Monthly Chronicle

Issue No.15 June 2006

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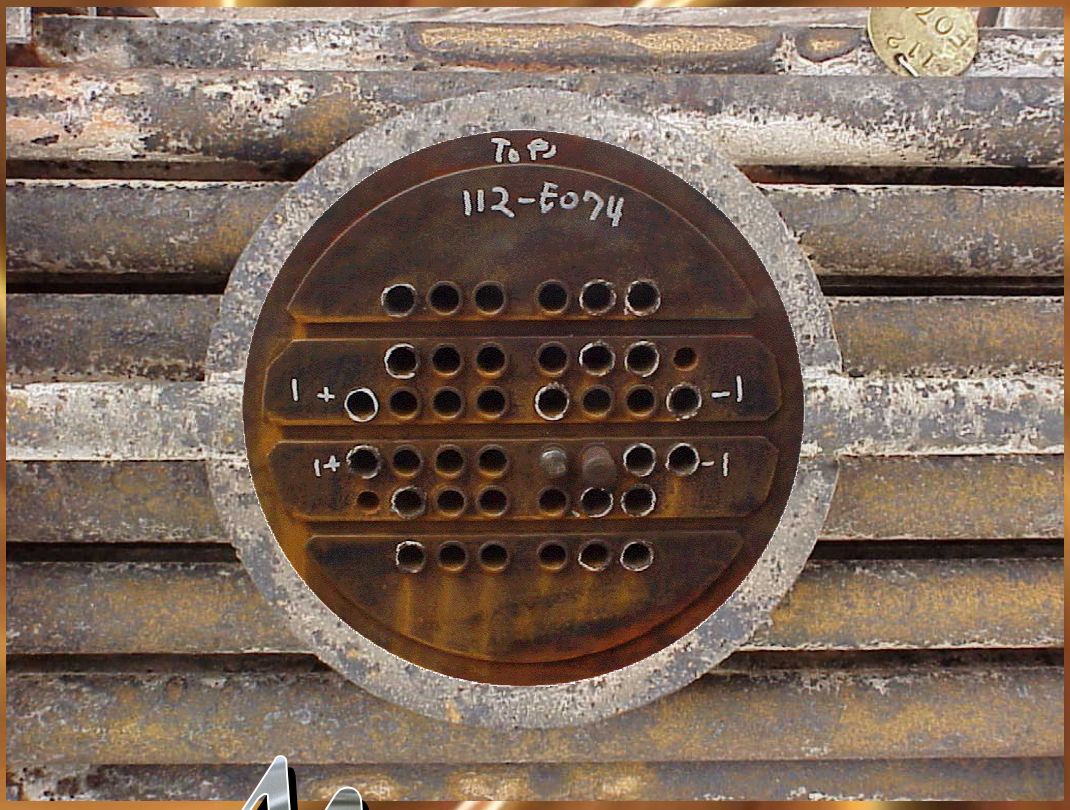
" FROM THE FIELD "



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Subject: O.D. Cooling Water Corrosion in Slurry Bundle

The tube and shell exchangers were found in a major south western refinery. The bundles were inspected to document recent failures and comply with Root Cause Failure Analysis (RCFA) prior to bundle being scrapped. The inspection was to aid in correct metallurgy upgrade selection for the replacement bundle.

The exchanger operates as a 2 bundle parallel feed, series flow, through the stacked exchangers with Slurry feed on tube side flow and cooling water on the shell side. The shell side feed enters the bottom rear shell nozzle and continues as a single pass flow across the tube matrix. The slurry enters the bottom channel nozzle and makes four passes through the tubing. This condition makes all areas of the tube matrix even in temperature gradients and would tend to layout cooling water deposits at an even rate across the entire bundle tube matrix. The tubing consists of 40 straight tubes – 1” O.D. X .109 min wall X SA-214 X 20 Foot long and were 7 years old. Upon visual inspection there was severe O.D. pitting noted across the entire bundle matrix and along the tube axis. There were heavy deposits noted to the bundle support structure and hardware with deposits of ¼” thick in many locations. The heavy deposits were primarily cooling water deposits and ferrous by-products which have layered across the bundle components

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during the service life. The Eddy current inspection was performed on 100% of the tubing to determine the presence of the active pit sites, defect depths and aid in recommendations for future operation. The inspection found pit sites with depths from initiation to 95% across the entire bundle matrix with consistent attack in every tube inspected. The pitting detected was most pronounces 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 matrix of tubes with relative defect depths being similar from tube to tube. The defect signals generated by the Eddy Current inspection were very complex in nature due to the presence of multiple pit sites and overlapping defects being noted in any one plane of the inspection probe. The overlapping of defect signals of different depth tend to result in a signal that contains components of both single defects with depth correlation skewed toward the larger/deeper of the individual defects. The tubing was inspected with an eight coil inspection probe which allows for specific angular sections of the tube wall to be interrogated with one pass of the inspection coil. This inspection helped in determination of the defect depths; however the complex defect geometries and total numbers of defects noted gene-

rated thousands of individual defect signatures for every tube. It should be noted that complex inspection techniques can aid in characterization of defects while simpler techniques provide the general conditional assessment and defect depth/location information with greater inspection speed and cost effective results. 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 inexperienced technicians the results can be defects reported incorrectly. The O.D. of the tubing was severely corroded due to under deposit cooling water corrosion on the O.D. of the tubing with failures being imminent in 85% of the tubes in the bundle matrix. The I.D. of the tubing which has slurry product was found in good condition with light gradual thinning being noted in the first inlet pass. This condition is common for exchangers in this service with many manufactures installing ferrules in these tubes to control the erosive affect of the slurry media. The central initiating factor that encompasses the fouling and pitting sequence is deposition of contaminates found in the cooling water with many years of service. Once established the corrosion cell environment and associated corro-

sion rates will accelerate in correlation with deposit deposition rate and service life. Increased deposit depths raise the heat gradient across the tube wall due to poor heat transfer and increase the rate of deposit deposition. For purpose of this discussion, the term high heat gradient is heat levels at and/or slightly below the recommended operating tempera-ture for cooling water bundles. Based on the inspection re-sults the bundles were recommended to be replaced with SA-179 seamless material, put on an increased cleaning cycle and inspected on a regular basis to track the corrosion rate. Recommendations were made to retrofit the bundles so they could be back flushed during operation.

Fixed Tube Sheet View of Straight Tube Bundle

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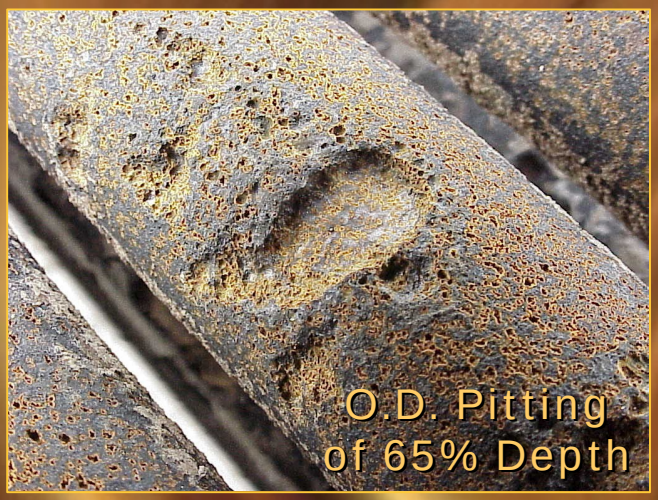

Severe O.D. Corrosion
Cooling Water Corrosion

Multiple Pit
Initiation Sites

Note: Numerous Initiation
Sites along Tube Axis

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Tube Support Location

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