



OTC 20074

Enabling Ultra-Deepwater Mooring With Aramid Fiber Rope Technology

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This paper was prepared for presentation at the 2009 Offshore Technology Conference held in Houston, Texas, USA, 4–7 May 2009.

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Abstract

New high-strength synthetic ropes constructed of para-bonded aromatic polyamide (aramid) fiber are being developed for ultra-deepwater mooring applications. This paper highlights new laboratory tensile/fatigue testing of rope assembly, computer modeling analysis of mooring performance under operating conditions, and the potential economic impact.

As the industry moves into ultra-deep water, traditional steel wire rope and chain moorings are being gradually displaced by polyester ropes. These synthetic ropes have been used in water depths between 3,000 feet and 8,000 feet. Questions arise, however, about whether polyester mooring ropes provide enough stiffness to maintain acceptable platform offsets in increasingly deeper water in all cases. Aramid fiber ropes are inherently stiffer and stronger than polyester ropes and therefore offer new solutions for ultra-deepwater mooring, as well as for other applications where production platform offsets may be critical.

Advanced technologies are being developed to optimize aramid fiber performance and rope design configurations. New laboratory tensile and fatigue data are presented to demonstrate aramid fiber rope properties, performance capabilities, and minimum tension settings meeting API RP 2SM guidelines. Mooring analysis comparing the performance of an aramid mooring system with that of a polyester mooring system under simulated hurricane and loop current conditions shows significant reductions in platform offsets are achieved with the aramid system without compromising safety.

This paper describes a new technology for ultra-deepwater mooring. The new approach offers the opportunity to design mooring systems for deeper water without modifying certain platform components and systems by incorporating stiffer, high-strength aramid fibers in the platform mooring system. Potential benefits include achieving optimal offsets for production risers in ultra-deep water, easier handling and installation due to smaller rope size, and greater flexibility in mooring system design. Economic analyses are presented to illustrate the advantages of the new technology as well as the financial impact.

Introduction

Industrial and commercial grades of aramid fiber have been used successfully for more than 25 years in numerous marine rope and cable applications, because of their unique combination of physical characteristics and performance capabilities. The linear molecular structure of aramid fiber yields a strength-to-weight ratio more than five times that of steel wire in air and more than 20 times steel wire in water. Aramid fiber is corrosion-resistant, nonconductive, and exhibits low elongation properties—or stiffness—in response to high loads, variations of mean load and rapid cyclic loading. Aramid fiber also performs well in arctic or elevated temperatures and is highly resistant to tension-tension fatigue.

Because of its high specific strength, aramid fiber has been recognized for more than 20 years as an option for mooring mobile offshore drilling units and production platforms in deepwater (Koralek, et. al., 1987). All-chain catenary mooring systems begin to approach the limits of their capabilities when operating water depths reach about 1,500 feet; combination chain-wire rope mooring systems are useful to water depths of about 3,000 feet. Beyond those depths, the sheer weight of either mooring option begins to develop the same fundamental performance problems: excessive catenary sag and