Heimdal Brae De-Waxing Operation

Arild Fahre-Skau, Statoil
Aidan O’Donoghue, Pipeline Research Limited
Hans Petter Rønningsen, Statoil
Ketil Rongved, Statoil
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Heimdal Brae Wax Removal Summary

Removing large accumulations of wax using an aggressive high-friction pig with bypass
Presentation contents

• Part 1:
  – System & History
Presentation contents

• Part 1:
  - System & History
  - Pipeline conditions
Presentation contents

• Part 1:
  - System & History
  - Pipeline conditions
  - Pigging operation
Presentation contents

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• Part 1:
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  - Pigging operation

• Part 2:
  - Pig design
Presentation contents

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• Part 2:
  - Pig design
  - Pigging dynamics
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  − Pipeline conditions
  − Pigging operation

• Part 2:
  − Pig design
  − Pigging dynamics
  − Observations
Presentation contents

• Part 1:
  − System & History
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  − Pigging operation
• Part 2:
  − Pig design
  − Pigging dynamics
  − Observations
System
System
Total Wax Volume = 350 m3 (ca)
From Heimdal to Kinneil

Heimdal

Brae Alpha

Forties Charlie

Kinneil

116 km
ID = 197 mm (8’’)
Turbulent

117 km
ID = 710 mm (28’’)
Laminar

169 km
ID = 860 mm (34’’)
Turbulent
Introduction of Vale fluids in 2002
Introduction of Vale fluids in 2002

Before 2002, no wax and no pigging performed. Then Vale field started up with high wax content.

- Build up of line differential pressure was insignificant until 2004
Pigging started early 2004 using foam pigs

First stuck foam pig April 2004
2004 - 2008
- Foam pigging program
- Stuck pigs

2008
- Fill and soak operation
- Chemical dissolvant
- Very good effect in laboratory
- Only minor effect in field

2008 - 2010
- Foam pigging
- Stuck pigs
2010: Aggressive pigging!

Why change strategy?
1. The pipeline NEEDS to become wax free due to inspection requirements
2. Progressive approach with foam pigs does not work

Two Alternatives for consideration:
1. Hydraulically Activated Power Pig (HAPP)
   • Limited experience
   • Assumed best for downstream facilities

2. High Friction Jetting Pig (HFJP)
   • Well proven technology
   • New application

Overall risk was evaluated together with our downstream partners, and the HAPP was chosen
HAPP pigging operation January 2012
Markland tests before and after

Figure 1. Wax thickness as function of distance from Heimdal, give as an evenly distributed layer around the pipe perimeter.

Pig stopped 15.01.12 at 8357 m

Estimated wax removed by HAPP = 80 m³
Remaining wax in pipeline = approx 350 m³
Decide to go for High Friction Jetting Pig
Basis of design

\[
Q_{bypass} > Q_{wax}
\]

\[
Q_{wax} > Q_{bypass}
\]
Continuity Principle (5 bar HF Pig, 18 mm port)
Pig Design

- Bypass port
- Shuttle valve
- Transmitter
- Slotted guide
- Tracking Magnets
- Sealing discs

Bypass flow / Pigging direction

ONLINE ELECTRONICS - ELECTROMAGNETIC
ATEX TRANSMITTER MODEL 3000X
WEIGHT: 3KG
MIN BATTERY LIFE: 26 DAYS - PULSE MODE
(ON = 0.5 SECS - OFF = 2.5 SECS)
Final pig ready for deployment
Testing and Validation
Other assurance

- Piggability studies (Negotiation of line components);
- Slurry study (transportation of wax particles);
- Risk assessments / Hazops;
- CFD work on bypass and forces on the pig;
- FMECA;
- Pig assembly checks / pig build quality.
1 pig launched from Heimdal using condensate
- Pig tracked through topsides down to riser hang-off
- Pigging speed: ca 0.3 m/s
When pig arrives at the 500m zone, confirm pig passage
HFJP Operation – flowline

- When pig arrives at kp's 7, 10, 20, 30, 40, 50 and 60 confirm pig passage
- Pig speed in waxy zone: > 0,1m/s
# Procedures – monitoring of pressures and flow

<table>
<thead>
<tr>
<th>Scenario</th>
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<tr>
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<td>7</td>
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<tr>
<td>Flow</td>
<td>Steady</td>
<td>Steady</td>
<td>Increase</td>
<td>Rising / falling</td>
<td>Dropping</td>
<td>Steady</td>
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<tr>
<td>Line Inlet Pressure</td>
<td>Falling slowly</td>
<td>Steady</td>
<td>Falling slowly</td>
<td>Erratic</td>
<td>Rising</td>
<td>Rises to 180bars max</td>
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<tr>
<td>Line DP</td>
<td>Falling Slowly</td>
<td>Steady</td>
<td>Falling Slowly</td>
<td>Erratic</td>
<td>Rising</td>
<td>Rises 124bar max</td>
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<tr>
<td>Action</td>
<td>Ideal, no action</td>
<td>Monitor, no action</td>
<td>Monitor, no action</td>
<td>Expected behaviour</td>
<td>Reduce Inlet Pressure, 20bar DP increase maximum</td>
<td>Reduce flow and monitor closely. Plan to continue</td>
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**Flow**: Steady, Rising/falling, Dropping, Steady, Goes to zero

**Line Inlet Pressure**: Falling slowly, Steady, Falling slowly, Erratic, Rising, Rises to 180bars max, Rises to 180bars max

**Line DP**: Falling slowly, Steady, Falling slowly, Erratic, Rising, Rises 124bar max, Rises 124bar max

**Action**: Ideal, no action, Monitor, no action, Expected behaviour, Reduce Inlet Pressure, 20bar DP increase maximum, Reduce flow and monitor closely. Plan to continue, Stop flow. Reverse
Initial Pig run

Pig stalled topside due to mislaunch through the eccentric reducer
Modified Pig Design

PIGGING DIRECTION

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(ON = 0.5 SECS - OFF = 2.5 SECS)

SEALS REMOVED
Line DP during the run

DP

Receipt of slurry

Wax thickness
Pig Location against time
Lessons and observations

• Isotopes would be better for location of pig topside;
• Magnetic signaller worked very well subsea;
• Monitoring of flows and pressures / pig location fed in well to the analysis of the pig run in real time;
• Understanding of the flow rate ranges and controllability of the flows is key to the operation;
• Control of outlet pressures and conditions would be good but not always possible (complex system);
• Shuttle valve for reversal was useful during initial mis-launch.
Final Markland test
After the HFJP

- Winter / Spring 2013: 4 operational pigs for wax control, similar design to HFJP
- June 2013: 1 pre-inspection scraper pig + 1 operational pig
- June 2013: Inspection pig from Rosen Pipeline approved!!
Cake!
There's never been a better time for good ideas