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A Numerical Investigation on the Hydrodynamic Performance of a New Dry Tree Semisubmersible Concept

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ABSTRACT

This paper presents a comprehensive study on the hydrodynamic performance of a new dry tree semisubmersible concept, Deepwater Tumbler Platform (DTP). The DTP concept is developed to suit the environmental conditions of South China Sea (SCS) and to tackle the challenges in deepwater development of oil and gas resources in SCS. A life-time feasibility study has been conducted, and this paper mainly focuses on the hydrodynamics of such a concept. Both frequency domain analysis and nonlinear time-domain dynamic analysis have been conducted, which include: (1) hydrodynamic characteristics; (2) load response; (3) frequency domain analysis; (4) nonlinear time-domain dynamic analysis.

KEY WORDS: Hydrodynamic performance; Dry tree semisubmersible; Deepwater Tumbler Platform; South China Sea;

INTRODUCTION

With the great development of China's economy and the improvement of people's living conditions, China's demand for oil and gas has been increasing during recent years. The South China Sea (SCS) is one of the four world-renowned offshore oil and gas resources. A preliminary estimate of the geological oil resources in the SCS's deep water totals 8.686 billion tons, with the expected recoverable resources at 2.733 billion tons; the geological natural gas resources are expected to total 5.96 trillion cubic m, with recoverable resources reaching 3.68 trillion cubic meters (Chen, 2009). However, the complexities of extreme environmental conditions, distribution of deepwater oilfields, and the status quo of China's deepwater equipment and infrastructures in SCS bring huge challenges for the development of deepwater resources.

- Frequent typhoons in summer and monsoon in winter are main hazards to offshore operation and platforms in SCS. Also, the internal wave, sand wave and sad ridge may also cause great damage. The extreme environments will not only lead to stoppage of oilfield, also damage securities of workers.
- The offshore oil and gas resources of SCS are mainly in deep water or ultra-deep water. As there are only a few deepwater oilfields in SCS for China currently, there are few supporting infrastructures, such as pipelines, supporting base.
- Offshore operation in deepwater generally requires huge cost and faces great risk. Additionally, the environmental window suitable for offshore operation is relatively limited.
- Due to the late involvement of China in the deepwater equipment, there are only a few vessels that can work in deepwater, such as "HYSY981" semisubmersible drilling platform, "HYSY201" pipe laying ship. To mobilize a deepwater vessel requires a great amount of cost and a long mobilization period.

In such circumstances, when selecting a deepwater floating production platform used for deepwater oilfields in SCS, following characteristics should be in pursuit of. From the viewpoint of improving safety, platforms with better stability should be preferred. From the viewpoint of reducing offshore installation time and cost, it would be better that the topsides and hull can be integrated at quayside and towed to site in a whole piece. From the viewpoint of decreasing operating expense, platforms that can support dry tree system should be preferred. The dry tree system has many advantages in efficient drilling and workover, low operation cost, short downtime and favorable flow assurance.

Due to the above considerations, after a comprehensive investigation on both conventional floating production systems and some dry tree semisubmersible concepts developed in the industry (Halkyard, 2002; Murray, 2008; Williams, 2010), a new dry tree semisubmersible concept, named Deepwater Tumbler Platform (DTP), has been developed.

To develop a concept applicable in the real engineering, performances throughout the whole operation life of a platform from manufacture, towing-out, offshore installation, operation to finally decommissioning have to be considered. And a trade-off has to be made even in the early design phase. In this paper, the in-place hydrodynamic performance of DTP is mainly focused.

DEEPWATER TUMBLER PLATFORM CONCEPT

Platform configuration and structure