Cathodic Protection for On-Grade Storage Tanks and Buried Piping

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Corrpro

Freshwater Spills Symposium
April 6-8, 2004
Why is Corrosion Control Important?

- Preserve Assets
- Reduce Maintenance Costs
- Governmental Compliance
- Preserve The Environment
What I Will Cover....

- Causes of Corrosion
- SPCC/State/OPS Regulations
- Cathodic Protection Applications
- Maintenance Requirements
Spill Prevention Control and Countermeasure (SPCC) Regulation (Implementation Required by 2/18/05)

- Provide buried piping that is installed or replaced after August 16th, 2002 with a protective coating and cathodic protection.

- Should a section of line be exposed for any reason it must be inspected for deterioration. If corrosion damage is found you must take additional examination and corrective action.
Federal Level
(Breakout Tanks)

a) Relieves surges in a hazardous liquid pipeline system or b) receive and store hazardous liquid transported by a pipeline for reinjection and continued transportation by pipeline
Breakout Tank Piping (DOT)

- Main Line
- Valve
- Meter
- OPS Inspection

Product Tank (Breakout)
State Level

- Approximately 25% of States now require cathodic protection be installed and maintained on new, refurbished, or repaired tanks in contact with soil or sand foundations.

- A number of other states are in the process of implementing regulations governing AST’s.
Corrosion Can be Defined as Either:

- **Practical**
  Tendency of a Metal to Revert to its Native State

- **Scientific**
  Electrochemical Degradation of Metal as a Result of a Reaction with its Environment
Corrosion - A Natural Process

IRON OXIDE + REFINING + MILLING = IRON OXIDE

IRON + CORROSION = IRON OXIDE
1) ANODE
2) CATHODE
3) ELECTROLYTE
4) ELECTRICAL CONNECTION

Anode: -600mV
Cathode: -550mV
Electrolyte: -575mV

Electrical connection indicated by arrows between the anode and cathode.
Corrosion of Metallic Structure
Corrosion Cell on Tank Bottom

Steel Tank Floor

CATHODE  ANODE  CATHODE

SAND  CLAY  CURRENT FLOW
Corrosion Caused by Poor Water Drainage

Dry Sand

Moist Sand

Water
New Steel Coupled to Old Steel

New Bottom (Anode)

CURRENT FLOW

Old Bottom (Cathode)

SAND
Galvanic Anode
Cathodic Protection

- Current is obtained from a metal of a higher energy level
# PRACTICAL GALVANIC SERIES

<table>
<thead>
<tr>
<th>Material</th>
<th>Potential*</th>
</tr>
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<tbody>
<tr>
<td>Pure Magnesium</td>
<td>-1.75</td>
</tr>
<tr>
<td>Magnesium Alloy</td>
<td>-1.60</td>
</tr>
<tr>
<td>Zinc</td>
<td>-1.10</td>
</tr>
<tr>
<td>Aluminum Alloy</td>
<td>-1.00</td>
</tr>
<tr>
<td>Cadmium</td>
<td>-0.80</td>
</tr>
<tr>
<td>Mild Steel (New)</td>
<td>-0.70</td>
</tr>
<tr>
<td>Mild Steel (Old)</td>
<td>-0.50</td>
</tr>
<tr>
<td>Cast Iron</td>
<td>-0.50</td>
</tr>
<tr>
<td>Stainless Steel</td>
<td>-0.50 to +0.10</td>
</tr>
<tr>
<td>Copper, Brass, Bronze</td>
<td>-0.20</td>
</tr>
<tr>
<td>Titanium</td>
<td>-0.20</td>
</tr>
<tr>
<td>Gold</td>
<td>+0.20</td>
</tr>
<tr>
<td>Carbon, Graphite, Coke</td>
<td>+0.30</td>
</tr>
</tbody>
</table>

* Potentials With Respect to Saturated Cu-CuSO₄ Electrode
Galvanic Cathodic Protection on Coated Pipeline

- Magnesium Anode

Current Flow

Structure
Cathodic Protection Test Station

Test Station

Magnesium Anode

Coated Pipe
FLANGE INSULATION KIT

INSULATING UNIONS
Galvanic Anodes

- Typically limited to new piping, that has a good quality coating and electrical isolation.
- If the particular location is lacking any of the above, an impresses current system may be warranted.
Internal Corrosion
Conventional CP Systems for AST’s

- Shallow (Distributed) Anodes
- Deep Anode Groundbed
Impressed Current Transformer Rectifier Unit
Impressed Current System

- Rectifier
- (-) and (+)
- Anode Groundbed
- Pipeline (Structure)
- Current Flow
Rectifier

Tank

Splice

Anode

Typical Depth 20'

Shallow Anodes
Shallow Anodes

Tank

Rectifier

Anode

Shallow Anodes
Anodes

Junction Box

Rectifier

Anodes
Directional Boring Under Existing AST
ABOVEGROUND STORAGE TANK

CATHODIC PROTECTION

- Test/Access Station
- Aboveground Storage Tank
- Grade
- 3" ø PVC 20% Exposure
- Anode Material
- Anode Tube
- 10' Typical
New/Refurbished AST Bottoms with or without Secondary Containment
Secondary Containment

- Environmental Protection
- Minimize Liability
- State and Local Regulations
New Tank Construction with Liner
Anode & Reference Cell Placement in High Resistance Sand
CP Installation on Double Bottom Tank
New Floor Installation on Existing AST
CP Installation on Rebottomed Tank
Installation of CP System on Lifted AST
Maintenance of Cathodic Protection Systems

- Conduct Annual Testing
- Meet NACE Criteria/Standards
- Conduct Bi-Monthly Rectifier Checks
- NACE Qualified Technicians
NACE Cathodic Protection Criteria

- -850mV or more negative with current applied
- -850mV “Instant off”
- -100mV shift between “Instant off” and “Native”
Annual Cathodic Protection Survey
Rim Potential Measurements

Portable Reference Cell

Soil

(+)

-850 mV

Tank

US EPA ARCHIVE DOCUMENT

INTERNATIONAL

THE CORROSION SOCIETY

ANACE®
<table>
<thead>
<tr>
<th></th>
<th>Rim</th>
<th>25'</th>
<th>Center</th>
<th>55'</th>
<th>Rim</th>
</tr>
</thead>
<tbody>
<tr>
<td>On</td>
<td>-1411</td>
<td>-698</td>
<td>-404</td>
<td>-601</td>
<td>-1455</td>
</tr>
<tr>
<td>Off</td>
<td>-902</td>
<td>-664</td>
<td>-402</td>
<td>-578</td>
<td>-911</td>
</tr>
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</table>

Potential (mV)
Stray Current Monitoring Test Station
Computerized Potential Logging Survey

Test Station → Backpack Computer Unit → Reference Cells

Chainer/Wire Dispenser & Counter → Pipeline
Monitoring

- Record volts and amps every 30-60 days
- Compare values to target setting
- Conduct annual cp survey by NACE engineer
- Maintain cp records
Bi-Monthly Rectifier Check
Record Keeping

- Provides History
- Computer Records/Data Collection
  Remote Monitoring
  Hand Held Computers
  Close Interval Surveys
  Data Printouts
  Flagging of Problem Areas
  Prioritize Action Items
- As Built Drawings
- Store Data & Records for Life
<table>
<thead>
<tr>
<th>Galvanic</th>
<th>Impressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>No external power</td>
<td>External power required</td>
</tr>
<tr>
<td>Fixed driving voltage</td>
<td>Voltage can be varied</td>
</tr>
<tr>
<td>Limited current</td>
<td>Current can be varied</td>
</tr>
<tr>
<td>Small current requirements</td>
<td>High current requirements</td>
</tr>
<tr>
<td>Used in lower resistivity</td>
<td>Used in almost any resistivity</td>
</tr>
<tr>
<td>environment</td>
<td>environment</td>
</tr>
<tr>
<td>Usually negligible</td>
<td>Must consider interference</td>
</tr>
<tr>
<td>interference</td>
<td>with other structures</td>
</tr>
</tbody>
</table>
Recommended Practices

**API-651** - Cathodic Protection of Aboveground Petroleum Storage Tanks:

“*Galvanic anodes method is not practical for protection of large bare structures.*”

**NACE RP0193-01** - External Cathodic Protection of On-Grade Metallic Storage Tanks:

“*Galvanic protection systems can be applied to tank bottoms where the metallic surface area exposed to the electrolyte can be minimized through the application of a dielectric coating or the area is small due to the tank size or configuration.*”
Questions...