Engineering Consulting & Training Services

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Aboveground Atmospheric Storage Tank Bottom Plate Corrosion

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The required internal inspection interval of an Aboveground Atmospheric Storage Tank (AST) must be determined based on corrosion rates measured during previous inspections or anticipated based on experience with similar tanks in similar service. Bottom plate corrosion normally controls the required internal inspection interval, and this corrosion may occur both from the top side and the underside.

Special consideration should be paid to tanks whose service has changed during their operating lives. Also, because underside corrosion of the tank bottom is generally the primary factor governing the required internal inspection interval, tanks in nominally the same service, even at the same location, could have significantly different underside corrosion and/or pitting rates. This is due to differences in soil conditions or contaminants or the presence of water under the tank. In this regard, there could be marked differences among different tanks located within the same geographic area or even among different locations on the same tank bottom.

The use of local experience gained from prior tank inspections is clearly the best tool for determining internal corrosion rates. These may then be used to help determine appropriate internal inspection intervals and the overall tank inspection plan for the site. Experience has shown that corrosion rates are extremely variable even for nominally the same service. Therefore in the absence of actual data, the topside corrosion rates indicated below may be used as a guide for scheduling internal tank inspections. They should be considered in combination with data from previous tank inspections, when available, including both topside and underside corrosion rate data. Underside corrosion is greatly influenced by tank foundation design, materials, and temperature. At elevated operating temperatures, severe corrosion can occur on the underside of the bottom plate around the perimeter of the tank.

The following lists typical tank storage services in descending order of internal corrosion severity based on information obtained from multiple sources.

- Crude Oil Storage Tanks - Pitting is major concern with reported pitting rates of 10-60 mils per year (mpy). Factors influencing pitting rate can include sulfur and salt water content, operating temperature, H_2S, heating coil design, microbe induced corrosion (MIC), rainfall, airborne chlorides, and others. Corrosion may be more severe at inlet and outlet nozzles.

Upcoming Training Courses scheduled to be held in Greece

- Course 710, *Mechanical Seal Selection, Operation, and Maintenance*, November 26-28, 2012
- Course 1250, *Industrial Energy Management in the 21st Century*, December 17-19, 2012

See our website for details

Work Highlights

Materials Engineering

- *Materials Operating Envelopes (MOE's) were developed for the FCCU, HF Alkylation Unit, and Sulfur Recovery Unit located at a US refinery. An MOE defines key parameters which, when monitored and/or controlled within a defined set of limits, will assist in maintaining a unit's reliability. The refinery's current monitoring and inspection programs were reviewed, and recommendations were made which, when followed, will improve the overall mechanical reliability of the units.*

Process, Operations & Safety

- *Providing ongoing process support to a refiner to investigate option benefits to upgrade their FCC reactor system with various riser cracking design improvements, and assistance to prepare the request for proposal (RFP) to technology licensors. Assistance in the evaluation of licensor proposals and work with contractor to follow.*
- *Supporting PIMS simulation (LP) modeling and refinery optimization remotely on various ongoing projects.*

- **Slop Water, Tanker Dirty Water Ballast, Fire Water** - Pitting rates can approach those experienced in crude oil tanks. Fire water tanks may be open at the top, permitting debris to accumulate on the bottom, thus accelerating corrosion.
- **Diesel and Fuel Oils** - Pitting rates vary depending upon sulfur content and storage temperature and can range from 5-15 mpy. Bunker C storage tanks frequently experience the most severe corrosion.
- **Motor Gasoline, Gasoline Blending, AVGAS, Naphtha** - Stored in floating roof tanks. Pitting ranges from 5-30 mpy, but in most tanks corrosion is not severe. Corrosion of the shell does occur and corrosion scale may bypass the floating roof seal and be deposited on the tank bottom. This position could accelerate corrosion.
- **Gas Oils** - Large variation in tank bottom pitting rates; similar to diesel and fuel oils. Largely dependent on sulfur content.
- **Solvents and Alcohol** - Tanks are internally coated to protect product quality. Methanol tanks may be gas blanketed to prevent water ingress.
- **Asphalts, Tars, Other Bitumens** - Generally stored at sufficiently high temperatures that there is usually no internal bottom plate corrosion. There is little or no water and a protective coating may be formed on bottom plate.
- **Boiler Feed Water** - Generally entire tank is coated to protect purity of water.
- **Jet Fuels** - Generally entire tank is coated because of product quality standards. If bottom plate is not coated, corrosion is similar to motor gasoline service.
- **Lube Oils and Waxes** - Little or no corrosion because of protective properties of the oil and waxes.
- **LPG Spheres** - Little or no corrosion expected.
- **Special Case** - Water Neutralization Tanks - Extremely corrosive service; pH can vary from 1-13. Entire tank must be lined with a chemically resistant fiber reinforced coating system. Abrasion may cause accelerated deterioration of the reinforced liner.

Accelerated Corrosion of Hot Tank Bottoms

Accelerated corrosion on the underside of bottom annular plates can occur with tanks that store heated liquids (e.g., asphalt or fuel oil). This underside corrosion can be especially severe when the tank pad is not well graded and sloped away from the shell on the outside to avoid rainwater accumulation at the shell and then running under it. When heated liquids are stored, a temperature gradient exists across the annular plate from inside to outside. This temperature gradient creates ideal conditions for accelerated underside corrosion of the annular plate when rainwater is present.

The corrosion is generally greatest just a short distance from the inside shell-to-annular plate weld, and has resulted in annular plate failures and loss of tank contents. Special care should be taken when inspecting the tank bottom near the shell in cases where there is a greater likelihood of such corrosion. This is especially true in situations where there is concern regarding rainwater accumulation at the tank, and/or if there are visible signs of corrosion of the bottom annular plate extension beyond the tank shell.

About the Author

Vincent Carucci, President of Carmagen Engineering, Inc., also provides mechanical engineering expertise in the areas of pressure vessels, heat exchangers, piping systems, and storage tanks to the process and power industries, insurance companies, and attorneys. If you would like more information, please contact Vince at vcarucci@carmagen.com.