

Thermoplastic Composite Pipe

An alternative for Coiled Tubing

Introduction

The variety of operations for which Coiled Tubing is considered now is greater than ever before. Where Coiled Tubing traditionally featured mainly in well intervention & well servicing type of operations, now Coiled Tubing is seriously being considered for many well side-track drilling programmes.

With a strong drive to increase oil recovery, well stimulation techniques become more advanced, using more enhanced and aggressive chemicals that in turn reduce coiled tubing life. This paper addresses that drawback and proposes a thermoplastic composite pipe as alternative.

Challenges

Steel Coiled Tubing has been used successfully for many years; the combination of stiffness, strength and ductility provides an excellent basis for well interventions where circulation is required. Some aspects limit their success:

- 1) Chemical resistance. Many new acids and chemicals are increasingly aggressive to steel and strongly reduce its working life. This, in combination with the difficulty in predicting accurate life time reduces the safety during operation and the risk of losing the coil.
- 2) Weight. With more offshore cranes being downgraded as they advance to their end of life, the weight of CT reels becomes a real issue, requiring expensive and complex offshore spooling activities or offshore connections to be made.
- 3) Fatigue life. Steel Coiled Tubing quickly reaches its fatigue limit. Although a known issue, the limits have been reached and with steel prices bound to increase a fatigue insensitive material has real benefit.





Perfect bonding: fibre reinforcement welded onto liner, resulting in collapse resistant tubing



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Solutions

Airborne Composite Tubulars proposes to apply Thermoplastic Composite Pipe (TCP) as an alternative to steel in the application of Coiled Tubing. This alternative to steel CT presents the following unique advantages:

- 1) Chemically resistant. Materials such as PE, PP and PVDF provide excellent chemical resistance, allowing most chemicals and acids to be pumped.
- 2) Lightweight. The weight to strength ratio of Composite is much better than steel:
 - a) For a TCP typically the coil is less than half the weight of the steel coil. In addition, the reel can be designed to be lighter and cheaper due to the lower loading of the coil.
 - b) The much lower weight of the coil in mud (up to 80 % lower than steel) in combination with lower friction coefficients, strongly reduce the surface weight when pulling out of hole. Simulations have shown typical pull reductions of more than 50%.
- 3) Fatigue resistant. Thermoplastic Composite Pipe has excellent fatigue life. Testing has proven up to 18000 bending cycles without any strength or stiffness reduction.
- 4) The liner has lower surface roughness, reducing pressure drop and improving flow conditions.

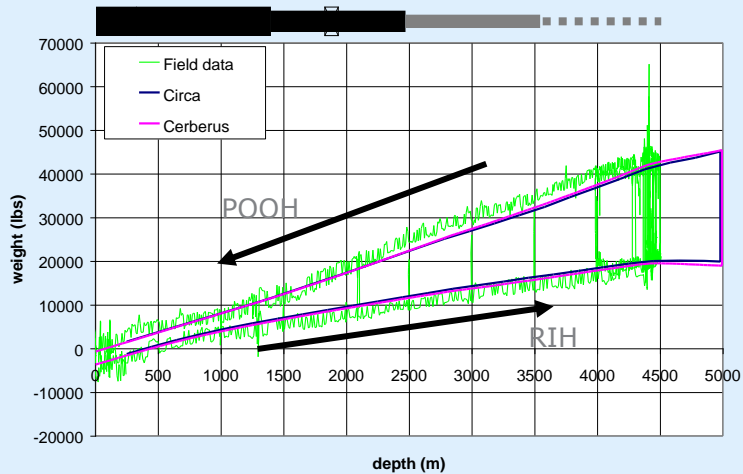
Operational considerations

Using Thermoplastic Composite Pipe in the coiled tubing application affects the operation. It allows for new possibilities but also puts additional demands on the operation. The most important consideration is that the coil is more flexible than steel. Airborne has performed extensive simulations with Coiled Tubing simulation software available in the industry, which yield the following results:

- 1) In regular well intervention operations, the TCP has similar or more extended reach than steel, due to the much lower friction and weight of the coil.
- 2) In Coiled Tubing Drilling operations with a high weight on bit, the tubing locks up earlier than steel CT as steel is

stiffer. This means that use of a downhole tractor requires consideration.

- 3) The TCP has lower friction coefficient and much lower weight in mud than steel, resulting in lower pull out of hole forces and lower loading on the coil.



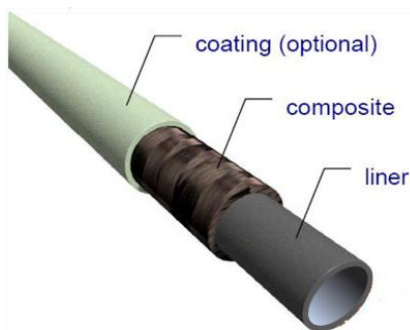
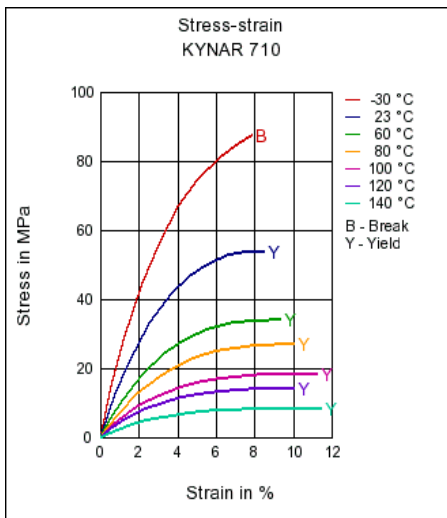
Technology

The technology developed by Airborne consists of melt-fusing fibre reinforced thermoplastic tapes onto a thermoplastic liner. In this process, a fully-bonded solid wall structure is created, covered by a coating of the same thermoplastic compound. This offers the following benefits:

- 1) High collapse rating as the liner is reinforced by fibres.
- 2) Good spoolability due to the ductility of the thermoplastic material used and avoidance of micro-cracking issues.
- 3) Long service life due to absence of any rapid gas decompression issues.
- 4) Greater toughness and superior impact resistance. Thermoplastic material is more ductile, thereby showing high impact tolerance and residual strength.
- 5) Easy to retrieve. The ductility of the thermoplastic material allows the coil to be plastically deformed, which is a requirement for regular fishing tools to work effectively.

Feasibility

The industry has seen developments in the area of Composite Coiled Tubing in the past 10 years. These developments were based on a brittle thermoset matrix system rather than a



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Airborne's In-house Pressure Test Facility



TCP Production Line



TCP Bending Fatigue Rig

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ductile thermoplastic system as proposed by Airborne. Airborne has selected the thermoplastic matrix system as opposed to thermoset in order to resolve the issues encountered with the thermoset composite systems. In addition, Airborne has all testing capabilities in-house, that can be used for testing and qualification of the manufactured pipe.

Production

Airborne's current production line capability extends to continuous pipe systems up to 3.5 inch OD using Glass & Carbon fibres and PE, PP, PA & PVDF polymer materials to provide the optimal solution for each application.

More information

Airborne is committed to the successful introduction of thermoplastic composite coiled tubing in the Oil & Gas industry through material research, knowledge development on industry specific requirements and fit for purpose designs, yielding technically and economically viable solutions. Other industry applications developed are Flowline, Production Riser, Service Intervention Line, High Pressure Hose and various specialty projects on a confidential basis.

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