

Continuous Digesters- A Story of Shell Corrosion Under Insulation (CUI)

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Background

- 1980 Pine Hill, AL catastrophic failure of upper continuous digester weld due to Stress Corrosion Cracking (SCC)
 - focus has been around inspection, repair, and elimination of SCC on internal shell welds
- Hidden external corrosion under insulation (CUI) can also pose a risk to vessel integrity



Corrosion Under Insulation (CUI)

- Has many different mechanisms
 - Galvanic
 - Acidic
 - Chloride
 - Alkaline
 - Typical Iron Oxide formation
- Dependent on Environmental Conditions



A Story of Continuous Digester CUI

- Two Continuous Digester case studies with CUI
 - Both Single Vessel Hydraulic
 - Digester “A” built in 1966
 - Digester “B” built in 1968
- Thru Shell breaches of continuous digester domes detected within 3 months of each other
 - Digester “A” discovered during hydrostatic pressure check for leaks coming up from annual outage
 - Digester “B” discovered during routine walkdown of the vessel while in operation



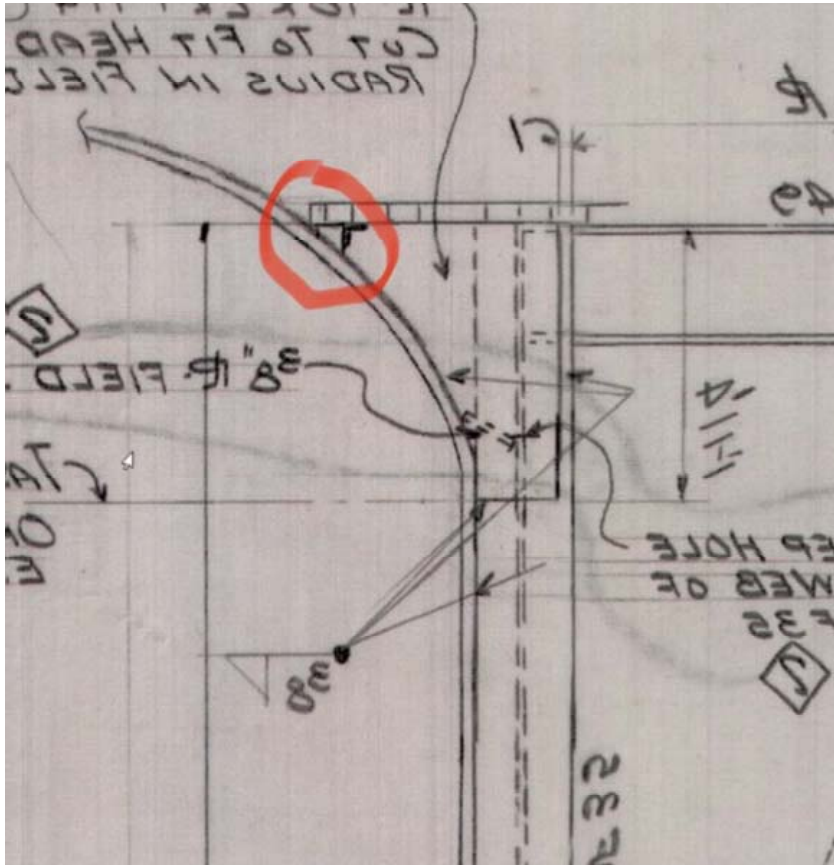
Digester “A” Discovery



- Discovered during walkdown after hydro of the vessel coming up from annual outage
- Pool of Water forming slowly by Top Separator Nozzle Repad while digester was squeezed for checking of over pressurization protection interlocks
 - Did not leak at operating pressure



Digester "A" Discovery



- Grating support ring allowed for collection of debris, seal water, and liquor
- These type attachment supports no longer utilized due to pressure vessel code changes



Digester "A" Discovery

- Exterior corrosion down to cladding of the digester dome
- Extensive repairs had to be made to circumference of the digester dome



Crack in Exposed Cladding

Digester “B” Discovery

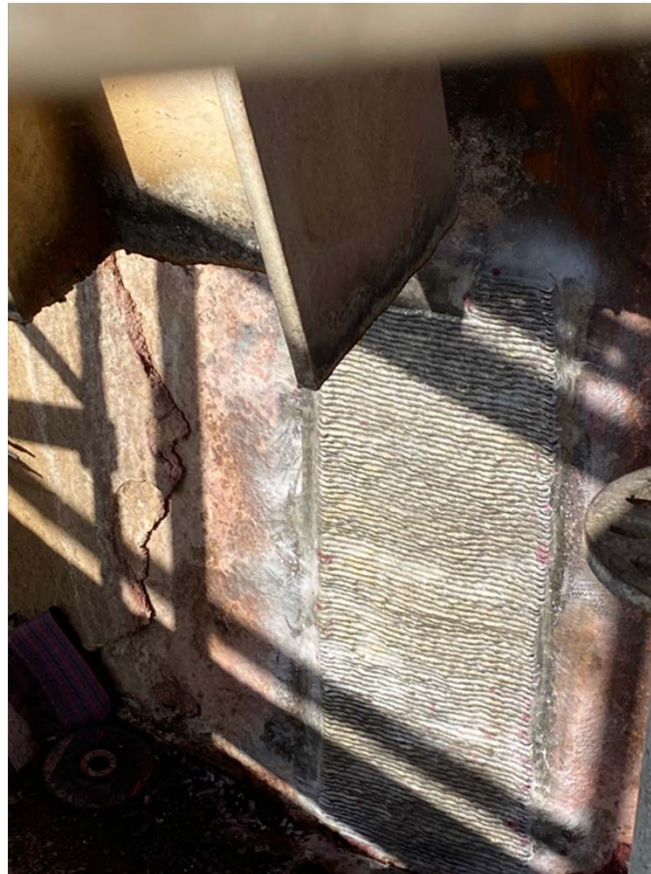
- Liquor leak discovered on upper digester dome during routine walkdown of the vessel 3 months after breach discovered on digester A
- Same mechanism where design of superstructure attachments to vessel created a void for collection of debris which blocked drainage of any water or liquor collected





Digester "B" Discovery

- Code repair of another attachment support area which had CUI below T-min





Not Just Digester Vessels

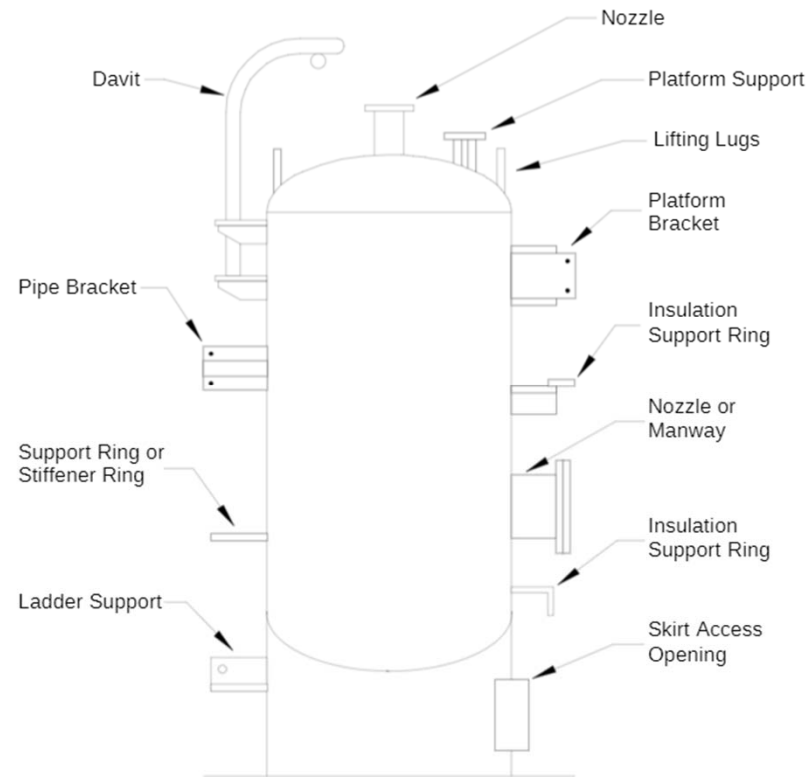
- Same mechanism of exterior corrosion seen on other equipment
 - Seal water draining onto steaming vessel
 - General Piping





GP Continuous Digester Changes

- Utilize best practice of walking down the unit for leaks during hydro/ functional test of overpressurization interlocks
 - Special attention to areas of interest per NACE SP0198 where water intrusion can occur





GP Continuous Digester Changes

- Develop mitigation strategy for risks associated with digester attachments
 - Retrofit digester support attachments to allow for better drainage
- Manage potential for external corrosion due to seal water accumulation at the top of the digester (i.e. appropriate drains, etc.)
 - Operator rounds to check to ensure appropriate drains are not blocked





Acknowledgements

- SP0198-2017, “Control of Corrosion Under Thermal Insulation and Fireproofing Materials - A systems Approach,” NACE International, SP, 2017.
- G. Danielson and N. Risebrough, “External Stress Corrosion Cracking of Evaporator Domes,” presented at the Engineering Conference, TAPPI, 1991. Accessed: Aug. 31, 2023. [Online]. Available: <https://imisrise.tappi.org/TAPPI/Products/eng/ENG91807.aspx>
- ASTM C195-2018, “Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel,” ASTM International. doi: 10.1520/C0795-08R18.
- M. Gorog, “Corrosion Under Insulation,” presented at the PEERS, TAPPI, 2011.