FEATURE

INTRODUCTION TO FLOATING, PRODUCTION, STORAGE & OFFLOADING TOPSIDE SYSTEM AND ITS DESIGN DEVELOPMENT

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The oil and gas business sector in Malaysia has matured and deep water or sea oil & gas field exploration and developments stimulate the need to drive and grow the industry. Inspired to support this deep water development campaign, different types of processing facilities are explored – rigid, versatile and robust to the environment as well as different from the shallow jacket fixed type platform. Here, we will briefly touch on floating, production, storage & offloading (FPSO).

THE FPSO VESSEL

In principle, FPSO is a ship-shaped vessel commissioned to receive crude oil, process it on board and store it in tanks in the hull for offloading to tankers or to oil terminals via pipelines. There is also a cylindrical FPSO.

Here, we will focus on and discuss the vessel type FPSO. This can be a converted or newly-built tanker, depending on the requirements of the users. Its size is measured by its maximum vessel tank storage capability, barrels and sometimes, by its capability to process the hydrocarbon in barrels per day.

The FPSO system consists of the vessel, the process top sides module for oil and gas separation, stabilising processing and treatment system. The hull comprises storage tanks, turret mooring system, accommodation and office area, helideck and gas offset discharge system with flaring tower. In addition to its main operating features, it is also equipped with a crane and hoisting equipment, the offloading system, vessel ballasting and stability, and last but not least, the vessel's power and control system.

Figure 1 illustrates the typical FPSO schematic diagram, with its interconnection to other oil operating structures.

WHY, WHERE & WHEN TO USE FPSO

As the demand for processed hydrocarbon increases, the quest for this is not limited to only onshore and typical, reachable offshore areas but also to hostile, remote and environmental challenging drilling and production areas. The FPSO vessel, equipped with the appropriate mechanisms and control, is a favourable and exciting selection for operating in harsh, corrosive offshore environments.

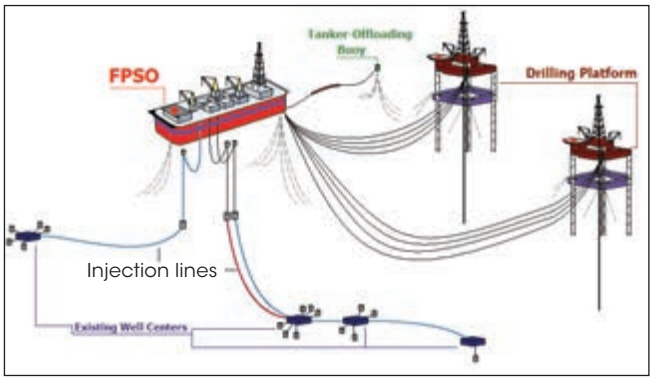

Figure 1: FPSO System and its operational diagram [Reference 1]

There are many reasons to use FPSO. First, the FPSO vessel floats, so there's high mobility and flexibility. Easy to manoeuvre, it has storage capacity, can be self-propelled, can withstand rough seas (weather-vaning) or be moved to avoid severe thunderstorms. So it is ideal for use in rough seas or adverse atmospheric conditions. FPSO can be used for deep sea operations and marginal oil reservoir fields as well as in places where there is no pipeline infrastructure.

The FPSO is best used when it is a lucrative investment by design comparison and manageable risks or requires rapid deployment to the field. It can be standardised in design philosophy.

FPSO SYSTEMS & COMPONENTS

The type of FPSO discussed here is the ship-shaped vessel. As such, the main subsystem or component is the vessel

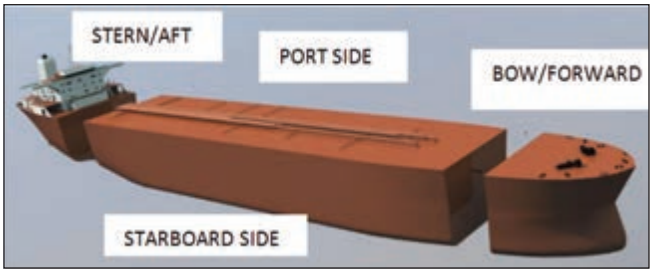

Figure 2: The FPSO vessel concept where tanks are positioned [Reference 2]

itself. This is the area where stabilised hydrocarbon or crude oils are eventually stored, prior to being offloaded to other tankers or areas. See Figure 2 for FPSO vessel information.

TURRET

The FPSO turret is the structure mounted externally or internally at the mid-ship forward or bow location. The technology selection also includes a fixed structure or a disconnectable type. Specifically, the turret contains a swivel stack (Figures 3a/b) which provides continuity paths for fluid and power flow to and from the other structures.

The design provides connecting links or an interfacing mechanism for the mobility of fluids to or from the FPSO and the outside structures or seabed. Through it, power and control signals to the seabed or subsea apparatus are also linked to the FPSO. In addition, it is also the structure to which mooring system devices such as wire rope and anchors connected to the seabed, are attached for dynamic stability of the vessel and for connecting the risers for transfer of fluid or power in and out of the vessel. Besides risers, the vessel mooring system can also be connected to the sides of the vessel; this design is called spread mooring (see references 12, 13).

Figure 3a: External turret with the mooring lines and risers [Reference 4]

Figure 3b: Internal turret system allows the FPSO to rotate around it (weather-vaning) [Reference 5]

RISER

This is basically a conduit or pipe that connects subsea wells to the FPSO production heads receipts. It is attached to the FPSO through the turret system or through the production topsides receiving piping system. It is a dynamic structure extending from the seabed and strategically located for topside processing facility at minimum interferences. Figure 4 illustrates the riser design on the side hull.

Figure 4: Risers connected to the side of the FPSO in lieu of the turrets [Reference 6]

PROCESS TOPSIDE LAYOUT

The FPSO has crude oil or hydrocarbon processing equipment on the top of the vessel hull. This process and utility equipment is fundamentally used for certain processing schemes and is categorically defined as a module.

Process modules include but are not limited to separation unit, gas treatment equipment, compressor system, gas sweetening modules, gas dehydration unit, water treatment and water injection modules.

Used mainly for processing and stabilising crude oil, the key layout approach is to position the module following the effective sequential flow of the processing modules, with emphasis on operation safety. Figure 5 shows a typical FPSO process flow schematic diagram illustrating the topside equipment or module in an optimised arrangement.

Based on this schematic diagram, the modules are organised in such a way that interfacing requirements, monitoring, control and maintenance become supportable and manageable. Moreover, the layout design philosophy focuses on hazardous areas and zones.

The design focuses on the idea that the most hazardous process classified should be located at the far end, typically at the aft of the vessel, farthest from where people or the crew are stationed, such as accommodation areas.

OTHER FPSO SYSTEMS

There are other non-process systems or features required for the FPSO vessel to operate effectively and within its design constraints, such as pipe rack system (normally located in the centre of the hull), storage tanks (in the hull),

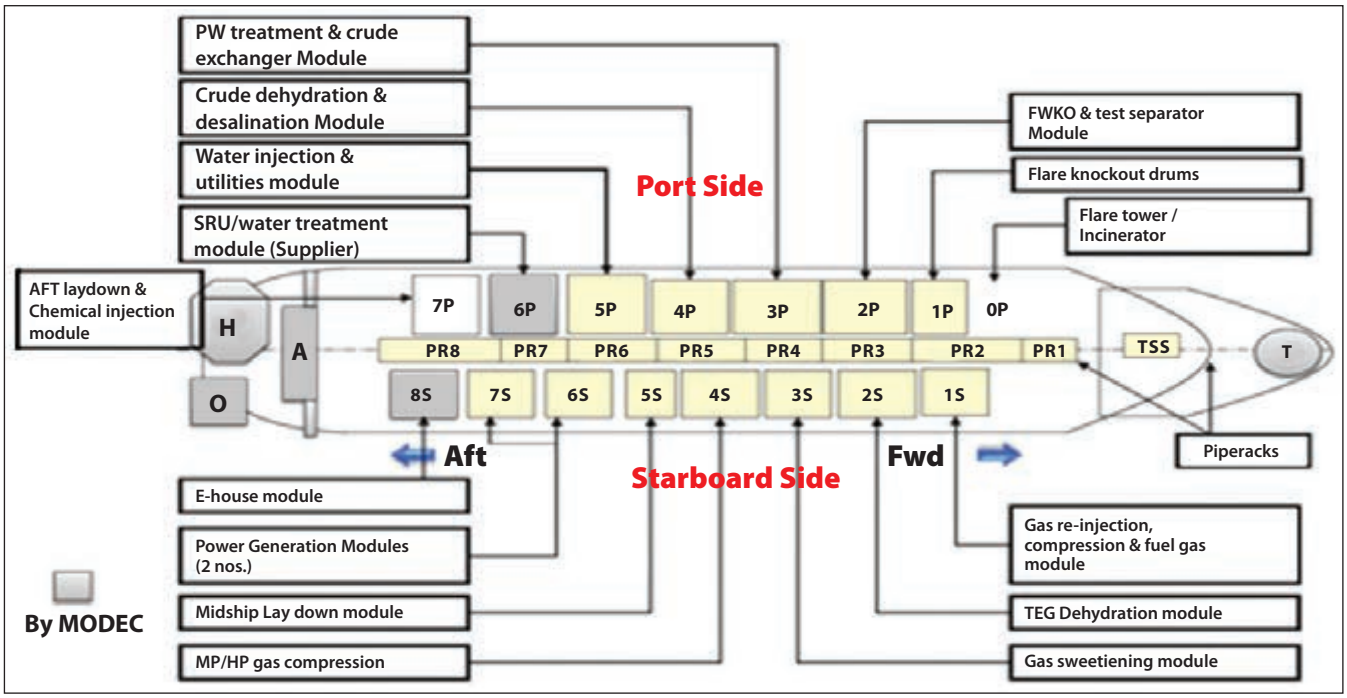

Figure 5: FPSO topside layout arrangement with port and starboard side modules [Reference 10]

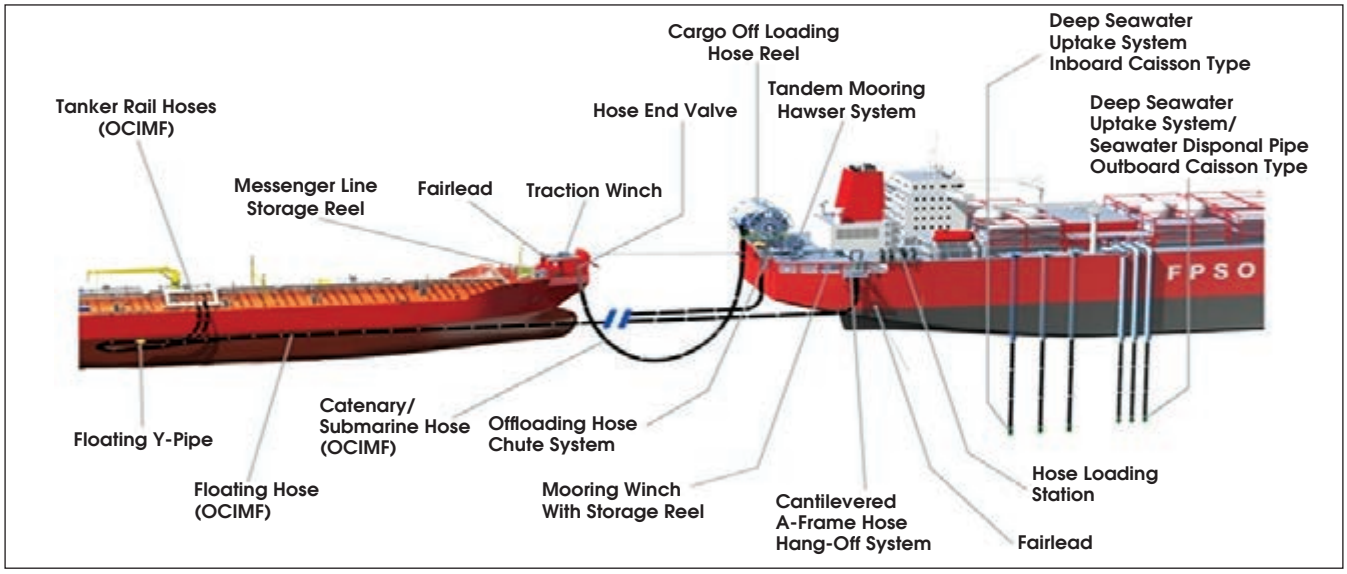

Figure 6: The offloading hose system to transfer stabilised crude oil to the receiving oil tanker. [Reference 11]

accommodation, helideck, engine room, maintenance & storage areas and bosun area.

The helideck or helicopter deck design, normally of a separate structure is designed for the helicopter landing area. The design should comply with the international aviation authority, and meet industry regulations and requirements.

The treated gas is normally used locally for power generation and for gas reinjection to increase well pressure in the oil recovery activity or is sometimes stabilised for export.

The offloading system includes a system hose capable of transferring the processed oil to the oil tankers for distribution (Figure 6).

DESIGN RISKS

Designing FPSO comes with great risks when major factors are not considered. This may result in cost overrun, unnecessary schedule extension, and excessive unbudgeted additional requirements during operations. These risks can increase with lack of coordination, incompetent workforce, and lack of local regulation and process understanding. Therefore it is important that the project team is able to monitor the designing stage vigilantly with periodical update meetings to ensure the major factors are taken into consideration as well as the project boundary is monitored to ensure that the FPSO stays within the basis of design philosophy.

CONCLUSION

Methods of extracting oil and gas are no longer restricted to a simple static steel legged platform installed in shallow water areas only. Today, the aggressive and competitive energy market has pushed the industry to venture further into deep waters and harsh environments. As such, large mobile and flexible infrastructures such as the FPSO vessels are now favoured and heavily invested in. This approach seems more promising when it comes to harsh conditions of deep-water production areas. ■

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