Cathodic Protection Case Study

Checking Your System: Water Storage Tank Galvanic Anodes

Presented by Bobbi Jo Merten, Ph.D.
Protective Coatings Specialist
TSC, Materials & Corrosion Laboratory
bmerten@usbr.gov
303-445-2380

Presented by Daryl Little, Ph.D.
Materials Engineer (Corrosion)
TSC, Materials & Corrosion Laboratory
dlittle@usbr.gov
303-445-2384
Tank Details:

- Bolted steel tank
- Glass lined
- Concrete floor
- Floor mounted anodes

Inspection report: “The tank’s Cathodic Protection system does not seem to be performing properly.”
Tank Anode and Cables
How to Check Your CP System

Learning Objectives
• Spot check your system
• Use equipment to test it
• Troubleshoot problems
CP System Check: Procedure

Steps: Test with voltmeter and reference electrode

1. Identify system components & ensure anode is submerged
2. “ON” potential
3. “instant OFF” potential
   • Record 2nd reading on voltmeter
   • Reconnect within 2-3 seconds
4. Anode current
5. Anode potential
6. Retest system

Visually inspect interior tank surfaces (if possible)
Step 1 – System Components

- Thin insulated cable and shunt connects anode and structure
- Large non-insulated cables are for grounding
  - May have grounded anode
Step 2 – “ON” Potential

- Positive terminal connected to tank manhole
- Negative connected to reference electrode (RE)
- -0.597 V vs Cu/CuSO₄ RE
Step 3 – “Instant OFF” Potential
(Also known as the polarized potential)

• Briefly disconnect anode at nut
• Reading should change

“ON”
-0.597 V

“Instant OFF”
-0.597 V

(no polarization observed)
Steps 1-3 - Troubleshooting

• Possible reasons:
  • CP system is not connected
  • Anode has been consumed
  • Anode type is incorrect or is passivated
    • Is it Zinc (Type I or II) or is it Magnesium?
    • What does water chemistry indicate?
  • Lightning system connected to anode is causing issue

• Possible solutions:
  • Clean connection points to ensure electrical continuity
  • Proceed with next steps
  • Get technical expert involved
Step 4 – Anode Current

• 0.01-ohm shunt
• Measure voltage across two posts and calculate current
• Measured 0.1 mV may be rounded

Current (I) = voltage (V) / shunt resistance (R)
I ≤ 0.1 mV / 0.01 ohm
I ≤ 10 mA (little or no current)
Step 5 – Anode Potential

• One bolt has isolation kit, which should be anode
• Anode potential when disconnected = -1.066 V = Zinc
  - Zinc anode = -1.1 V
  - Magnesium anode = -1.5 to -1.7 V

Isolation prevents direct contact between anode and tank wall

Anode potential shows anode is not passivated
Step 6 – Retest

Always retest the CP system:
• After all connections are secured to ensure it is operating
• After any adjustments are made

Retested hours later: “ON” = -0.882 V
“OFF” = -0.672 V

Original “ON” of -0.597 V may be native potential (if disconnected for a significant amount of time allowing the tank to depolarize)
Zinc anodes with minimal degradation in each tank

Interior ladder corroding
- Aluminum poor choice in high chloride environment
Summary

1. Cable connections:
   • ALWAYS check that CP system is operating (if potential drops when anode disconnected then the system was operating)
   • External connections are vulnerable to damage
     • Did someone snag the cables and pull them apart?
     • Connection issues
       • Are bolts coming undone over time?
       • Oxidation of surface disrupting electrical connection?
   • Labels help future testers
   • Avoid connecting anode directly to lightning and ground system

2. Visually inspect anodes
   • Active anodes change shape and degrade with time
     • No change could mean it is passivated or not connected
     • Potential readings aid in determining anode passiviation
   • Can be used to determine when to replace the anode
Questions?
Materials and Corrosion Laboratory Staff - 8540

Cathodic Protection

Chrissy Henderson, Ph.D., P.E.
chenderson@usbr.gov
303-445-2348

Matt Jermyn
mjermyn@usbr.gov
303-445-2317

Daryl Little, Ph.D.
dlittle@usbr.gov
303-445-2384

David Tordonato, Ph.D., P.E.
dtordonato@usbr.gov
303-445-2394

Grace Weber
GWeber@usbr.gov
303-445-2327

Hazardous Materials

Lise Pederson, P.E.
lpederson@usbr.gov
303-445-3095

Kevin Kelly, Ph.D
KKelly@usbr.gov
303-445-7944

Group Manager

Jessica Torrey, Ph.D., P.E
jtorrey@usbr.gov
303-445-2376

Protective Coatings

Brian Baumgarten
bbbaumgarten@usbr.gov
303-445-2399

Carter Gulsvig
cgulsvig@usbr.gov
303-445-2329

Bobbi Jo Merten, Ph.D.
bmerten@usbr.gov
303-445-2380

Rick Pepin, PCS
rpepin@usbr.gov
303-445-2391

Stephanie Prochaska
sprochaska@usbr.gov
303-445-2323

Allen Skaja, Ph.D., PCS
askaja@usbr.gov
303-445-2396