Field Development Floater

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Abstract

A concept for a Field Development Floater (FDF) to bring a confirmed hydrocarbon discovery offshore to production and to provide for well intervention and subsea construction services during the production phase. The FDF as defined here is a Floating Production Storage and Offloading (FPSO) vessel of a design and concept for extended well test, pilot production, heavy crude production and marginal field production.

The FDF would feature a crude oil process plant, crude oil storage capacity and offloading facilities. In the basic concept the FDF would also be equipped with a moonpool, a cellar deck and substructures to facilitate the installation of a mast or tower and associated equipment for riser, well intervention and work over capabilities.

The added capabilities of the FDF include operation of the following equipment: wireline, coiled tubing, lubricator, well completion tools, production tree, manifold, template, electrical submerged pump and subsea equipment in general. Additional to the basic concept after being further equipped the FDF would be capable of working with the deployment and retrieval of flexible risers and flow lines, rigid tensioner supported risers and free standing buoyancy supported risers. The floater would feature accommodation and workshops to accommodate for field development.

This paper will identify how an FPSO could be developed for work tasks beyond its production capabilities to also include production riser handling and well intervention and work over capabilities. The FDF is a development in this direction to make the floater more versatile with a concept applicable to South East Asia and other offshore areas worldwide.

Introduction

Hydrocarbon discoveries offshore, particularly in deep waters, historically take several years from discovery to first production. In remote offshore areas and in deep waters worldwide there are a large number of oil discoveries that are not commercially viable to produce using conventional methods. There are other discoveries in areas with existing production facilities but not put on stream because the knowledge of the reservoirs is not sufficiently known to sanction a field development program.

The objective with the FDF is to develop a producing floater that would have the flexibility and capability of multiple tasks in a field development program where the economics of conventional methods of production options to support the capital cost to build, install, operate and decommission the floating structure would not work towards production in a specific offshore area or a field with limited reserves. The focal point for the FDF is not the reservoir size, but to get a significant production from one or a few wells, to sustain the production as long as possible, to abandon the prospect at some reasonable economic limit and move on and, most importantly, to do all this as quickly as possible and at costs that make the venture profitable for the operators.

Pilot Production and Production of Heavy Crude

A number of presentations have been held at offshore and petroleum conferences worldwide on the subject of pilot production and the production of crude with difficult characteristics. Two of these presentations are directly related to the development of the Field Development Floater (FDF).

1. At the Offshore West Africa conference in 2005 the paper “early production in deep waters” was presented by the author. The presentation was based on an existing FPSO floater, the Dynamically Positioned (DP) FPSO “Seillean” which is presently still producing for Petrobras in Brazil, and how this FPSO could be further developed with additional capabilities. This proven and unparalleled concept has been a success story in Brazil since the late 1990’s.

2. At the Deep Offshore Technology conference in 2006, the paper “production of heavy crude in deep waters” was presented by the author. The presentation was based on the well known Jubarte field development in Brazil. The operator Petrobras and its chartered DP FPSO “Seillean” demonstrated that it is possible to produce crude with a low API grade in deep waters to plan for a life of field production system.

By utilizing a pilot production system the time frame from discovery and well completion to producing oil can significantly be reduced, pending time for regulatory approval in the host country of operations and an available pilot production system.

The objectives with a pilot production system could be to reduce the time from a made discovery until first production, or it could be to determine well stream evidence and reservoir characteristics to handle challenging crude properties of low API grade and high viscosities to declare a field commercial and to plan for a life of field production system, optimized and designed from obtained results from the pilot production phase. During the phase of pilot production attractive cash flow can be generated to contribute to field development funding.

The discoveries of heavy crude in deep waters is demanding solutions to handle low API grade crude, high viscosities and contents as sulfur and acids. Uncertainties of well stream evidence and reservoir characteristics makes it difficult to design and optimize a life of field production system without first deploying a test and pilot production phase to obtain the required data.
There are several uncertainties related to the production of heavy crude such as: reservoir performance, flow assurance, processing, oil-water and gas-oil separation performance, and oil

storage and offloading operations. Usually the development plans for deep water heavy crude production with low GPR's and higher viscosities requires an artificial lift, often using an electric submersible pump (ESP). The FDF with its moonpool and substructures would be prepared to receive equipment and tools for well intervention to service the ESP and associated equipment.

The Seillean DP FPSO – Concept

The Seillean is a DP class 2 redundant FPSO equipped for test and early production operations in up to 2,000 meters water depth. The FPSO is highly self contained with a full size derrick to handle the rigid production riser and subsea equipment, resulting in very fast mobilization and demobilization times. Experience has shown this to be two days mobilization time in 1,000 meters water depth from arriving on the well location until the production riser has been connected to the production tree on the well and production has started.

Offloading of produced crude is carried out to a shuttle tanker with a flexible hose connected between the two vessels.

Seillean DP FPSO - Particulars

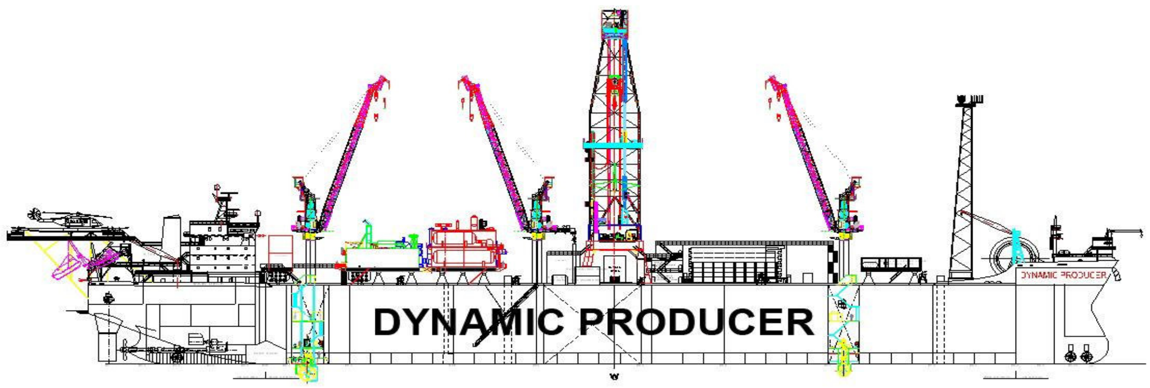
- Length Over All: 249.7 meters
- Breadth: 37.0 meters
- Crude Production Capacity: 22,500 bpd at API 17 with higher capacity for lighter crude
- Crude Storage Capacity: 300,000 bbls
- DP System: Class 2
- Main Power: Total 22 MW, diesel generator sets and dual fuel gas/diesel turbines
- Thrusters: Total 21 MW

DP FPSO Seillean

The Pipa2 DP FPSO - Concept

A further development of the DP FPSO “Seillean” concept resulted in a project called Pipa2, an ultra deep water FPSO contracted to Petrobras in Brazil. Presently the Pipa2 floater is subject to be built in Singapore from the hull of an existing tanker vessel, with a projected delivery date of late 2009.

The Pipa2 DP FPSO floater named “Dynamic Producer” offers larger capacities than the “Seillean” with regards to operational water depth, increased to 2,500 meters, and the processing and storage of crude that has been increased to 30,000 bpd and 600,000 bbls respectively. The rig equipment for riser handling has also been adapted to facilitate for well intervention tools.



The Field Development Floater (FDF) - Concept

With the two aforementioned FPSO’s (Seillean and Pipa2) as a reference, further capabilities could be added to the floater in a modular concept, here called the FDF, where the floater as a producing unit would form the basic model for the concept. The FDF is a result of combining a number of potential capabilities to one single floater.

The concept is equally suitable for a new build floater or the conversion of an existing tanker vessel to the FDF. The economics with regards to construction cost, financing, availability of a suitable shipyard, availability of suitable candidates for conversion and time frames would dictate the most attractive solution to build the FDF. The FDF is intended to be classed as a barge, without its own main propulsion, to keep the construction cost to a minimum and to reduce operational costs related to maintenance and crew.

The physical size and capacities of the FDF are highly flexible, starting with a smaller floater with a 10,000 bpd production process facility and 100,000 bbls of crude storage capacity. There is no limitation on the physical size of the FDF, but as the concept is directed towards production opportunities for extended well test, pilot production, production of heavy crude and marginal fields with economical restrictions, it is not envisaged that the FDF should have any larger capacities than a 30,000 bpd process plant and a 500,000 bbls crude storage.

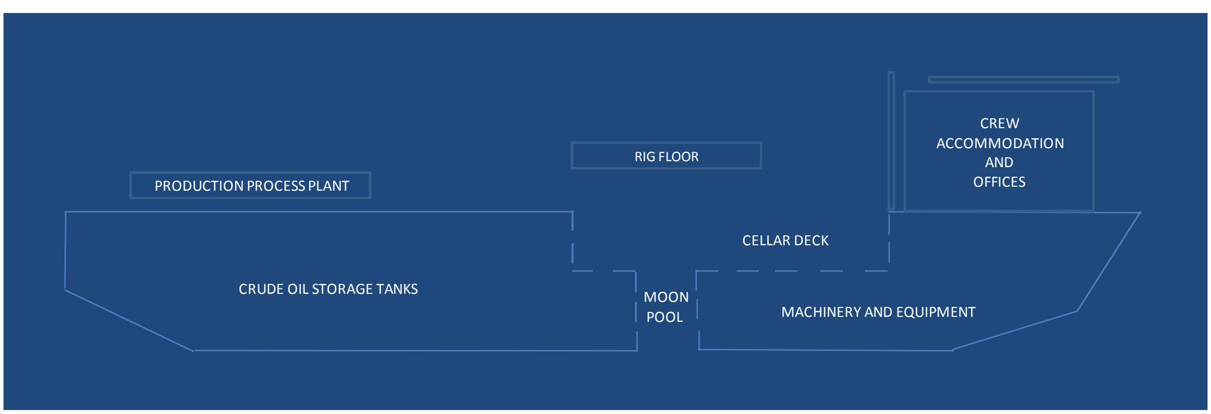
A conventional spread moored anchor mooring system would be the standard system to keep the floater on location, but the design incorporates preparations and the flexibility to install thrusters for a dynamic positioning system that may be required at certain larger water depths or to meet specific operational requirements. The projected anchor mooring system would be based on pre-deployed anchors, set by two anchor handlers in advance of the field arrival of the FDF, to minimize the time of mooring operations. The same anchor handlers would be utilized for supply and service functions when the FDF is moored on location and in operation.

A large moonpool would be incorporated in the hull to facilitate for well intervention and workover applications to make the FDF as self contained as possible, reducing the need for external assistance to service wells that need to be attended. There would also be a large cellar deck adjacent to the moonpool to install equipment and tools for well intervention, workover, subsea construction and the handling of risers and flow lines.

Above the moonpool, a substructure with a rig floor would be installed to facilitate for the temporary installment of a mast or a tower that would be required to give support to the above mentioned equipment and tools.

The FDF would have cranes with the capacity to mobilize modular equipment and de-mobilize equipment as required to meet operational requirements. The cranes would also be equipped for subsea construction work and rated to 100 ton.

The largest impact of the cost effectiveness in the building of the FDF is the flexibility to add and remove various modules as the needs occur. When the well is making little or no water, there would be no need to have onboard expensive water treating equipment. Also, since the production units are designed to be modular, the installed units onboard the FDF could always be controlled to match the actual requirement for processing capacity.



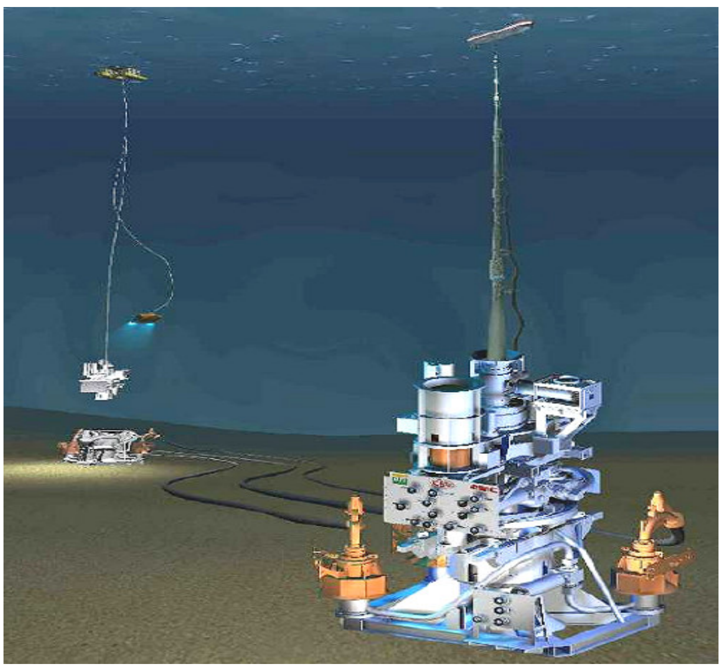
Field Development Floater – centerline side view

Production Riser System

The FDP would be prepared for a number of different riser system applications:

1. Flexible riser; the traditional method of producing a well with an FPSO. The FDF would have the capability to deploy the riser from the cellar deck through the moonpool to the subsea production tree.

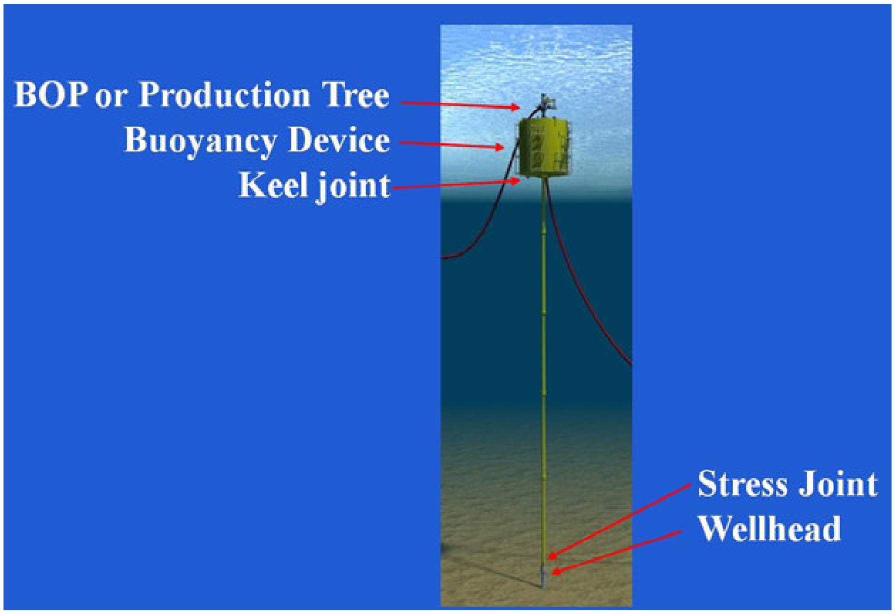
2. Rigid riser; a proven concept with a production string made up by drill pipe of size 6 5/8". To handle the riser the FDF would require to install a mast on the substructure and rig floor, and a riser carriage system suspended by a tensioning system to maintain the rigid riser subject to tension once hooked up to the well head production tree. A lower riser assembly with an emergency disconnect package (EDP) is controlled by a multi functional control system. A flow rate of up to 25,000 bpd could be achieved with this type of riser application.



Drill Pipe Production Riser

3. Self standing riser (SSR); SSR's are not new to deep water technology and have been used to support production tie-back lines to FPSO's and other floating production facilities. A further development would be the production riser suspended by a buoyancy device that would accommodate a production tree some 30-60 meters below the surface to minimize the effects of surface currents. In a combination with a development drilling program, the SSR would be deployed by the drilling unit and used as a marine riser with a blow-out preventer on the buoyancy device during the drilling phase. Subsequently the SSR as the production riser would feature a short flexible jumper between the production tree and the FDF. This production riser application with the tree placed on the buoyancy device has not yet come into use, although in November 2006 Anadarko deployed an SSR

in deep water at a depth of 3,395 feet in the Gulf of Mexico to collect data and to verify SSR simulations from earlier produced wave tank test results.



Self Standing Riser System

Self Standing Riser Buoyancy Device – GOM 2006

Conclusions

The FDF concept for extended well test and pilot production has the ambition towards making it economically feasible to develop and produce a large number of oil discoveries that currently cannot be achieved with conventional methods due to the cost associated with these methods. The FDF should also be seen as a platform for research and development to promote new unconventional approaches and technologies, some that may already work well onshore but still have not found an offshore application. The key element in the development of the FDF is the modular concept and the simplicity of the systems to obtain cost effective solutions to meet the actual operational requirements for each project, without investing resources in over capacity and equipment not required for the specific project.