Performance and Analysis of a New Pipeline Pig Design for the Removal of Deposits from Corrosion Pits

Dan Fletcher, Ph.D., P.Eng.
Vincent Foong, MIET, MCMI, FIDIAE
Michael Hooper
Fiberbuilt Manufacturing Inc.
Introduction

- Internal Corrosion cause of 51% [1] of upstream multiphase pipeline failures
- Pitting is a major concern
  - Under Deposit Corrosion
  - Microbe Induced Corrosion
- Need to disrupt deposits
- Improve pig effectiveness
- Improve pigging programs
- **Improving pig performance can improve entire mitigation program effectiveness**

Mitigating Pit Corrosion (UDC/MIC)

- Disrupt deposits
- Local pit environment
- Improve surfactant efficacy

- Remove Deposits from pit
- Clean to depths of pits
- Get inhibitors to pit bottom
Background Study

• AITF – PICOM Joint Industry Project Phase 1
  – Completed December 2014
  – Evaluation of Pig Design for Deposit Removal from Corrosion Pits

• Test Method and Apparatus
  – 4 Inch Flow Loop (Water), simulated ‘sludge’
  – Measure the depth and volume removed from pits

Results of Background Study [3]

- Evaluation of commercially available pigs
- Brushes are essential to effective pit cleaning
- Brushes did not reach to nominal size
- Effective cleaning to a depth equivalent to only to 25% of Pit Diameter
- Multiple passes provides only a very slight (not statistically significant) cleaning benefit

Improved Pit Cleaning Pig and Method

• Significant room for improvement
• Clear need to improve pit cleaning brushes
  – Improve effective reach into pits
  – Make multiple runs more effective
• Improve pigs and pigging programs
  – Increase pig performance
  – Develop pig that allows for multiple runs
  – Enable pigging in aggressive applications
New Pit Cleaning Brush Design

- Improved brush geometry
- Combination of Radial and Raked Brushes
- Increase brush oversize
- Brush spacing resists debris buildup and pack-off
- Performance testing completed at the 4” AITF Flow Loop
Cleaning Performance

Depth of Cleaning with Successive Runs - Various Pit Sizes

- 1 Pass
- 2 Passes
- 3 Passes
- 4 Passes

DEPTH OF CLEANING (mm)

PIT DIAMETER (mm)

- 4.8
- 7.9
- 9.5
- 12.7
- 19.0
Depth as a % of Pit Diameter

Depth of Cleaning with Successive Runs - Various Pit Sizes

Depth of Cleaning (% Pit Diameter)

PIT DIAMETER (mm)

4.8  7.9  9.5  12.7  19.0
Depth as a % of Pit Diameter

Depth of Cleaning with Successive Runs - Various Pit Sizes

50% - 70% Improvement

Best AITF JIP Results [3]
Volume Removed from Test Coupons

Volume of Cleaning with Successive Runs - Various Pit Sizes

<table>
<thead>
<tr>
<th>PIT DIAMETER (mm)</th>
<th>1 Pass</th>
<th>2 Passes</th>
<th>3 Passes</th>
<th>4 Passes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

% VOLUME OF SLUDGE REMOVED

Edmonton, Alberta, Canada
February 14\textsuperscript{th}-16\textsuperscript{th}, 2017
Clean 0.75 inch (19 mm) pit

- Concentric rings in false colour image show conical drill point
New Pig Seal Design

- Composite Construction
- Brush/Diaphragm/Brush
  - Brushes = Support
  - Diaphragm = Sealing
- Modular Design
- Reduced pressure differential
  - Pig more often
Pigging with Reduced Differential Pressure

- New Seals reduce Differential Pressure (DP)
- Can select DP for requirements
- Alternative to Urethane
- Modular and easily adapted for aggressive environments
  - Aromatics, Bitumen, H₂S, CO₂, H₂, High Temperatures
Improved Pig for Pit Cleaning

New Pit Cleaning Brush

• Novel brush geometry
• Deep pit cleaning: effective to 37-40% of pit diameter
• Volume cleaning: removes up to 100% of pit deposits
• Performance improves greatly with multiple passes

Multiple Pass Pigging

• Enables improved corrosion pit cleaning – multiple runs
• New seal concept
• Reduced drag and applied differential pressure
• Reduced pigging impact on well production