Deep J-Laid Pipe-In-Pipe

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ITP
Total
vallourec
Summary

- Deepwater pipeline challenges for 4000m water depth
- ITP system - baseline
- New design
- Main Results
- Conclusions
Thermal Insulation amid Deepwater technology challenges

As seen by Operators (Total)

Enabling technologies:

• Flow assurance strategy and flow modeling
• Subsea boosting
• Subsea pipeline electrical heat tracing and insulation
• Subsea power transmission & distribution
• Subsea robotics
• Composite lines and risers
• Drilling
• Pipe laying

Higher hydrostatic pressures

Developing and producing fields at WD down to 4000m technological challenges:

JT cooling in riser \(\rightarrow\) highly insulated pipelines

Heavier flowline installation

High riser backpressure
Benchmarking Oil developments

Challenges: Deeper, longer... Cheaper
Standard ITP PIP Flowline

Single/Double/Quad joints
Prefabricated onshore

Only one offshore weld
Efficient assembly with a sliding sleeve

ITP factory
Insulation
Insertion

Product Pipe
Outer Pipe
Izoflex insulation material
Swaged & welded ends

Pre-fabricated double or quad joint
Offshore weld
FJ sleeve
Fast-curing resin

Swaging
Sleeves
Can PiP go longer?

Max residence time $\sim \frac{\text{Energy provided by well}}{\text{Energy lost to sea}} \sim \frac{Q C_p}{UD}$

Residence time = flowing time + cooldown time

Wet insulation $U=3W/(m^2.K) \rightarrow t\sim12\text{ hrs} \rightarrow L_{max}=5-10\text{km}$
ITP insulation $U=0.6\ W/(m^2.K) \rightarrow t>50\text{ hrs} \rightarrow L_{max}=30-60\text{km}$

Yes, we can go longer. But can we go deeper?
Depth capability of J-laid PiP: Limited by high axial loads

- High axial loads during J-lay installation: all the suspended PiP weight is carried by the Inner pipe in the Field Joint

PiP Challenging for waterdepths > 2000m
Weight becomes design-driver... limitation @ 2500-3000m

- Note: for pipes with continuous annulus (welding of inner and outer pipe)
  the issue stands as the weight is suspended by only the outer Pipe
Technology development: PURE® by Vallourec used for Pipe-in-Pipe

Current design

- Pipe ends are as thick as Pipe body

New design with PURE®

- Pipes ends are thicker than Pipe body
- Double / Quad joint...
- Outer pipe
- Inner pipe
- Upset ends
- Outer pipe
- Inner pipe

Deeper than 2000m water depth
Stress (Weight) > Max. allowable stress

From 2000m to 4000m water depth
Stress (Weight) < Max. allowable stress
**PURE® by Vallourec**

**PURE® features:**
- ID-tolerance of +/- 0.25mm
- OD-tolerance of +/- 0.25mm
- Wall Thickness tolerance at pipe ends: +/-0.5mm
- Low Carbon linepipe pre-material
- Grade: up to X80

**PURE® Value proposition:**
- Reduce the weight thanks to adapted wall thickness in the pipe ends and in the pipe body
- Increase the welding rate thanks to a perfect fit-up

**PURE ® Upset process**
- Rolling
- Inductive heating
- Upset
- Full body Q&T

- NDT
- Machining
- NDT
Study scope

- Comprehensive design of the proposed solution:
  - 6”, 8”, 12” Inner Pipe
  - Pipes steel grade: X70/X65
  - Water Depth 2000 m – 4000 m
  - U-values 0.5 – 1.0 W/(m².K)
  - Topside/ Sagbend stress during installation
  - Operation stress
  - PiP bending efficiency

- Compliance with DNV code (burst Inner Pipe, collapse Outer Pipe, LCC in operation...)
Results: PiP with upset ends can be installed down to 4000m
Ex Typ: 8” Inner Pipe

- Stress can be controlled at 350 Mpa (in line with DNV OSF201) in the field-joint during PiP installation regardless of topside tension loads.

- Upset values are feasible with respect to pipe body thickness and process capabilities.
- Upsets are lower in non-flooded configuration → installation process optimization.
Results: PiP weight and FJ stiffness

- Most configurations are in line with present vessels maximum tensioning or laying capacities (2000 tonnes)

- There is no change to current installation procedures

- Bending loads: The upset end is beneficial to the stiffness of the field joint
Results: Thermal performance

- **Good U values:**

  ![U values graph](image)

  - U values are between 0.5 and 0.7 W/(m².K)

- **The upset provides a naturally increased annular gap for Izoflex placement**

- **Long Cooldown Times: 50°C → 20°C:**

<table>
<thead>
<tr>
<th>Water depth (m)</th>
<th>2000m OIL / GAS</th>
<th>2500m OIL / GAS</th>
<th>3000m OIL / GAS</th>
<th>3500m OIL / GAS</th>
<th>4000m OIL / GAS</th>
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</thead>
<tbody>
<tr>
<td>6” Inner Pipe</td>
<td>52 / 26</td>
<td>54 / 29</td>
<td>54 / 31</td>
<td>57 / 33</td>
<td>62 / 38</td>
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<tr>
<td>8” Inner Pipe</td>
<td>74 / 39</td>
<td>73 / 39</td>
<td>74 / 41</td>
<td>73 / 42</td>
<td>85 / 52</td>
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<tr>
<td>12” Inner Pipe</td>
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<td>104 / 56</td>
<td>103 / 57</td>
<td>124 / 73</td>
<td>132 / 80</td>
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Conclusion

ITP PiP with PURE® with existing vessels and laying methods,

<table>
<thead>
<tr>
<th></th>
<th>6”</th>
<th>8”</th>
<th>12”</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;3000m</td>
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<td>OK</td>
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</tr>
<tr>
<td>3500m</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>4000m</td>
<td>OK</td>
<td>OK</td>
<td>Need for optimization</td>
</tr>
</tbody>
</table>

- Enabling technology for water depths beyond 2000m with long tie-backs (>20km)
- Based on field proven components
- Cost effective solution
Thank you for your attention

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