Hydrate and Wax Plug: Prevention and remediation using active heating technology

Cyril Holyst
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Agenda

1. Overview & challenges
2. ETH flexible pipe technologies
3. ETH rigid pipe technologies
4. Performance summary
5. Key takeaways
6. Q&A
Overview & challenges
Overview & challenges

Deepwater / long tie back challenges:

Flow assurance challenges:

Viscous oil
Wax
Hydrate
Active heating technologies – Benefits

Main benefits of Electrically Trace Heated (ETH) by Joule effect:

- Cost effective alternative to chemical injection (hydrate mitigation)
- Wax and Hydrate prevention & remediation (control of heating power and live monitoring)
- Accelerate start-up operations after a shutdown
- To enhance flow rates by increasing fluid temperature for viscous oil, long tie-back or deep water development (continuous heating)

Active heating by ETH technologies provides the most adapted solution for demanding applications
ETH track records

- 1st Flexible Pipe: Conoco Udang (1970)
- ETH-PIP: Early Qualification Work (1990)
- 1st ETH-SP: Conoco Udang (2000)
- 1st ETH-IPB: Dalia (2010)
- ETH-IPB: Papa Terra (2010)
- ETH-HCRAW: Alta Gohta (2020)
- 1st ETH-PIP: Neptune Energy Fenja (2020)

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ETH flexible pipe technologies
**Integrated Production Bundle – System description**

**IPB: Integrated Production Bundle**
- Flexible pipe production core structure
- Bundle assembly
- Thermal insulation

**IPB key capabilities**
- Multiple functions available combined within single bundle design (ETH, GI, GL, WI, OF etc.)
- Temperature monitoring
- High electrical efficiency
- Wet insulation (~U value = 3–6W/m2K)
- Internal diameter capabilities: 2–12”
ETH-HCRAW technology – System overview

**HCRAW = Heating Cables Replacing Armour Wires**

- Cost effective, simple design
- No bundle (weight and OD reduction compared to ETH-IPB)
- Embedded electrical cables, high heating efficiency
- Tailor made design: design number of cables selected for each application

Design & number of cables adapted to each specific project requirements
ETH-HCRAW technology – Temperature monitoring

Distributed Optical Fibre Temperature System (DTS)

- Deep understanding of the temperature variations along and within the flexible pipe & detection of any water presence in annulus
- Can be combined with topside interface system (warm up / maintain modes)
- Field proven technology

Typical ETH - Flexible temperature profile
ETH rigid pipe technologies
Pipe-in-pipe – Extensive track record

**ETH-PiP** = Using reeled PiP track record to develop a new technical solution
ETH-PiP – System description and functions

Standard Pipe-in-Pipe (PiP)

- Trace heating used in other industrial applications
- Exposed to harsher conditions
- Reeled Pipe-in-Pipe Offshore track record
- Manufacturing in standard adapted spoolbase

The ETH-PiP is the combination of qualified components for dry environment
ETH-PiP – Active heating rigid pipe technologies

- Low U-Value (0.6 to 2 W/m².K)
  - Reducing power requirement during keep warm mode
  - Allows longer cool down and no touch duration
- Simplify operating procedure and subsea architecture
- Reduce chemical injection volumes (MEG)
- High redundancy,
- Temperature monitoring (DTS) allowing
  - Wax / plug management via continuous monitoring
  - Hydrate plug melting operations
- Field proven technology

ETH-PiP provide the full range of functionalities for hydrate management
ETH-PiP – Qualification and track record

Early qualification work (1999 to 2004, extended to 2010)

- Full scale tests on 12m joints, including all electrical circuits and mechanical parts
  - Confirmation of the high level of heating efficiency (heating curves)
  - CFD model calibration
  - Confirmation of reel-ability

Extended qualification (2009-10)

- Re-assessment of technical readiness with a project study case with TOTAL TEQP programme (Technology Evaluation & Qualification Process)
  - Confirmation of the high redundancy and operation under degraded mode
  - Ageing long term at 120°C, higher specification on trace heating cable
  - CFD, lab test and mechanical testing
ETH-PiP – Track record

ETH-PiP – First project application
Total Islay, 2011

- 122m WD with challenging bathymetry
- 6 km single well tie-back
- 6.625” x 12.75” ETH-PiP line
- U value (20°C) = 0.9 W/m2.K
- High Temperature (120 °C)
ETH-PiP – Track record

ETH-PiP – Neptune Energy Fenja
- Ongoing pipe manufacturing
- 324m WD
- Longest and largest ETH-PiP
- 36 km single well tie-back
- 12” x 18” Production ETH-PiP
- Continuous heating

- ETH-PiP selected vs
  - chemical injection option
  - heated dual flowline and riser

Significant CAPEX reduction
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ETH-SP & ETH-PiP Reel-Laying (based on DEEP BLUE capabilities - flooded pipe)

Deepwater in-field lines

NOT INSTALLABLE (top tension)

Wet Insulated single pipeline

Reel-lay PiP or ETH-PiP

Data PiP

PIP OD limitation

Large OD tie-backs

Beyond current net capacity

Missing efficient product for deepwater and large OD tie-back field development
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Development of Wet Insulated ETH Single Pipe

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**ETH-SP (Single Pipe)**

- Solution in development
- Designed for both continuous and intermittent heating
- Wet insulated pipeline, for project where U-value is not driving
- Unlock deeper water installation with moderate top tensions
- Compact solution giving access to longer tie-back
- High redundancy
- Temperature Monitoring (DTS) with similar benefits than the ETH-PiP

**ETH-SP complementary of the ETH-PiP**

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Performance summary
# Active heating pipe technologies – Performances

<table>
<thead>
<tr>
<th></th>
<th>ETH-HCRAW</th>
<th>ETH-IPB</th>
<th>ETH-PiP</th>
<th>ETH-SP</th>
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<tbody>
<tr>
<td><strong>Construction</strong></td>
<td>Flexible Pipe</td>
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<td>Pipe-in-Pipe</td>
<td>Wet Insulated</td>
</tr>
<tr>
<td><strong>U-Value / OHTC (W/m².K)</strong></td>
<td>3 to 6</td>
<td>3 to 6</td>
<td>0.6 to 2</td>
<td>3 to 6</td>
</tr>
<tr>
<td><strong>Power requirement (base ETH-PIP)</strong></td>
<td>x 2</td>
<td>x 3</td>
<td>x 1 (reference)</td>
<td>x 5/6 (estimation)</td>
</tr>
<tr>
<td><strong>Maximum diameter (inner pipe)</strong></td>
<td>2” to 20” ID</td>
<td>2” to 12” ID</td>
<td>Up to 12” ID (dependent on vessel capabilities)</td>
<td>Up to 16” OD (dependent on vessel capabilities)</td>
</tr>
<tr>
<td><strong>Heated length (in one go, size dependant)</strong></td>
<td>up to 12km</td>
<td>up to 12km</td>
<td>up to 50km</td>
<td>Up to 75km (estimation)</td>
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<tr>
<td><strong>Maturity</strong></td>
<td>3 projects</td>
<td>2 projects</td>
<td>1 project + 1 on-going</td>
<td>Under development</td>
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Key takeaways
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- ETH-Technology is a versatile, and cost effective solution for hydrate and wax plug management
- Field proven technology with more than 45km of ETH Pipes successfully delivered to date (80km by end 2020)
- Integrated solution part of a Subsea 2.0 technologies portfolio
- Early engagement
- DTS part of iLoF products for complete field condition performance monitoring solution
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Questions
ETH-HCRAW technology – End fitting

- **End Fitting**

Integration of connector will slightly increase external size of EF
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