DC and AC Coupon Technology

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DC & AC Coupon Technology

• What are they?
• What do they look like?
• How do you install them?
• What is the Data From A Coupon Good For?
• How Do You Read Them?
DC & AC Coupon Technology

- This is a coupon:

![Coupon Image]

Coupon History

- Traditionally Coupons Were for Internal Corrosion and Atmospheric Corrosion Monitoring and Testing
Coupon History

• Internal Corrosion Coupons Were Placed Inside the Pipeline To Monitor the Corrosive Effects of What the Pipeline Carried.

• Liquids or Gas

Coupon History

• Atmospheric Coupons Either Tested Multiple Metals or Multiple Coatings to a Corrosive Atmosphere
Coupon Definition

• A coupon is a representative piece of material or metal subjected to an environment for testing purposes.

• SP0104-2014: “Cathodic Protection Coupon – a coupon that is connected to the external surface of, and immersed in the electrolyte adjacent to, the structure being protected by cathodic protection.”

Pipeline Coupon Examples

• Basic
  • Simple Single Coupon
  • Two Wire
Pipeline Coupon Examples

- More Advanced
  - Multiple Coupons
    - 1 cm² for AC
    - 2-100 cm² for DC
  - Reference Electrodes
  - Test Station Switching

Coupon 101 – Install

- Coupon is placed in the ground next to the pipe – IN THE SAME ELECTROLYTE
- Cpn is connected to pipeline in test station
- Ref Cell is used to read pipe or cpn potentials
**Coupon 101 – How to Read**

- Regular Ref Cell Placement
- Coupon Still Hooked Up to Pipe – Read Both
- Break Coupon Lead Wire – Read Just Coupon
- Sounds Simple – Right?
- Well It Is – Sort Of

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**Coupon 201**

- Buried Reference Electrodes Fail!
- Coupons can upset CP-Pipeline circuit.
  - Well coated pipeline – coupon is large holiday
  - Too many coupons on a well coated pipeline
  - Coupon can become part of interference circuit
- Wires Break
- Forget to Flip the Switch (On or Off)
- Lightning Damage to Coupon or Circuit Card
Data from a Coupon - DC

- Native Potentials – This Coupon is never hooked to pipeline
- ON Potentials – Read with the Pipeline
- I-Off Potentials – Disconnect Coupon and read the Coupon Instant Off
  - Do not Have to Interrupt Multiple Rectifiers
  - Direct Connect Sacrificial Anodes
  - Interference Studies
  - Multiple Pipelines in single ROW

Data from Coupon – DC & AC

- Measure Current Coming From Coupon
- Calculate Current Density
- Common Unit of Measure is A/m²
  - Amperes Per Square Meter
  - Watch Your Units!!!!!!
    - Real current measurements can be mA or μA
      - Clamp-On Ammeters Cannot Read This.
    - Coupons are measured in cm².
    - For a 1 cm² AC coupon: 100A/m² = 10mA/cm²
    - For a 100 cm² DC coupon: 100 A/m² = 1A/cm²
Why Is Current Density Important?

• “Cathodic Protection” by PE Francis
  • Expected DC Current Densities for CP in:
    • Acidic Solutions: 350 - 500 A/m²
    • Saline Solutions: 0.3 – 10 A/m²
    • Sea Water: 0.05 – 0.15 A/m²
    • Saline Mud: 0.025 – 0.05 A/m²

• “AC Corrosion-A New Challenge To Pipeline Integrity” by Gummow/Wakelin/Segall
  • Expected AC Corrosion Damage for Given AC Current Densities on Adequately Cathodically Protected Pipelines
    • $d < 20$ A/m²: No AC Induced Corrosion Expected
    • $20$ A/m² $< d < 100$ A/m²: Unpredictable
    • $100$ A/m²: Expected

Why Current Density is Important?

• “AC Corrosion – Case Histories, Test Procedures & Mitigation” by Gummow/Wakelin/Segall

AC Corrosion Rates
  • Are highest at holidays having a surface area of 1 – 3 cm²
  • Increase in chloride containing or deaerated environments
  • Increase with decreasing AC frequency below 100 Hz
  • Decrease with increasing CP current density
  • Decrease with time

\[ i_{ac} = \frac{8V_{ac}}{\rho \pi d} \]

• $i_{ac}$ = AC current density
• $V_{ac}$ = AC voltage of pipeline to remote earth
• $\rho$ = soil resistivity
• $d$ = diameter of a circular holiday having an area equal to that of the actual holiday
How do you read them?

- Directly – Voltmeter for Potential Measurements
- Directly – Ammeter for Coupon Current Measurements
  - Very Low Scale Such as Milliamps or even Microamps
  - Careful – Breaking the circuit to hook up the ammeter in series causes depolarization
- Remote Monitoring – Reads It For You
  - Remote Access
  - Constant Monitoring
  - Records History
- CAUTION: Every Meter Has Errors.
  - Since you are reading very small numbers, a small error can sway data.

Guidance

- Company SOPs
- Vendors and Suppliers – Materials and Individual Equipment Instruction