Engineering Consulting & Training Services

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eNewsReport

September 2014

Top Ten Ways to Control Corrosion in Process Plants

By Michael J. Humphries, Ph.D.

Corrosion in industrial facilities in general, and process plants in particular, is a costly degradation mechanism. It could also have safety, environmental, and equipment reliability consequences should it result in a loss in pressure containment. Listed below are the top ten ways to control corrosion in process plants.

1. Corrosion of Buried Piping or Pipelines
   Apply impressed current cathodic protection and polarize the system to –850 Mv. If there is evidence of microbiological activity, polarize to –950 Mv. For new equipment, apply a coating to reduce CP system demand and backfill with graded fill to prevent coating damage by rocks.

2. Corrosion of Underwater Pipelines
   Apply cathodic protection using impressed current or sacrificial anodes. Polarize to –850 Mv. For new facilities apply a protection system incorporating a heavy extruded jacket over a liquid applied coating. Joint protection is critical, and should employ a heat shrunk sleeve after the joint is prepared and coated.

3. Corrosion by Organic Sulfur Compounds in Hydrocarbon Streams
   If carbon steel has proven inadequate, upgrade to 5 Cr or higher alloys. Carbon steel clad with stainless steel is a good alternative in many applications. Do not use solid 13 Cr or Duplex stainless steels above 600ºF because they may embrittle. Be aware that low silicon carbon steel components sulfide faster than higher silicon steels.

4. Corrosion by Naphthenic Acids
   For the most economical approach, inject a Naphthenic Acid corrosion inhibitor in conjunction with limited alloy upgrading to Type 317 stainless steel of circuits that cannot be protected by the inhibitor. Alloy upgrading alone is rarely cost effective, and only practical if there is a longer term supply of high TAN crude.

5. Corrosion by H_2S/Hydrogen
   Selectively upgrade circuits to stainless steel. The severity of attack depends on the H_2S content of the stream and the liquid/vapor ratio. For many applications, Type 304/304L is adequate. Various API, NACE, and other industry documents can provide guidance on alloy selection (e.g., API RP 571, NACE MR 0103, etc.).

Upcoming Training Courses

- Course 607
  Design and Maintenance of Aboveground Atmospheric Storage Tanks

  November 18-20, 2014 in TX
  December 16-18, 2014 in NJ

- Course 1600
  Achieving World Class Maintenance Performance

  November 4-6, 2014 in NJ
  February 10-12, 2015 in TX

For more information, see our website at www.carmagen.com.

Work Highlights

Process, Operations & Safety

- *Completed process support to a refiner associated with FEL-2 process design to upgrade their FCC reactor system with riser cracking design improvements, and provided assistance to provide process review of licensor revamp design package. Starting support for the next phase (FEL-3 work) associated with this FCC revamp project.*

- *Providing pilot plant support associated with the assessment of pertinent design practices/ engineering standards/SSHE procedures, and general process consultation to relocate pilot facilities.*

6. Corrosion at Pipe Supports
   Piping experiences increased external corrosion where it sits on a support. Water and corrosives can become trapped in the crevice between the pipe and the support, and movement between pipe and support dislodges scale which would retard corrosion. Corrosion at this location is difficult to monitor and measure. It can be controlled by attaching a shaped shoe to the outside of the pipe at the support.

7. Corrosion in Recirculating Cooling Water Systems
   Corrosion is controlled by application of a biocide and a chemical treatment to control scaling and corrosion. When hydrocarbon leaks into the system, the biocide is consumed by the hydrocarbon and organic deposits form, leading to localized corrosion. A first step in controlling corrosion is to break the "Vicious Cycle" initiated by hydrocarbon leaks.

8. Corrosion in Boilers
   Provided feedwater treatment is correctly maintained, online corrosion is rarely a problem. Many corrosion problems in boilers occur when the unit is offline. Boiler layup procedures are critical and should include oxygen removal and exclusion, and chemicals to raise pH. Alternatively, the boiler may be dry stored, with water completely removed. The fireside should be maintained warm to prevent water and acid condensation.

9. Corrosion Under Insulation
   Field experience has shown many cases of Corrosion Under Insulation (CUI) on carbon steel equipment operating between 25 and 350ºF (Ref. NACE SP0198-2010) when water penetrates the insulation. Salts carried in with the water, or derived from the insulation, form a corrosive environment at the pipe surface. Corrosion is controlled by applying a coating such as an epoxy or epoxy phenolic to the pipe and by ensuring that the weatherproofing over the insulation excludes water.

10. Corrosion in Crude Column Overheads
    Corrosion in the overhead of atmospheric crude units is caused by condensation of acids or desublimation of ammonium chloride. It is usual to add inhibitors to control acid corrosion. Control of corrosion under ammonium chloride deposits has become a more critical problem due to increased ammonia levels caused by ammonia recycle within the refinery. Corrosion under Ammonium Chloride deposits is best controlled by a continuous water wash in the overhead system. Water introduced to the overhead must be removed in the downstream drum.

About the Author

Michael Humphries has over 45 years experience as a Materials Engineer in the power generation and petroleum industries, including both the refining and pipeline sectors. He retired after 29 years with Exxon Research & Engineering Company (ER&E). Mike's areas of specialty include corrosion, metallurgy, materials engineering, pipeline engineering, heavy wall vessel fabrication, water treating, inspection, and general fabrication.

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