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HPCC Tubesheet repair after conductivity increase in the steam condensate due to the leakage

Workshop 14th Stamicarbon symposium

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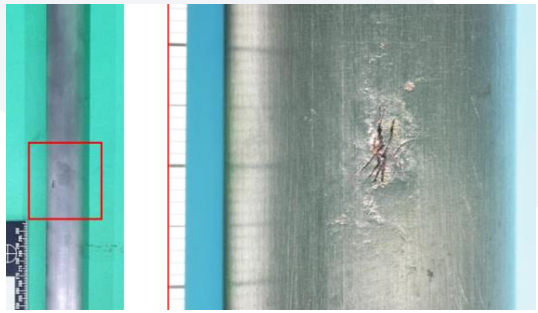
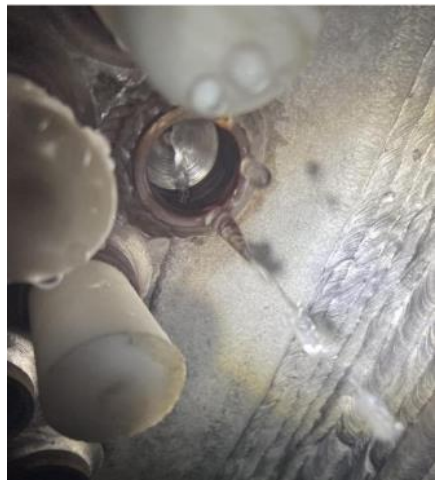
Monitoring the steam conductivity in a high pressure carbamate condenser (HPCC)

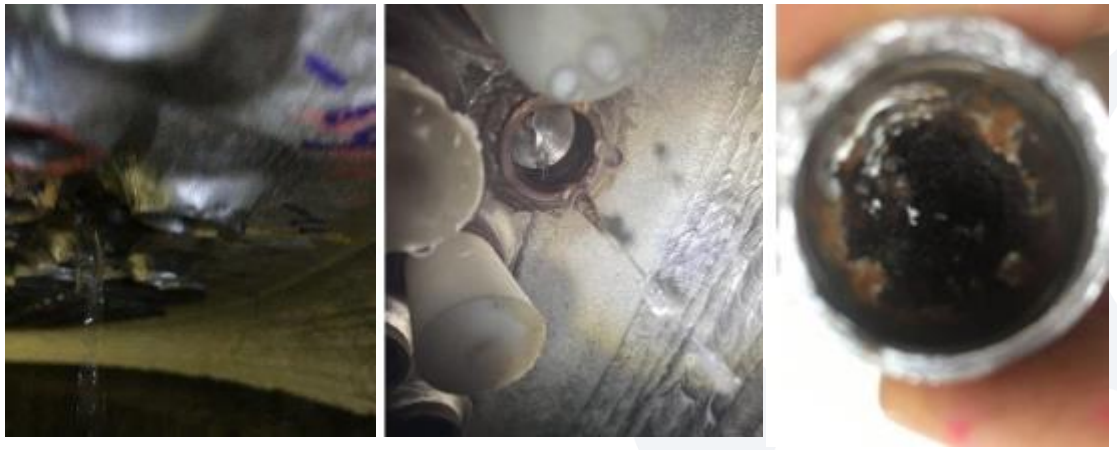
General causes of small leakages

LEAK DETECTION AND STEAM CONDUCTIVITY

- In case of a leak, there will be increase in the conductivity of the steam condensate by disassociation of carbamate into ammonia and CO2
- Therefore, the steam conductivity is being monitored as leak detection system
- Leak can be occur at and caused by:
  - At HP section tubesheet side (caused by leaking tube to tubesheet weld, plug, weld overlay)
  - At LP section steam side (caused by the stress corrosion cracking)
- In Stamicarbon heat exchanger design concept, expansion/rolling of the tubes in the tubesheet is not allowed (leak path)
- The steam conductivity is typically monitored from the steam drum and/or blowdown of HPCC
- **Stop the plant immediately** in case of a suspected leakage



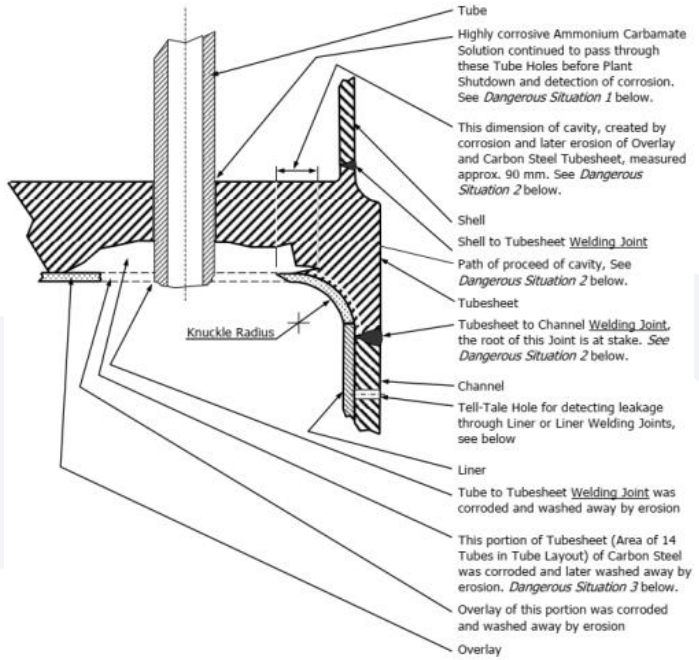


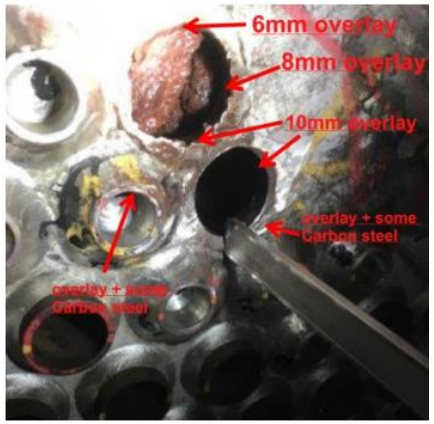


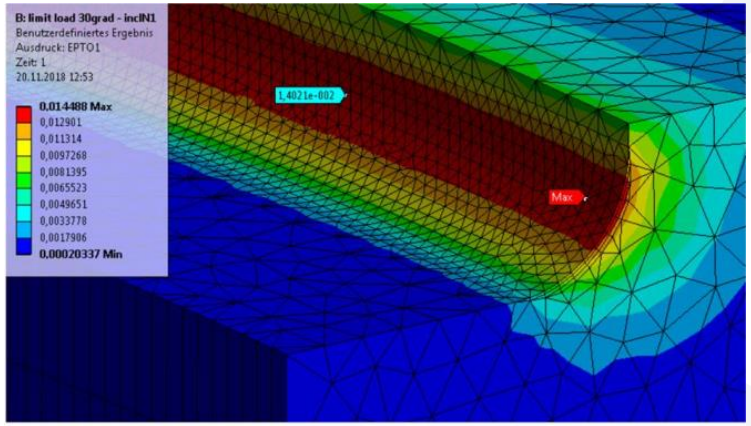
- A leaking plug

Consequences of leakages and cavity in the tubesheet

- Leakage of carbamate can cause to corrosion of tubesheet resulting in a cavity or metal loss
- In one case, a plugged tube was leaking, carbamate went into just above the weld overlay.
- the C-steel tubesheet is corroded also partially the weld overlay and the surrounding HEX tubes at the back side
- Cavities on the knuckle radius of the tubesheet are subject to higher stress levels during operations
- The corrosion of the carbon steel tubesheet can lead to unsupported area underneath the weld overlay which needs to be supported (Leading to higher bending moment on weld overlay without the carbon steel support)
- Cavities needs to be closed to restore integrity of the tubesheet for further safe operations.
- Stamicarbon can support on the repair procedure







Local high stresses in the knuckle radius between tubesheet and HP Channel.

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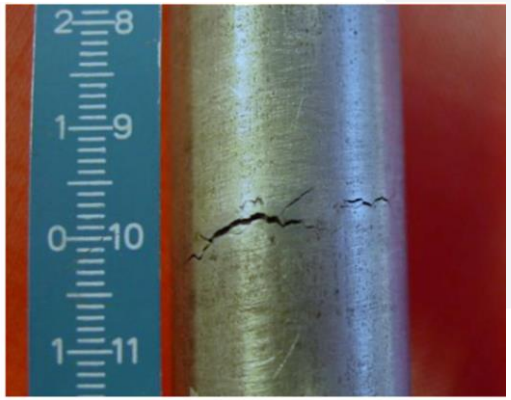
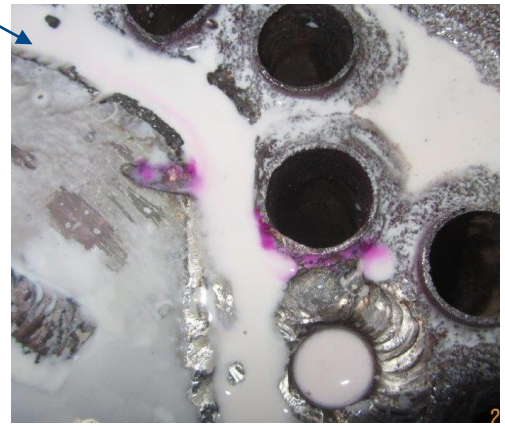
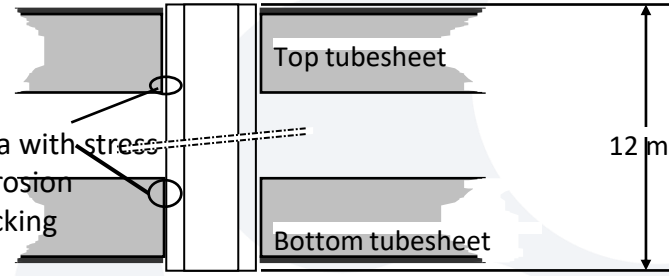
Inspection of the suspected leakages and damages

Inspection steps

- Visual inspection of the bottom/top tubesheet and tubes
- Eddy Current examination to detect missing carbon steel in the tubesheet
- Eddy Current examination to determine the presence of Stress corrosion cracking in the HEX tubes
- Hydrostatic test by water to identify leaking tubes (filling the shell with condensate water)
- Leak test by air/nitrogen
- Ammonia leak test
- Helium leak test is not preferred

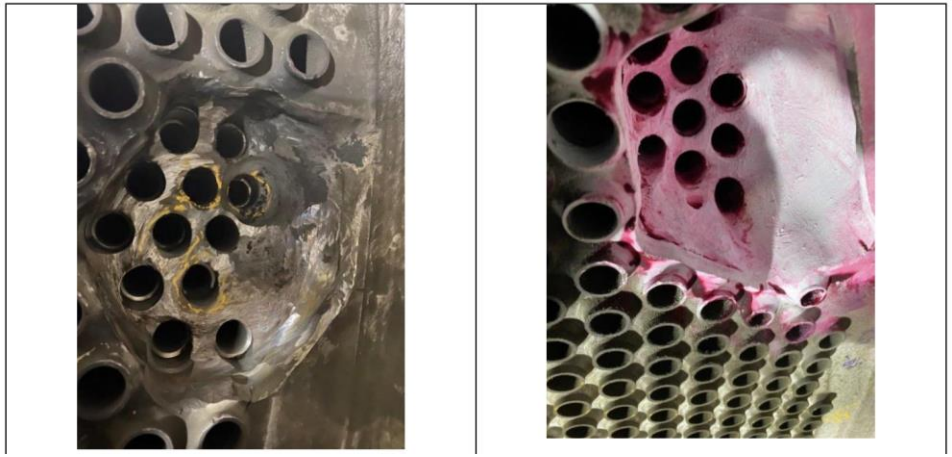






Repair of a damaged tubesheet with cavity
The considerations when the plugging is needed

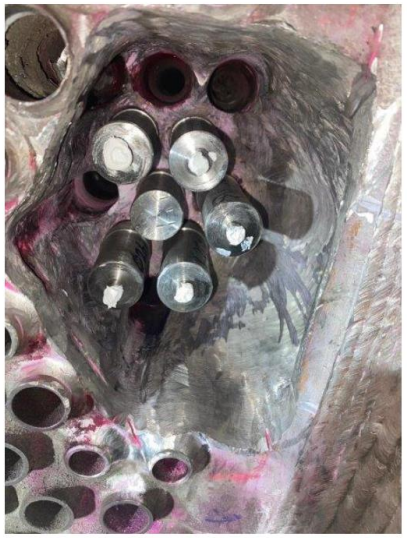
Example repair of a cavity on a damaged tubesheet



Removing the unsupported weld overlay above the cavity

Cover the cavity with a carbon-steel (CS) plates

Final examinations (PT, leak/ammonia tests)



installation of the stud bolts at the position of the tubes

Cover the CS plate with a BC.05 liner plate (SS plate

Connect by welding the liner plate to the existing weld overlay

Repairs should be considered as temporary approach

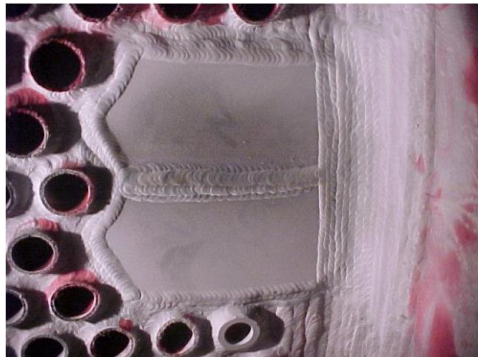
Cavity Repair Similar Cases

Fit-up c-steel plate 1

Fit-up c-steel plate 2

Removing the unsupported weld overlay above the cavity

installation of the stud bolts at the position of the tubes



Liner plate

<u>Important tips:</u>

Welding to the Carbon steel tubesheet is avoided due to the heat treatment requirement

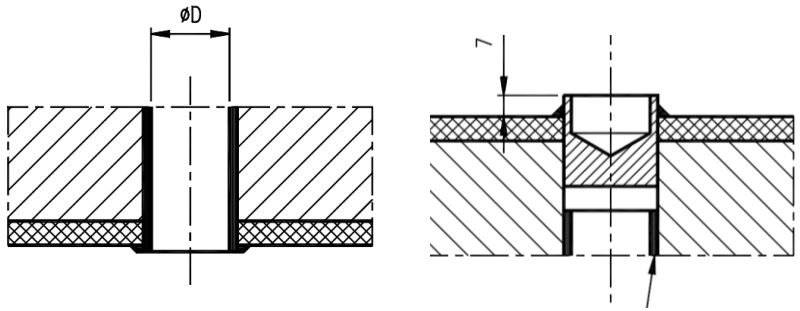
Create a passageway between one of the tube holes and the cavity for leak detection.

Minimum required thickness of the carbon steel support plate by calculation

Grind / mill the tube ends down the tube hole below the bottom level of the cavity.

PLUG ON A TUBE

- During a such tubesheet repair, plugging of some tubes will be needed. (plugging the tubes next to the cavity area, the tube ends at the opposite tubesheet)
- Besides, the tubes with the Stress corrosion cracking indication, depending on the measured crack depth by ECT, can be needed to get plugged.
- In all cases plugging a tube introduces a potential for leakages. It is important to make proper preparations for optimal plugging executing to achieve safe operations.
- Potential risks such as use of inferior plug material, introduce of welding heat, difficulties of welding, poor workmanship, wrong plug design, present defects originated from the fabrication..etc
- Proper plugging and welding procedures also a proper weld executing is of importance
- Proper NDE/visual checks in accordance with the procedure



Every new plug that being installed in the HPCC is increasing the risk of another potential leakage

Questions?

Thank you!

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