SULFURIC ACID TANK INSPECTION

By
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Tank Engineering And Management Consultants, Inc.
Introduction

- Jeff W. Kitchen
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- API-653 Certified Tank Inspector
- API-570 Certified Piping Inspector

Tank Engineering And Management Consultants, Inc.
Introduction

- TEAM Consultants is currently under the same ownership as Penn-Pro Engineering.
- TEAM has been in business since 1983
- Originally founded by James E. Pandolph, P.E.
Corrosion in Sulfuric Acid Tanks

- Corrosion = The deterioration of a substance or its properties because of a reaction with its environment.
- Anytime you store liquids in a metal container you have the ingredients for corrosion.
Corrosion in Sulfuric Acid Tanks

- Sulfuric acid (H₂SO₄), in carbon steel tanks, reacts with iron in the shell to form a ferrous sulfate product and hydrogen according to the reaction:

  Fe (iron) + H₂SO₄ (sulfuric acid) → FeSO₄ (ferrous sulfate) + H₂ (hydrogen)
Corrosion in Sulfuric Acid Tanks

- The FeSO₄ forms a protective layer between the acid and tank wet surfaces.
- Many conditions deteriorate this protective film – such as flow, liquid turbulence, diluting the acid with additional water, high temperature, or agitation.
- Without protective film, the steel is subject to accelerated and localized corrosion.
Corrosion metal loss in acid storage tanks.
Tank Construction Standards

Vertical Tanks

- API 650 - Tanks are usually vented. However, Appendix F allows small internal pressures up to 2.5 psig.
- API 620 - Applies to design pressures less than 15 psig.
- Equal or more than 15 psig containers use ASME Section VIII – Pressure Vessel Code.
Tank Construction Standards

- API 650 was developed for oil storage (specific gravity <1.0, typically 0.75 - 0.95). The specific gravity of 93% and 98% sulfuric acids are 1.8354 and 1.8437 respectively. Sulfuric acid is about double the weight of the lighter oils.

- A sizable corrosion allowance is typically added for sulfuric acid service.
Tank Construction Standards

- **Horizontal Tanks**
  - Section VIII of ASME Boiler & Pressure Vessel Code
  - UL-142 is NOT suitable for sulfuric acid. It only applies to non-corrosive materials with a specific gravity of 1.0 or less.
Tank Inspection Standards

- Vertical Tanks
  - API Standard 653 (Tank Inspection, Repair, Alteration, and Reconstruction)
  - Covers carbon and low alloy steel tanks built to API Standard 650 and its predecessor 12C
Tank Inspection Standards

- Horizontal Tanks
  - API Standard 510 (Pressure Vessel Inspection Code)
  - Intended for pressure vessels, but has the best criteria for formed heads, thick plates, support saddles, etc.
Tank Inspection Methods

- Ultrasonic Thickness Measurements (UTM’s)
  - Pay careful attention to location and direction of testing.
  - Take more UTM’s around typical high product level AND sludge line near tank bottom.
Example:

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Tank Inspection Methods

- Ultrasonic Thickness Measurements (UTM’s)
  - Pay careful attention around nozzles and vents, and directly on piping and flanges.
  - It is important to combine visual inspection with UTM locations.
Example:

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Tank Inspection Methods

- Floor Scanning in Vertical Tanks
  - Magnetic Flux Leakage (MFL) only works up to ½” plate thickness.
  - SLOFEC (Super Low Frequency Eddy Current) will work on thicker materials.
  - Spot UTM’s may be a suitable and cheaper alternative.
Tank Inspection Methods

- Location of Cracks In and Near Welds
  - Sulfuric Acid will tend to attack the heat affected zone (HAZ) on weld seams.
  - Typically use Magnetic Particle (MT) or Dye Penetrant (PT) for finding cracks.
Indirect Causes of Corrosion and Failure

External and Piping Corrosion
Indirect Causes of Corrosion

- Corrosion behind exterior insulation
  - Insulation material will “wick” rainwater, condensation, etc., and hold it near the tank shell, eventually leading to coating failure and corrosion.
  - Sulfuric acid drips and leaks can also get trapped between insulation and tank shell causing dilution of the acid and accelerated corrosion.
Indirect Causes of Failure

- Corroded Vent Pipes and Valves
  - Vent piping will corrode, which could plug the vent and over pressure the tank.
  - In the following example, a check valve in the vent system corroded shut, leading to over pressuring the tank during a fill operation.
Interior Coating Inspection

Importance of Inspection Before, During, and after Coatings Application
Interior Coating Inspection

- Inspection Before and During Coating
  - All sharp edges must be ground smooth.
  - Proper surface preparation is mandatory.
  - For heat cured coatings, proper temperature gradients must be adhered to.
Coating failure due to improper application.
Interior Coating Inspection

- Holiday Testing Inspection
  - Use NACE RP0188 for procedures and standards.
  - Proper and thorough holiday test is critical.
  - A holiday test is generally not effective on a coating that has already been in service.
Inspection Interval Calculations

- API-653 uses \( \frac{T_{act} - T_{min}}{\text{Corr Rate}} \) to determine next inspection date. Corrosion rate is established by previous inspection data.

- API-570 (Pipe) uses same formula, but schedules next inspection at HALF remaining life.

- For severe localized corrosion applications, I prefer using the API-570 method.
SUMMARY AND CONCLUSION

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Summary

- Thorough and proper inspection is critical.
- Visual inspection of both sides is extremely helpful.
- Use visual to guide UTM locations.
- Don’t wait for a leak to start inspection!
CONCLUSION

Tanks for listening!

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