Inspection of Pipeline CP Systems with ILI Tools

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Agenda

• Review of Corrosion and CP of Pipelines
  • Description of the CPCM concept
  • Field trials and CPCM data
  • Benefits of CPCM
  • Acknowledgments
  • Questions & Discussion

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Cathodic Protection

• Reduction or elimination of corrosion of a metal by the application of direct current from an anode through the electrolyte to the metal surface.

• Same 4 components that are needed for corrosion are required for CP. We just control where the anode and cathode are located.

• Note: The DC current is normally supplied by a galvanic anode or by an impressed current source such as a rectifier.
Standard practice is to measure the pipe-to-soil potential from the surface of the right of way at predetermined intervals. If the potential is more negative than some number (this number varies depending on many factors) then it can be assumed that at the pipe surface cathodic protection current is being applied.
Concerns with Potential readings

- Limitations of using potential based criteria can be due to many factors.
- Both cp and non-cp related influences can cause problems in the collection of accurate potential measurements.
  - Right of way access issues (urban, rural, industrial)
  - Non conductive surfaces (pavement)
  - Congested rights of way
  - Waterways
  - High earth currents both AC and DC
    - Foreign or third party CP currents
    - Transit systems
    - Power Line Corridors
  - Distance to coating holiday (well coated lines) or pipe/soil interface
CP current is being “pushed” by the rectifier to the anodes where it enters the soil (electrolyte) then travels to the pipe surface where it enters the metal (cathode) and returns via a cable or other connection (negative).

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CPCM – Cathodic Protection Current Measurement

CPCM –

• Measures a voltage drop across a length of pipe (~ 2m) caused by the current flow from the CP system.

• Using Ohm’s law we can calculate the actual current.

• Changes in current at any point along the pipe gives a signature which allows us to know something about the system.
The CP circuit (pipeline)--Current Graph

• In this illustration CP current is shown in its complete circuit. Notice that the current flowing in the pipeline causes a voltage drop because the pipe is a resistor.

$\Delta V \sim I$

Anodes

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CPCM ILI Tool

On board caliper section used for alignment and deformation

Tool reads and records voltage difference (both AC & DC)
Between these two points.

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CPCM – Fast Facts

- Measure change in CP current due to poor/missing coating
- Identify galvanic anode and rectifier locations and measure current output
- Find unknown bonds and confirm bond current and locations
- 100% inspection of CP systems ensuring minimal gaps in integrity inspection data

*(Especially viable in locations where access is difficult such as offshore, swamps, mountainous terrain and congested urban areas (HCA’s))

Note: The pipeline cannot be internally coated. Build-up of scale, paraffin, bitumen may be problematic.
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Field trials and data

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**Signals**

Large gains or losses over a single point = Rectifiers, Bonds, Shorts, Anodes

Large gains over several feet or meters = areas of poor coating or bare pipe – high current density

Small gains over longer areas are ideal and evidence of good coating and well distributed CP

Shallow positive (up left to right) slope across the zero line = mid point between sources and good CP coverage

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Rectifier

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Pipe change

Rectifier

Repair Sleeves

Pipe change

current

current
Sample raw data – Rectifier and Rect/Interrupter

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Galvanic Anode & Short

Short 4.5 Amps

Anode at platform 1.2 Amps
Bond or Short

Bond or Short 1.8 Amps to foreign structure
8 Miles of pipeline before and after rectifier added

Area void of CP

New Rectifier

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Signals – cont.

Large gains or losses over a single point = Rectifiers, Bonds, Shorts, Anodes

*Large gains over several feet or meters = areas of poor coating or bare pipe – high current density*

Small gains over longer areas are ideal and evidence of good coating and well distributed CP

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**Downstream of Rectifier w/ Filter On**

**Pipeline Management Group**

Rectifier 5 Amps  
Coating issues  
Bond

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Area of damaged coating

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Well coated pipe

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Well coated pipe
noise caused by welds

Good coating and well protected

welds

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Area void of CP

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Signals cont.

Large gains or losses over a single point = Rectifiers, Bonds, Shorts, Anodes

Large gains over several feet or meters = areas of poor coating or bare pipe

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*Shallow positive (up left to right) slope across the zero line = mid point between sources and good CP coverage*
Mid point between rectifiers

CP Mid point between two rectifiers
Pig direction

Current from rectifier behind
Current to rectifier ahead

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Benefits of CP Current Monitoring via ILI

- Minimal personnel requirements
- Ease of evaluation
  - Only affecting currents are recorded
  - Good understanding of overall pipe condition
- 100% inspection
- Not dependent on ROW access
- Ease of which data is integrated with other ILI information
Data Integration

- Direct correlation with metal loss data makes data integration easy and meaningful.

- Aids in action planning
  - Is metal loss likely active or passive?
  - Is more CP needed to arrest corrosion?
  - Is shielding the most probable cause and recoating needed?
  - What action is needed to prevent future repairs?
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Groups working on CPCM

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Peter Katchmar – Project technical manager

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Patent Issued

United States Patent
Pots et al.

SYSTEM AND METHOD FOR MEASURING ELECTRIC CURRENT IN A PIPELINE

Inventors: Bert Pots, Houston, TX (US); Kola Fagbayi, Houston, TX (US); P. Kevin Scott, Harvey, LA (US); Mark W. Mateer, Katy, TX (US)

Assignee: Shell Oil Company, Houston, TX (US)

(Continued)

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EP 0 235 478 B1 11/1993

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