

Reeled rigid pipe-in-pipe technology

For oil and gas fields with
flow assurance challenges



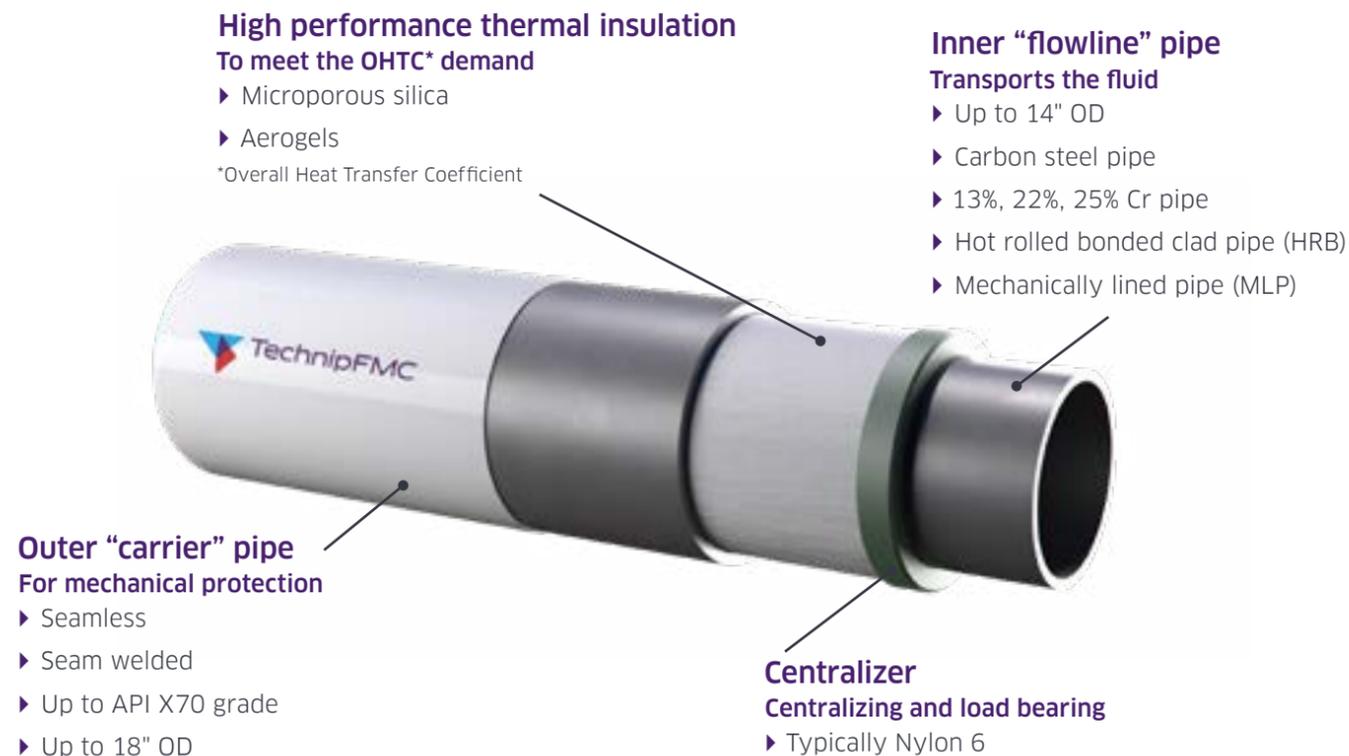
Highly insulated pipelines for the development of challenging fields

TechnipFMC is the recognized subsea industry expert in the design, assembly and installation of reeled pipe-in-pipe systems. Our expertise helps operators address flow assurance challenges, especially in fields requiring very high thermal insulation performance. We offer a full range of pipe-in-pipe services,

including design, manufacture and installation by our vessels using the cost-efficient reel-lay method. We have achieved a significant worldwide track record in this specialized technology, with more than 1,100 kilometers of installed pipe-in-pipe.

The pipe-in-pipe concept

TechnipFMC's pipe-in-pipe solution is ideal for subsea developments with flow assurance challenges, such as long tie-back applications where the pipeline must maintain a minimum temperature to prevent wax or hydrate formation.



Technical advantages

TechnipFMC's pipe-in-pipe solution offers advantages compared to other insulation methods, including:

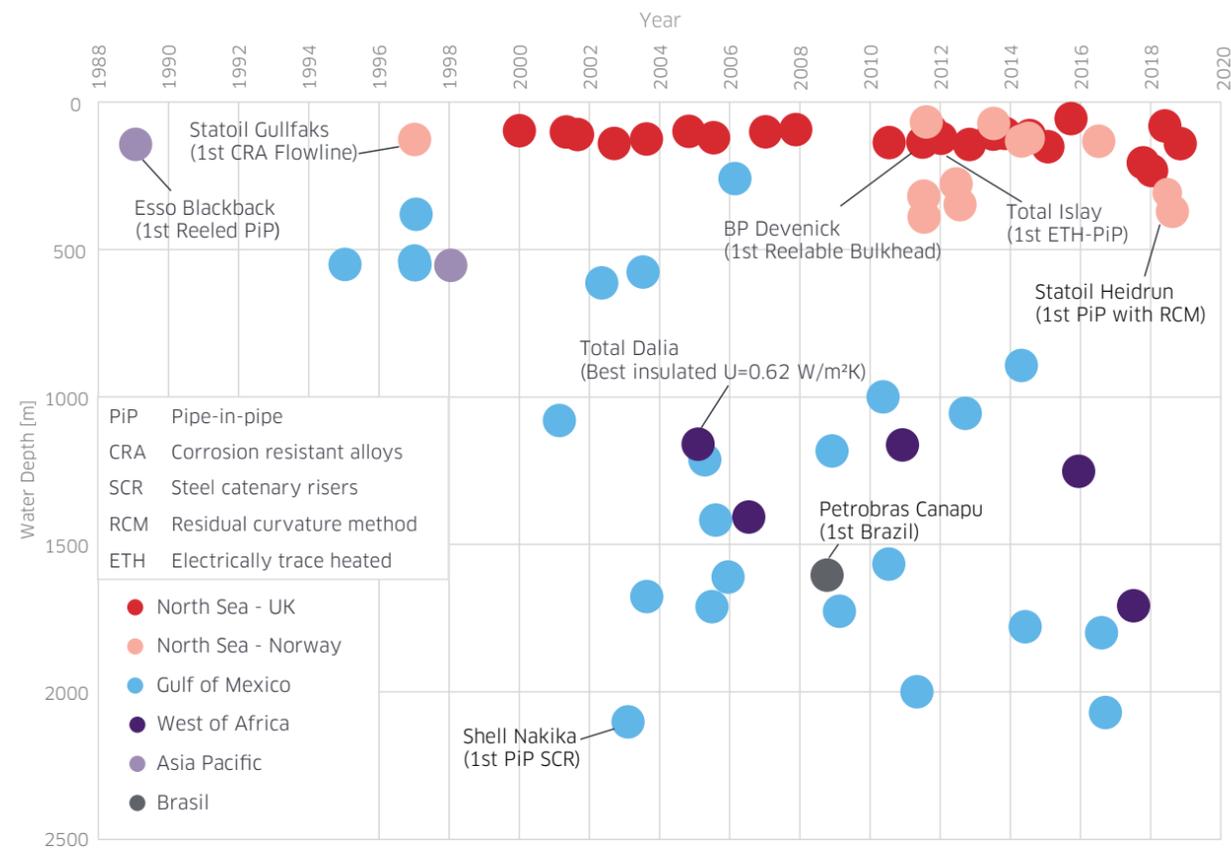
- ▶ Superior thermal insulation performance enabling fields with flow assurance challenges
- ▶ Compatibility with higher temperature and pressure applications
- ▶ Compatibility with reel-lay installation, including residual curvature method (RCM)
- ▶ Additional mechanical strength against severe loading conditions
- ▶ Carrier pipe acts as a second barrier offering protection against dropped objects such as fishing boat trawl beams and vessel anchors, potentially avoiding the need for additional intervention such as trenching
- ▶ Compatibility with high fatigue performance steel catenary risers (SCRs)
- ▶ Best configuration for integrating highly efficient electrically trace heating (ETH) or optical fiber technologies for real-time data monitoring
- ▶ Compatibility with mechanically lined and metallurgically bonded corrosion resistant alloys (CRAs)

Reeling-on to Deep Energy



Expert knowledge of reeled pipe-in-pipe mechanical and thermal behavior

Worldwide track record including significant milestones

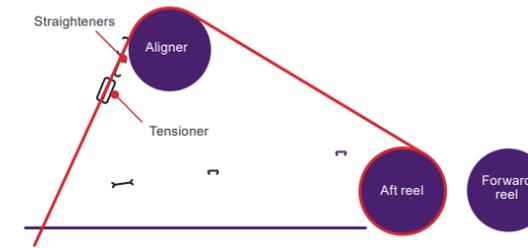


TechnipFMC is the industry leader in pipe-in-pipe installation via reel-lay, successfully completing over 65 projects which include steel catenary risers and the world's first electrically trace heated (ETH) pipe-in-pipe. Our pipe-in-pipes are made

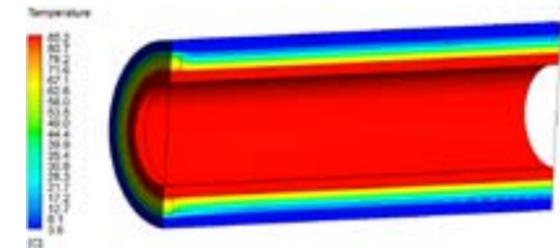
from carbon steel, corrosion resistant alloys or a hybrid construction with a carbon steel parent pipe and internal corrosion resistant cladding or lining.

TechnipFMC have the capability to simulate the reeling process using finite element analysis software. Stresses and strains are evaluated for both carrier pipe and flowline of a project pipe-in-pipe system to determine their suitability for installation via reel-lay. Loadings on key pipe-in-pipe components such as centralizers and insulation are also assessed as part of this

analysis. When appropriate, physical testing may be performed to confirm the results of engineering analysis. Verification of pipe-in-pipe components is conducted with a testing regime representative of loadings experienced during the installation and in-service conditions. We perform thermal analyses and full-scale thermal tests to verify the insulation performance of pipe-in-pipe.



Mechanical design - finite element analysis (FEA)



Thermal design - computational fluid dynamics (CFD)



Thermal test



Component testing

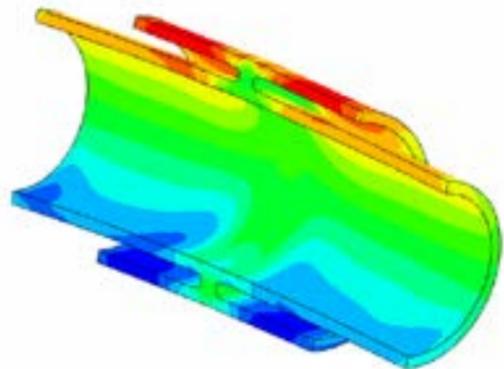
Auxiliary pipe-in-pipe components

As the leading expert in reeled pipe-in-pipe solutions, TechnipFMC has developed, qualified and implemented major technology enhancements to the basic pipe-in-pipe system, including:

- ▶ Buckle arrestors and waterstops for deepwater pipe-in-pipe
- ▶ Numerous reeling aids to enhance efficiency of pipelay operations:
 - Permanent/temporary reelable bulkheads
 - Permanent/temporary transition pieces
 - Temporary installation aids such as embedded pawlheads
- ▶ Trace heating/fibre optic cables helically wound on flowline to control and monitor fluid temperature

With this unique expertise and extensive experience of field installations, we deliver innovative and reliable solutions to operators.

Waterstop



Reelable bulkhead



Offshore installation from Deep Energy

Rigid Pipeline & Installation Technologies

David Kaye

+33 (0)1 85 67 77 62

david.kaye@technipfmc.com

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