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|  | **Marathon – Mandan Refinery** |  |
| **2021 HF Alky Turnaround** |
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**E-014**

**INTERNAL INSPECTION**

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| **Orientation** | **Data Plate** |

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| **Exchanger** |

***SUMMARY***

During the scheduled 3rd Quarter 2021 HF Alky Unit Turnaround, the Acid Vaporizer (E-014) was removed from service for maintenance and inspection. The exchanger was completely disassembled for cleaning and inspection. All of the components and tube bundle were transported to the blast pad for cleaning. The shell was cleaned in place. An internal visual inspection was completed. All nozzles were opened, cleaned, and a visual inspection was performed on the gasket seating surfaces. IWR# 017 (WSA# 0735) was generated and completed to skim cut the channel head body flange (channel cover side) gasket surface. This repair required weld metal buildup on damaged areas of gasket surface prior to machining. A Dye Liquid Penetrant Examination (PT) was performed on the channel head internal welds with two linear indications reported, rounded indications (Porosity) were reported on the 18” flange attachment weld. Areas of porosity were removed with tiger disk and area was copper sulfate tested and accepted with no welding required. An Ultrasonic Lamination scan (UTL) was performed on 100% of the channel weld seams with no relevant indications reported. Eddy Current Testing (ECT) was performed on 97% of the bundle tubes with no wall loss detected. Upon successful completion of all maintenance and inspection related activities, the exchanger was reassembled, and a successful hydrostatic test was performed at 150 psig on the shell side and 165 psig on the tube side. The exchanger was then returned to operations.

***REPAIRS***

1. IWR# 017 (WSA# 0735):

Weld metal build up and machining was performed on the channel (channel cover side) gasket surface due to mechanical damage.

***FUTURE RECOMMENDATIONS***

The following recommendations were made as a result of the findings from this inspection:

1. Remove the blind on the ¾” axillary nozzle (N7) flange face associated with the top channel nozzle during next scheduled turnaround.
2. Consider having a new channel head built completely out of Monel for replacement next scheduled outage.

***CLEANING METHOD AND ACCESSIBILITY***

The components and tube bundle were removed and taken to the wash pad for cleaning and inspection. The shell was cleaned in place in the unit. No scaffolding was required.

***SHELL:***

This shell was inspected from the shell flange due to the limited size of the shell ID. The internal shell surface had light product scale less than 0.010” thick with a general corrosion up to 0.030” in depth and isolated pitting on the bottom section up to 0.060” in depth. There were no bulges, blisters, or distortions. All of the accessible welds were flush with the shell with the same general corrosion in depth as the adjacent surfaces. The shell flange gasket sealing surface had no visible corrosion or mechanical damage. The stagnant zone inside of the shell flange gasket sealing surface had isolated corrosion up to 0.060” in depth.

***CHANNEL HEAD:***

The channel head barrel section and the attached nozzle bodies are Monel. The channel body flanges and nozzle flanges are carbon steel with a Monel overlay. The pass partition plates are SB-127. The internal surface of the barrel section had a general roughness to 0.010” deep with widely scattered pitting to 0.030” deep. The barrel section weld seams had a general roughness to 0.010” deep with isolated pitting to 0.030” deep. The channel body flange (channel cover side) gasket seating surface had isolated 0.010” deep mechanical gouges across 90% of the surface. IWR# 017 (WSA# 0735) was submitted and completed to perform weld metal build up and machining of the gasket surface. A PT examination was performed after machining with linear indications reported to the bottom of the partition plate to channel barrel attachment weld. MPC evaluated the indications and determined that no further repairs were required. The channel body flange (shell side) gasket seating surface had no corrosion or mechanical damage. There were two (2) isolated areas of corrosion to 0.090” deep adjacent to the shell side body flange. The pass partition plates were secure with general roughness to 0.010” deep with no distortions. The leading edges had scattered thinning to 20% of the surface and the attachment welds had general roughness 0.010” deep. The interior of the channel head was PT’d per the inspection plan with two (2) areas of linear indications 1” & ½” in length on the pass plate attachment weld and two areas on the body flange dissimilar weld where porosity was present in a 5” and 2” long area. The areas where the porosity was present were removed with a tiger disk and area was copper sulfate tested assuring that the dissimilar weld was not breeched.

***CHANNEL COVER:***

This channel cover was hydro blasted clean prior to visual inspection. There was no mechanical damage to the circumferential or partition plate gasket surfaces. The was no damage or process degradation to the raised process surfaces.

***NOZZLES:***

There was no access to the top nozzle on the south end of the shell. The bottom nozzle ID surface on the north end of the shell had the same general corrosion of 0.030” in depth as the adjacent shell surfaces. The nozzle to shell backwelds were flush and comparable to the adjacent surfaces.

The channel nozzle bores were clear of obstructions with no measurable corrosion or pitting. Nozzle “7” had general corrosion to 0.010” deep with 0.030” deep corrosion adjacent to the nozzle flange. The gasket seating surface had wash-out corrosion to 0.020” deep across 30% of the inner surface. The gasket seating surfaces were free from corrosion and mechanical damage.

***BUNDLE:***

The drawings indicate the front side of the tubesheet to be weld overlaid with Monel with the surfaces being smooth with no corrosion. The backside of the tubesheet had no measurable corrosion. The gasket surfaces had no corrosion or mechanical defects. The tube internal surfaces had up to 0.010” deep pitting. Eddy Current Testing (ECT) was performed on 97% of the tubes with no wall loss detected. There were no previously plugged tubes nor any plugged as for the result of this inspection. The tube exterior surfaces had up to 0.010” deep pitting throughout. None of the tubes were bent or had external damage. The baffles were straight with no corrosion or erosion. The tie-rods were slightly bent however not an issue at this time.

***EXTERNAL:***

During this down time an external inspection was performed. There was no evidence of previous leaks. The flange assemblies associated with this exchanger were in satisfactory condition exhibiting no evidence of damage or deterioration. The coating was 100% failed with surface with corrosion less than 0.010” in depth where the coating had failed. The shell was 100% insulated. The insulation was intact and secure with no penetration in the jacketing and all the banding was secure. The data plate was intact, secure and legible. The ground cable for the exchanger was missing. The anchor bolts for the saddle support on the north end of the exchanger were not secure.

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| **INSPECTION PHOTOS** |

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| **Shell and bottom nozzle** | **Shell flange corrosion adjacent to gasket seating surface** |
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| **Overview of bundle** | **Tubes and tubesheet** |

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| **Channel Cover** | **Channel Cover** |
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| **Channel Head Overview** | **Channel Head gasket surface damage** |
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| **Channel head internal surface** | **Channel head gasket surface after machining.** |
|  |  |
| **Channel Head Nozzle (N7) gasket surface** | **Channel Head Nozzle (N7) gasket surface** |