Multi-diameter, bi-directional Pigging for Pipeline Pre-commissioning

The Alve Pigging Experience

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Dewaxing R&D

Dual Diameter Pigging
Alve Field Overview

- 10” x 12” Pipeline – 25% increase in diameter;
- 12” 5D bends – no bends in 10”;
- Pigging facilities only topside Norne (No launcher/receiver subsea);
- Vertical launch and receipt;
- RFO Philosophy – two scenarios.
Pig Functional Requirements

• The pigs must be fully bi-directional with high sealing ability in both directions;

• Low flow rates were expected, in the region of 300-400 l/min resulting in pig velocity of 0.03 m/s to 0.08 m/s. The pig must be able to operate at such low velocities;

• Good seal efficiency and pig support/centralisation were required to ensure safe negotiation with minimum bypass through all components along the system. The risk of gas bypassing on return to Norne could result in hydrate formation;

• Ratio between pig flip differential pressure (pressure to flip the seals forward and cause them to fail) and running differential pressure to be at least 5:1;

• The drive differential pressure in all pipeline components was requested to be less than 7 bars;

• Pigs to be fitted with isotope holder for tracking purposes;

• Pig handling to be considered for vertical launch and receipt.
Development Strategy

Study Options

Select Pig Type / Concept

Detailed Design

Test / Optimise

Supply Four off Pigs for Alve Project

Single concept and spares – not a competition!

Base case pig and spares
Pig Selection for Alve

- “Traditional”, V-slot supports;
- Paddle Pig from Pipeline Engineering;
- Wheel Pig from FTL Seals Technology;
- Other technologies.
Initial Pig Concept

- Single seal for all diameters;
- Wheels in an axi-symmetrical layout.
Piggability – problem at bend

Limited interference between the seals and the inside of the bends. There is therefore a risk of leakage.
Final Base case pig design
Buckling Modes

- No buckle;
- Buckles when forced, but recovers;
- Buckles only when forced but does not recover;
- Buckles even when not forced to do so.
Non-buckling Seal Design

Select seal size and parameters to avoid buckling in all diameters.
Test Facility

Launcher
Fully Automated with SCADA type system
Open ended testing with water drive

I can't see a thing...but it looks alright!

Allow sealing problems to be picked up and corrected
Test List

1. Full Facility Test;
2. Reverse Pig in Full Facility;
3. Initial Spool Test, 10”;
4. Observation of rear of pig for buckling – buckle recovery test;
5. Main pipeline test, 12” 320mm ID;
6. Pig into 305mm ID section;
7. Bend test;
8. Flip test at bend;
9. Manifold Tests – Contingency testing;

• Test at very low velocity 0.03 to 0.08m/s;
• Measure running DP, DP to reverse pig, flip DP;
• Observe leakage.
Buckle Recovery Test Video
Pig Parameters

- Tests performed at low velocity, 0.03 to 0.08 m/s;
- No visible leakage from seals (forward leakage);
- Pig reversible from 305mm straight pipe;
- Flip capacity ratio acceptable;
- No problem with permanent set;
- Non buckling performance of seals acceptable.

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<thead>
<tr>
<th>PARAMETER</th>
<th>DRIVE DP</th>
<th>FLIP DP</th>
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<tbody>
<tr>
<td>257 mm / launch into 10&quot;</td>
<td>2.2 bar</td>
<td>nan</td>
</tr>
<tr>
<td>267 mm ID straight pipe</td>
<td>1.8 bar</td>
<td>7.2 bar</td>
</tr>
<tr>
<td>323 mm ID straight pipe</td>
<td>0.1 bar</td>
<td>1.2 bar</td>
</tr>
<tr>
<td>305 mm ID straight pipe</td>
<td>0.3 bar</td>
<td>1.6 bar</td>
</tr>
<tr>
<td>305 mm ID bend</td>
<td>0.5 bar</td>
<td>1.3 bar</td>
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Problem...Contingency Reversal from Manifold

If leading pig travels as far as the manifold, then can it be reversed?
1. Pig stopped at the ball valve. Bypass ports open to transfer pressure;
2. Start flow. Leaks past rear seal;
3. Increase flow and pressure starts to build;
4. Increase flow further, pressure eventually flips seals and starts to reverse pig;
5. Finally pig moves but bypass ports need to be big enough to allow all the flow past or else the seals will flip and the pig will stall again.
Testing at the Manifold
Final Position from where reversal was possible
Final Pig Design for Alve Pipeline RFO
Future Developments...

- 12” x 16” Dual Diameter, Bi-directional Pig – 40% Increase in Diameter
Thank You.