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Materials:

- Mechanically Lined Pipe
- High strength steels
- SCR Welding

Flow Assurance:

- PIP systems
- Active Heating

Summary/Discussion



Reeling of Mechanically lined pipe

Phased development with extensive input from Buttings including:

- Reeling tests
- Material test
- FE analysis
- Fatigue testing
- Pressurisation and pigging procedure
- Seven Oceans Reeling Trial
- Range of Diameters and Liners
- DnV Qualification
- On-going development of optimized pipe









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High Strength Steel



 High strength steels enable reduced top tension for installation or reduced air can size for riser towers

| Pipe Grade | X65 | X70 | X80 | X100 |
|--|--------|--------|--------|--------|
| Pipe OD (mm) | 244.5 | 244.4 | 233.5 | 220.7 |
| Pipe ID (mm) | 171.3 | 177.3 | 177.3 | 177.3 |
| Wall Thickness (mm) | 36.6 | 33.57 | 28.1 | 21.7 |
| Reduction in total WT (%) | - | 8.3 | 23.2 | 40.7 |
| Line Length (m) | 2000 | 2000 | 2000 | 2000 |
| Steel Density (kg/m ³) | 7850 | 7850 | 7850 | 7850 |
| Cross sectional Area (m ²) | 0.024 | 0.022 | 0.018 | 0.014 |
| Mass per meter (kg) | 187.65 | 174.54 | 142.34 | 106.50 |
| Mass of the riser (tonne) | 375.31 | 349.09 | 284.68 | 212.99 |

Comparison of 2000mtr. riser with different steel grades

 Particularly suited to deep water/high pressure applications



High Strength Steel

- Challenge is to develop welding procedures that result in appropriate weld mechanical properties
- Welding using the GTAW/PGMAW process based on existing procedures and filler wire
- Welding procedures developed for X80 pipe
- Good mechanical properties including strength, hardness and fracture toughness
- Scope of testing completed: Mechanical testing, fracture toughness testing, HIC and SSC testing and testing in strain aged condition
- Qualification to DNV and full scale bending trials underway



324mm OD x 18mm WT X80 steel pipe



- PIP systems are used where a high level of insulation is required, typically below a U-value of 1.5 – 2.0 W/m²K
- Conventional PIP system is qualified for reeling and will be installed next year for Statoil
- Good track record in the industry for reeling conventional PIP systems



 Challenge is to further improve the efficiency of the insulation to reduce cost and improve installability



Development undertaken with ITP

- Based on field proven ITP system with Swaged field joint
- No centralisers to improve thermal efficiency
- Reduced pressure annulus to take advantage of Knudsen effect and further improve efficiency of Izoflex



Significant improvement in cool down times, verified by full scale testing





- Extensive FE work undertaken on Swage weld under reeling conditions
- Drag through without centralisers tested and confirmed
- Full scale bend testing undertaken
- Technology is fully developed and qualified by DNV as 'Fit for Service' (DNV RP A203)







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Trace Heated Pipe-in-Pipe

- Maintain temperature above HAT during shutdown, assist with restart, reduce chemical injection requirements
- Alternative to DEH lower power consumption
- Extensive FE and full scale bend testing undertaken
- Fully qualified for reeling as per DNV RP A203









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