Tapered Column Deep Draft Semi-submersible (TCDD-Semi) Platform for Dry-tree Application

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ABSTRACT

A Tapered Column Deep Draft Semi-submersible (TCDD-Semi) concept has been developed for dry tree drilling and production application. The new concept features lower hull geometry with gradually varying column cross-section, in contrast to the conventional semi-submersible design with uniform columns. The enlarged lower columns, in combination with properly sized upper columns and pontoons, provide sufficient buoyancy and stability for topside quayside integration and offshore pre-service operations such as submergence and wet-tow. Most importantly, this new TCDD-Semi concept with tapered columns optimizes the cancelation effect of wave force and is able to reduce the heave motion in harsh environmental condition to such a level that the utilization of top tensioned drilling and production riser system with dry trees is feasible. Additionally, the tapered shape of the columns helps reduce the vortex induced motions (VIM) of the platform in currents.

This new concept has been applied to the development of a host facility for a gas project located in South China Sea. A Dry Tree Semi-submersible-based drilling and production facility is designed for a water depth of 1,500 m in 100-year return typhoon conditions. The hull is 4-column/4-pontoon configuration with a square footprint of 100.5 m, and with nominal operating draft of 48.75 m. The hull is designed to support open truss topsides with in-place operation weight of 19,631 MT. The host facility accommodates 12 top-tensioned dry tree risers (1 drilling riser, 11 production risers and/or water injection risers) and 12 steel catenary risers (SCR). The platform is anchored to the seabed by a spread mooring system of 16 lines.

The design analysis results show that the proposed TCDD Semi-submersible platform has superb heave motion performance, sufficient quayside integration buoyancy, and adequate transition stability during pontoon submergence. Its excellent heave motion performance enables the application of top-tensioned riser system with 35 feet (10.5 m) stroke limit, including all contributing factors such as platform offset, heave motion, tide, seabed subsidence, thermal expansion, damaged tank and damaged mooring. The new design also significantly reduces platform VIM compared with conventional deep draft semi-submersible.

KEY WORDS: Floating Platform, FPS, Tapered Column, Deep Draft, Dry Tree, Semi-submersible, low heave motion, riser tensioner

INTRODUCTION

Dry tree development with vertical access top tensioned risers (TTRs) allows direct monitoring, control, intervention of subsea wells, improves hydrocarbon recovery rates compared with wet tree development. Drilling, completion and work-over operation with a dry tree platform also provides benefits in operational costs and project schedules. Currently, only tension leg platforms (TLPs) and Spar platforms can be used as dry tree floaters because of their superior heave motion responses in waves. However, for deep and ultra-deep water drilling and operations, alternative dry tree concepts need to be developed to alleviate constraints in water depth limitation, payload and topside deck area, as well as costly and complex offshore installation operations of TLP and Spar platforms. A dry tree semi-submersible can be a viable solution due to the fact that it has no water depth limitation, allows quayside topside and hull integration and commissioning, and provides larger topsides capacity.

The relatively large heave motions exhibited by many conventional semi-submersible platforms usually dictate the use of steel catenary risers (SCRs) that extend between the platform and the seafloor, and the positioning of wellhead equipment such as the production tree at the sea-floor (i.e., a wet tree), rather than on the platform (i.e., a dry tree). The catenary shape of SCRs is able to accommodate and absorb the large heave motions and horizontal motions of the semi-submersible platform. However, due to their large motions, especially those in vertical direction, conventional semi-submersible platforms usually do not support top tensioned risers (TTR) with wellhead Christmas Tree above waterline.

Over the years, concepts have been developed for dry tree semi-submersible by either increasing the riser system compliancy, or

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