plate which corresponds to the high heat /fouling

area. The relative operating pressures and temperatures were in the mid range for this material and due to the age of service the tubing would have experienced many years of low temperatures which is analogous to a short time frame of high heat with regard the de-alloying (de-zincification) potential of the material. The Eddy Current Inspection was performed on 100% of the tubing to determine the presence of the active pit sites and determine the defect depths and remaining life of the bundle. The inspection found pit sites with depths from initiation to 95% in the upper half of the bundle and 35% in the lower half. The pitting detected was most pronounced and in highest concentration near the center of the bundle which corresponds to the highest heat gradient within the bundle matrix. The pitting appeared to be consistent in attack and concentration across the top row of tubes with relative defect depths being similar from tube to tube in this area. The defect signals generated by the Eddy Current inspection were found to be modified from what would be a normal defect type pattern which is attributed to the presence of copper lay-out in the pit site. The presence of any metallic material within a defect location generates a signal that is a combination of the two individual signals which results in modified signal that is not representative of the defect signal alone. This scenario can make data reduction to accurate wall loss quite complex, and for

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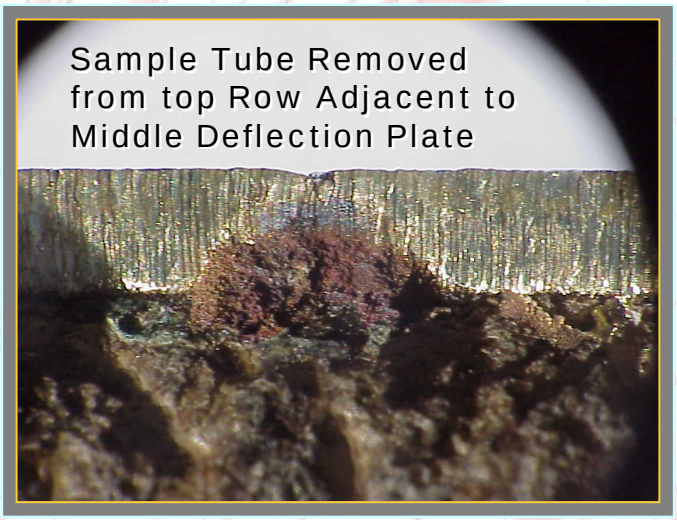

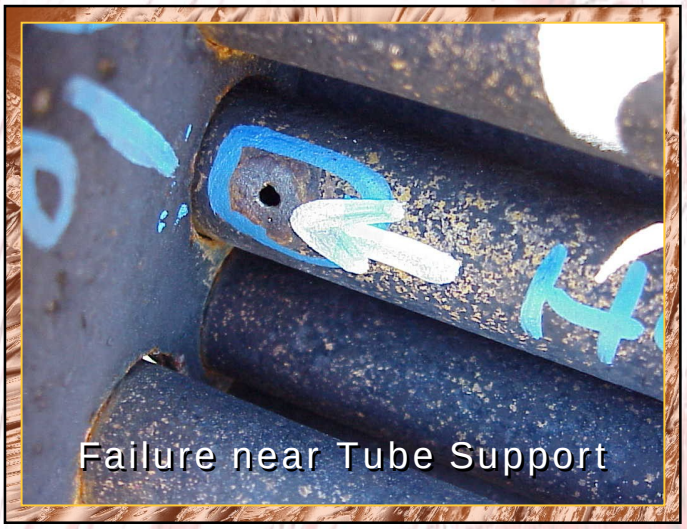

inexperienced technicians, the results can be defects which are reported incorrectly. Brass tubing will tend to de-alloy (De-zincification) in high heat gradient areas and pit sites will develop due to the disruption of the alloy structure and elemental copper released from the parent material will lay-out in the pit sites which is commonly called plug type de-zincification. Material in this de-alloy and pitted condition is highly susceptible to failure from pit penetration and /or cracking. Tube samples were removed from the bundle to document the active corrosion mechanisms and allow for material to be sent out for metallurgical analysis. The inter-relationship of selective de-alloy and subsequent pitting is rather common in brass tubing and bundles in this service. There tends to be a central initiating factor that encompasses the de-alloy and pitting sequence which is high heat gradients, fouling/deposition of contaminates, and many years of established corrosion cell environment. For the purpose of this discussion, the term “high heat gradient” is referring to heat levels at and/or below the recommended operating temperature for brass tubing. Low heat levels for long periods of time have the same net effect as high heat levels for short time frames. Based on the age of the bundle, defect depths and economic loss’s due to re-occurring failures both bundles were re-tubed.

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Tube Section from Sample tube. Is 3 " away from Failure & Retained for Metallurgical Sampling