Monthly Chronicle

Issue No.18

June 2007

Magnetec Inspection, Inc.

www.magnetec-inspection.com

" FROM THE FIELD "

Excellence in Eddy Current Inspection Technology & Failure Analysis

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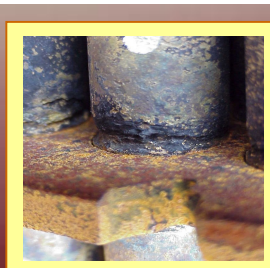

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Subject: High Temperature Sulfidic Corrosion

The exchanger is found in a small sized Eastern refinery. The bundle was inspected to determine active corrosion mechanism and determine failure mode for two recent tube failures which resulted in unit upsets.

The exchanger operates as a Stabilizer effluent/feed with 1 other sister/parallel exchangers in a De-sulfurization unit. The bundles were moved from other service and installed in current service in 2001 due to a unit upgrade and change to processing ultra-low products. The paired bundles are vertically stacked with 2 pass, split flows across the shell and process inlets on the top front of the bundles. The tube side flow enters the bottom channel and makes 2 pass's before exiting the bundle. The tubing consists of 1052 straight tubes – .750" X .065 min wall X 20'- SB-111 -443 admiralty brass tubing. The exchanger was reported with two recent tube failures that caused the unit shutdown and warranted a bundle change out due to reliability concerns. No inspection was performed at the time of the tube failures due to time constraints, economic factors and lost opportunity. New bundles were ordered and the current bundles were inspected as part of a post failure assessment program.There was no previous Eddy current inspection

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history and the last (2003') external visual found/reported no adverse conditions. Based on the new service of the bundles no history had been developed on corrosion potentials, corrosion rates, type and/or expected life. There was concern when the bundles were installed in the new service due to potential for corrosion activity in the brass material and temperature gradients above the recommended levels for the tube material. The recent corrosion activity since the 2003' inspection alludes to an environment that was developed quickly & has aggressive activity. The inspection scheme was performed on 100% of the tubing across the entire bundle matrix with the bundle being previously hydro-blasted & located on the bundle pad.The brass tubing was found to contain O.D. wall loss in the form of severe grooving & isolated pitting on the lower periphery of the bundle with most severe attack at the last support nearest the bottom u-bends. The corrosion was noted from approximately the center support locations and progressed in defect depths towards the rear of the bundle. The process flow enters the top front of the shell and exits the bottom front (2 pass – Split flow) which tends to establish a low flow/stagnant area near the bottom rear of the bundle. The bundle was noted with 18 previous plugs and 23 tubes with wall loss/defects of depths 75%+ and 5 active failures. The I.D. surface of the brass tubing was found with no active corrosion or wall loss greater than 10%.

The bundles were in relatively clean service prior to being moved to the current service and corrosion rates in the previous service had been minimal during the life of the bundle. The new service is naptha with water vapor and significant sulfur content. The tubes were detected with severe O.D. corrosion in the form of under deposit pitting and localized grooving at the support locations. It appears that the sour acid gas condenses at the support locations and forms a sulfide scale where aggressive anodic corrosion cells establish with associated pitting and groove type defects. The grooving is similar the non-conden-sable gases (Ammonia- NH3)that form at temperature gradient/ dew points in steam systems. The condensed acid gas H2S at the support locations forms individual pit sites that connect with continued service and leave the appearance of the grooving at the support locations. Sulfidic acid corrosion and high tempera-ture crude corrosivity in general is a reliability issue in terms of corrosion in process heat exchangers. The presence of sulfur compounds considerably increases corrosion in the high tem-perature parts of the process units. The difference in pro-cess conditions, materials of construction and corrosion consti-tuents in a specific process flow increases the problem of correlating corrosion within a unit to a certain single aspect of unit operation.

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The following recommendations were made to control the acid gas corrosion.

- Water injection
- Backflushing
- Filming agent
- Alloy upgrade
- Increase regular cleaning cycles
- Dedicated spare exchangers to be installed while offline cleaning is performed

Bottom Row of Tubes near U-bend

Note: Grooving adjacent to the supports

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Grooving at support location

Removed tube sample: Note failure in tube

Severe groove depth adjacent to edge of support.