Deep J-Laid Pipe-In-Pipe

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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





Benchmarking Oil developments

Challenges: Deeper, longer... Cheaper



Standard ITP PIP Flowline Single/Double/Quad joints **Prefabricated onshore** Insulation **ITP** factory Insertion **Outer Pipe Product Pipe Izoflex** insulation material Swaging Only one offshore weld Swaged & welded ends Efficient assembly with a sliding sleeve Pre-fabricated double or quad joint Sleeves FJ sleeve Offshore weld Fast-curing resin

MCE Deepwater Development 2016

Can PiP go longer?





Max residence time~	Energy provided by well	$Q C_p$
	Energy lost to sea	$\sim UD$

Residence time = flowing time+cooldown time

Wet insulation	U=3W/(m ² .K) \rightarrow t~12 hrs \rightarrow Lmax=5-10km
ITP insulation	U=0.6 W/(m ² .K)→t>50 hrs→Lmax=30-60km

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



Stress (Weight) > Max. allowable stress

From 2000m to 4000m water depth Stress (Weight) < Max. allowable stress



PURE[®] by Vallourec

PURE®

• <u>PURE® features:</u>

- 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

• <u>PURE[®] Value proposition:</u>

- 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



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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 stiffeness



- 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:



> Long Cooldown Times: $50^{\circ}C \rightarrow 20^{\circ}C$:

The upset provides a naturally increased annular gap for Izoflex placement

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

Water depth (m)	2000m	2500m	3000m	3500m	4000m
Cooldown time (hr)	OIL / GAS				
6" Inner Pipe	52 / 26	54 / 29	54 / 31	57 / 33	62 / 38
8" Inner Pipe	74 / 39	73 / 39	74 / 41	73 / 42	85 / 52
12" Inner Pipe	101 / 52	104 / 56	103 / 57	124 / 73	132 / 80

Conclusion

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

	6"	8 "	12"
<3000m	ОК	ОК	ОК
3500m	ОК	ОК	ОК
4000m	ОК	ОК	Need for optimization

- > 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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