Pipeline Engineering

ASSESSMENT OF THE EFFECTIVENESS OF CLEANING PROGRAMMES

Presented by: Neil Errington

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Why Cleanliness Inspection?

- Why would an operator want to measure debris?
  - ... because pipelines are found to be dirty when they are thought to have been clean

- Why does this matter?
  - Ensuring successful ILI surveys (first run success rate)
  - Ensuring effective chemical treatment programmes

- The presence of internal debris can compromise these programmes
Design Considerations

Two philosophies:

- **Direct measurement**
  - Local
  - No information on other (geometry) defects

- **(High Resolution) Calipering**
  - Mature technology
  - Dependent on accurate information on diameters
System Solution

- Proximity measurement
- Arm-mounted magnetic sensing technology
- “Intelligent Caliper”
PECAT®

10”/12” Dual Module

18” Single Module
Measurement Capability

- Waxes form in crude oil pipelines
- Temp. dependent (25 – 40°C)
- Drop out in zones depended on crude
- Melt when scraped off pipe wall
- Fluid flow also strips wax

- Various scales – Calcium Carbonate, Barium Sulphate, Iron Sulphide, Calcium Sulphate, Sodium Sulphate
- Primarily in water injection lines and gas lines
- The deposits can be enhanced by bacteria (Iron Sulphide)
- NORM (Naturally Occurring Radioactive Material) and LSA (Low Specific Activity) Scale
Measurement Capability

- Any inline non-ferrous debris present on the internal surface of a pipeline
- Hall effect sensors combined with small permanent magnets under Patent Pending
- Measure features which are in the range of 0 – 20mm
- Types of debris detected:
  - Wax (hard and soft)
  - Scale
  - Sand/Sand in wax
- Would not use this type of tool to detect hydrates as the risk of blockage is too great
Loop Testing

- **Test Section**
- **4 flanged sections**
  - 1-off with 5 simulated dents, ranging from 2% to 25%
  - 2-off each with 2 PU liners, ranging in thickness from 5 to 20mm in 5mm steps
  - 1-off make up spool to bring length up to 10m
## Loop Testing

- **Petrofac Pipe-loop Facility, Montrose**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>10” Pipeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>OD</td>
<td>m</td>
<td>0.273</td>
</tr>
<tr>
<td>WT</td>
<td>m</td>
<td>0.0078</td>
</tr>
<tr>
<td>ID</td>
<td>m</td>
<td>0.2574</td>
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<tr>
<td>Length of Pipeline</td>
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<td>1000</td>
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<tr>
<td>Unit Volume</td>
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<td>0.052</td>
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<tr>
<td>Total Pipeline Volume</td>
<td>m³</td>
<td>52.035</td>
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</table>
Loop Testing
Data Visualisation & Reporting

Debris Sensor Readings in Test Spool
Loop Testing

Test Spool

3% Dent
Test Spool Data

Pipeline 12% Dent Test Data
Loop Testing

- 15 test runs at various speeds
- Mechanical robustness of tool design tested
- Capability of measurement systems established
- Sub-millimetre accuracy achieved on artificial debris measurement
- Repeatability of measurement established
- Basic caliper functionality demonstrated
Field Experience

- North Sea Operator
- Medium length pipeline
- Medium diameter pipeline
- Wax believed to be present
Clean Signal
Clean Pipe – 3D View
Dirty Pipe – 3D View
Statistical Interpretation

(Zero Values Suppressed)
Localised Features

3D Anomaly Visualisation
In-line Features

Offtakes

Drain
Data Interpretation

- Positioning from odometry data
- Position benchmarked by reference to pipeline features (expansion spools, tee-pieces, etc)
- Regions with significant debris identified from overview plots
- Detailed examination performed
Commercial Application

- Debris measurement exercise early in programme
- Significant debris present throughout line
- Six week cleaning programme
- Re-survey measures reduced wax quantity
- Amounts removed consistent with survey
- Quantitative support for decision on cleanliness of line
Summary

- “Intelligent Caliper”
- Direct measurement using magnetic technique
- Integrating into pipeline cleaning process
- We have field validation of PECAT technique
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