Multi-Diameter Pig Development for the Gannet Field

PPSA – Aberdeen 2018

7th November 2018

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Background

- Gannet to Fulmar 16” oil export pipeline commissioned 1992
- Regular operational pigging currently carried out for wax removal and corrosion management
- Alternative export route required
- New oil export route will require pigs to traverse 16”, 24” and 34” sections with increase in travel distance from 107km to 450km
- Not an option to stop pigging, use of wax inhibitors/depressants and corrosion inhibitors will not be sufficient

→ Multi-diameter pigging with 132% increase in pipeline size is unknown territory for Shell (& the industry?)
Current Route

- Bi-directional metal bodied pigs varying in aggressiveness launched approximately every 7 – 10 days

- Selection of pigs dependent on wax returns recovered at Fulmar and monitoring of pipeline fouling factor
Future

- Requirements vary for each section of the pipeline
  - 16” → Sweep water and remove wax
  - 24” → Sweep water and remove wax
  - 34” → Travel only

- Low flow rates through 4 wye sections which decrease over time...

New total length = 450km

132% increase...
Trial Overview

Series of trials completed at vendor facility to test multi-diameter prototypes in February and June 2018 (with new trials ongoing)

- "Sun" Pig – Prototype 16/24 A
- Titanium Body Pig – Prototype 16/24 C
- Steel Body Pig – Prototype 16/24 D

- Metal Body Pig – Prototype 16/24 B
- Prototype E currently awaiting testing

Trial Criteria

- Remove wax & water in 16” & 24” sections
- Traverse asymmetrical diameter changes from 16”, 24” & 34”
- Traverse wye structures at low flow
- Self travel in 34” sections
Trial Setup

- Trials proved that pigs can travel through 16” and 24” sections

- Key challenge is transiting through the wye pieces… pigs do not seal completely and require very high flow rates

Test Cases

- 16”, 24” & 34” transitions with wye pieces
- Wax removal
- Buoyancy tests
- Interaction with other 24” and 34” pigs
Trial #1 – February 2018

- Prototypes A & B tested… Sun and metal bodied pigs
  - Sun Pig – Prototype 16/24 A
  - Metal Body Pig – Prototype 16/24 B

- Different hardness of polyurethane trialled to test wax removal and sealing capabilities (different colour discs)

- Similar performance from both prototypes, though type B slightly more successful hence selected for further development
Prototype A – Sun Pig

- Able to travel in 16” and 24” sections
- Successfully removed wax in 16”, more limited in 24”
- Issues with transition from 16” to 24”
- Large flow rates required to move in 34”
Prototype B – Metal Bodied

- Similar performance to ‘Sun’ pig, though slightly better at removing wax in 24”

- Some issues noted with uniform fold away of 24” discs in 16”
Trial #2 – June 2018

- Prototypes C & D tested… Steel and titanium metal bodied pigs

  - Titanium Body Pig – Prototype 16/24 C

  - Steel Body Pig – Prototype 16/24 D

- Titanium pig able to self-transit at lower flow rates in 34”

- Finger spacers added to the front of sealing discs to give additional support in 24” and centralise the pig, more uniform folding of 24” sealing discs in 16” section

- Syntactic foam added to try make it neutrally buoyant for self transit in 34” section
Prototype C - Titanium Metal Bodied

- Steel metal bodies replaced with titanium and syntactic foam added
- Fingers good at removing wax in 24” but leaving streaks of wax

- Prototype D... similar performance but heavier due to steel instead of titanium
Backup Option

- 16” cast PU pig with syntactic foam
  - Wax removal and water sweep in 16” section only
  - Able to self transit in both 24” and 34”

- No water removal from 70m section between two wyes… mitigate with larger corrosion allowance

- Dual diameter foam pig considered to sweep water from 70m section… not viable
Next Steps

- Prototype E currently in development…
- Investigate replacing PU support components with carbon fibre or composites
- Trial low drag materials where PU components contact pipe wall

→ Trials have identified a suitable design to progress…
   Results expected November 2018

1. Replace all steel components with titanium (bolts, tow arm)
2. Add syntactic foam to PU discs
3. Replace non-wear PU components with syntactic foam