Addressing Defective Cathodic Protection Systems On Above Grade Storage Tanks

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Cathodic Protection Systems

- Cathodic protection is used to control corrosion on the underside (soil side) of above grade petro-chemical tanks

- Effective cathodic protection will increase reliability and reduce costs associated with maintenance and inspection

- Several states, the DOT and the DoD require the use of cathodic protection to reduce product release
Cathodic Protection Types

- Galvanic
- Impressed Current
Single Bottom Storage Tanks

- Rectifier
- Tank
- Protective Current
- Foundation
- Anode
Cathodic Protection Arrangement

- Many above grade tanks are equipped with under floor containment liners

- The type of liner used will determine the anode placement
Clay Fabric Containment Liner

- Current passes through liner
- Anodes can be placed below liner or around tank
- Replacement anodes can be placed around tank
Non-Conductive Liner

- Containment liner blocks current from reaching tank bottom
- Cathodic protection readings around tank give indication of effective corrosion control
- Tank bottom subject to corrosion above liner
• Anodes are placed in sand between liner and tank bottom
• Anodes can not come in contact with tank bottom
• Distance between anode and floor determines current distribution
Galvanic Ribbon Systems

- Spacing between ribbons must adequate to provide current distribution

- Sand fill can not be corrosive, and must remain relatively dry

- When moisture enters the sand, most galvanic systems continue to protect the tank bottom but a shorter anode service life may result.

- Some early galvanic ribbon systems were actually used to detect leaks
Zinc Anode Ribbons

36 to 60 inches

Zinc ribbon

Test Box
Cable Connections

Tank Shell
Magnesium Anode Ribbons

- Magnesium Ribbons
- 24” Centers
- #10 RHW-USE
- Splice
- Test Box
- Permanent reference cell centered between ribbons
- Tank Shell
Galvanic Anode Splice

- Mastic Patch
- Solid Copper Crimp
- Exposed Steel Core
- Magnesium Ribbon
- To Next Anode
- #10 RHW-USE
Galvanic Test Box

- Live Shell
- New Floor
- Sand
- Liner Seal
- Reference Cells
- Anode Ribbon
- Test Box
- Seal off 1 ½” dia. conduit
- Grade
- Couple
Current flows off magnesium anode into sand
Current flows through sand and onto underside of floor
Current returns in steel and cable to anode
Sand Contamination

- Rain water enters at leak detection tubes
- Rain water enters at chime (new floor to old shell)
- Water bottoms seep through flaws in welds or floor plates
Water Entering Sand

- Weld defect
- Defect in plate
- Water entering sand
- Sand
- Dead Shell
- Leak detection port not sealed
- New Floor
- Chime
- Lack of seal weld
- Old Floor

- Water entering sand
- Live Shell
Impressed Current

- Rectifier supplies current to anodes in sand
- Anodes deliver current to floor which is returned to rectifier
- Reference cells are used to monitor protection levels
Galvanic System Deficiencies

- Anode ribbons are too far apart
- Anode ribbons do not deliver sufficient current
- Sand used as fill is conductive and corrosive
- Water enters sand causing it to become corrosive
- Galvanic anode ribbons are depleted
- Reference cells are inaccurate or inoperable
Impressed Current Deficiencies

- Rectifier inoperable or not properly adjusted
- Cables between rectifier and anode box are severed
- Anodes are spaced too far apart
- Anode ratings are too low
- Anodes are grounded to tank bottom
- Reference cells are inaccurate or inoperable
- Positive and negative cables are connected with the wrong polarity
- Sand is too dry
The CP System Doesn’t Work. Now What?

- Monitor tank bottom using API-653 inspection code, take action if corrosion losses are significant
- Lift the tank or remove the floor and replace the cathodic protection system
- Attempt to insert anodes between liner and floor through holes cored in ringwall
- Inject inhibitors into sand in place of cathodic protection
Inject Water Based Inhibitor

Monitor Discharge

Electrical resistance probe or coupon

Inject Water Based Inhibitor

Shell
Conclusions

- Best solution is to avoid the problem to start with; specific requirements for construction
- Monitor tank floor using API-653 inspection code, take action based on inspection results
- Inhibitor inject shows promise, concerns are accuracy of corrosion monitoring and life cycle of inhibitor
- Inserting anodes between liners and floors is not practical in most applications
- Lift tank/remove floor – be sure any replacement systems are design and installed to provide long term service
Thank you.