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Advances in Deepwater Top Tensioned Riser Design Consideration

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ABSTRACT

A high proportion of cost in any deepwater field development comes from drilling, completion and workover activities, due to increased day rates and limited rig availability. Dry tree floating production facilities such as spars or TLP's provide a direct well access below the platform, and eliminates the need to mobilize specialist vessels for drilling and completion activities.

This paper presents the key design challenges involved with the top tensioned riser (TTR) systems. The TTR's have numerous specialist components and interfaces which require accurate modeling and analysis techniques. Typically, riser tension is provided by means of aircans or hydro-pneumatic tensioners. The aircans are guided within the hull at multiple locations along the riser, resulting in complex interactions between them. In addition, these guide surfaces are sometimes pre-loaded and result in a stick-slip effect that further complicates the design. At the seabed, the riser pipe-soil interaction and the fatigue critical conductor casing connector beneath the mudline has a significant effect on the taper stress joint design.

This paper describes the advances in TTR design understanding and the methods to accurately predict the strength and fatigue response of the riser to ensure fitness of purpose through life.

INTRODUCTION AND BACKGROUND

Commercial development of deepwater oil and gas fields face a significant challenge due to increased day rates and reduced availability of deepwater drilling vessels that can be used for drilling, completion and work-over activities. The requirement to reduce the cost of these activities has increased the attraction towards dry tree production systems such as spars, TLPs, and possibly deep draft semi-submersibles, Figure 1 – 3, which are continually being evaluated, selected and installed for deepwater developments worldwide.

Top tensioned risers for dry tree facilities can be either single or dual casing riser systems depending upon the work-over requirements. Top tensioned risers provide direct well access for drilling and completion operations and potential cost savings by eliminating the need to mobilize deepwater drilling rigs for subsea well development drilling and future workover.

Trends show that dual casing risers are typically preferred by operators since they provide the capability for improved thermal performance during production mode, and a way of reducing risk during work-over mode. The production fluids are carried through the internal production tubing during the production mode. In case of critical work-over operations the internal production tubing is removed and the completion fluids are contained within the inner casing. In case of inner riser leak, the outer riser provides a pressure barrier and also helps detect the leak by the pressure build up in the outer annulus.

Typically, dry tree riser systems are supported using buoyancy cans, Figure 4, or using hydro-pneumatic style tensioners, Figure 5. The outer casing for both dual and single casing riser systems consists of standard riser joints within the hull which are connected to a dual tapered keel joint keel ball arrangement, Figure 6, to react the drag loads on to the keel of the dry tree FPU. Standard riser joints are run through the water column below the keel joint to the lower taper joint that connects to the subsea wellhead via a tieback connector. The taper joint either has a crossover joint above or connects directly to standard risers joints, depending on the structural performance at the base of the riser. The keel joint near the vessel keel and the tapered joint above the wellhead are used to alleviate the stresses in the high bending areas. The standard riser joints are centralized at a few locations along the hull to relieve local bending stresses, particularly near the top of the riser.

The buoyancy can supported systems consists of a stem pipe that runs through the hull. The buoyancy can and the stem pipe are centralized at multiple locations along the hull which provides reaction points between the riser and the hull. The riser pipe runs inside the stem pipe and guided through a series of centralizers inside the stem pipe.

The standard riser joints are connected using either 'weld-on' threaded connections or threaded and coupled (T&C) connections. The inner riser pipe for dual casing riser system consists of standard riser joints between subsea tieback connector and surface wellhead.

The top tensioned riser interfaces with the subsea conductor casing system at the subsea wellhead. The subsea wellheads are usually connected to either 38-inch or 36-inch conductor pipe which are the primary load carrying members of the conductor casing system. The mudline casing strings use quick mate-able casing connectors and exhibit poor fatigue performance.

The top tensioned riser system incurs significant fatigue loading at the critical locations near the vessel interface, the subsea wellhead and at the conductor connector beneath the mudline.