OTC 19111

Composite Carbon Thermoplastic Tubes for Deepwater Applications

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Abstract

As production of oil and gas move into deeper waters, weight, cost and mechanical resistance of systems such as tubular elements become increasingly large. Composite materials offer the attractive properties of light weight for high strength and stiffness, good corrosion resistance and excellent fatigue properties that make them ideal candidates for use in deepwater. The thermoplastic composite tube is manufactured as a continuous process with composite reinforced carbon layers and a thermoplastic liner. The fabrication process involves winding specially pre-impregnated carbon layers around the liner with specific angles. Long pipe sections can be connected together with specially developed metal end terminations. The use of composites for deepwater risers is now close to reality. A 6” high performance composite pipe has been designed and manufactured for pressures corresponding to water depths up to 3000 m. The performance of the pipe has been assessed in tension, collapse and burst. With these promising results, a high performance 10” pipe is currently being designed for fabrication.

Introduction

Composite technology is mastered in many industrial sectors such as aeronautics. Composite materials for riser applications provide attractive properties such as high mechanical strength which allow the limits of water depth to be pushed back. At the same time composite materials are five time lighter than steel counterparts and therefore the supporting surface facilities require less buoyancy. Moreover, adding the good corrosion resistance of this kind of material, composites are totally aligned with the requirements of deepwater applications.

The installation of a composite production riser joint on the Heidrun TLP in the Norwegian North Sea during the period from July 2001 to January 2002 [1] is the first successful stage in the integration of composite materials in offshore applications. A composite riser design Standard and Recommended Practice were published by DNV in 2002 and 2003 [2], [3].

The composite riser presented hereafter distinguishes itself from other competitive risers by a radically different structure, an innovative continuous process of fabrication and a thermoplastic liner. Moreover the composite layers are made with continuous carbon fibres in a thermoplastic matrix, which is different from other applications of composites for offshore which use thermo-set glass-epoxy or carbon-epoxy. Specially developed metal end terminations ensure connections between pipe lengths.

The objective of this paper is to present the technology of the composite thermoplastic tubes and to show the first results for a 6” composite pipe which has been designed for deepwater applications.

Partnership

The composite carbon thermoplastic tube has been developed within the frame of a partnership comprising Doris Engineering, Freyssinet, Total and Soficar.

Doris Engineering is responsible for the design of the composite thermoplastic riser and has performed the calculations to reach the expected target applications. Pipe prototypes have been tested in specialised laboratories to assess the behaviour of the manufactured tube and to check the good correlation between calculation and experience.

Total is involved in the research and development and has joined the group to further the development for offshore applications. Total provides its offshore experience for the target applications.

Soficar is responsible for the fabrication and has developed a dedicated machine to fabricate the thermoplastic composite tube as a continuous process.

Freyssinet International is responsible for the design and fabrication of the end connectors that are fitted to the composite pipe.