

FPSOs lead the offshore charge

The most expensive tankers afloat are not tankers at all but floating oil production, storage and offloading platforms - FPSOs. Relatively speaking, FPSOs are also the fastest growing sector of the 'tanker' fleet

Offshore oil production now accounts for one-third of total world production and is growing at a faster rate than the onshore sector. Success in developing offshore oil fields has come as a result of the rapid evolution of floating production systems, otherwise known as FPSs or 'floaters', in tandem with advances in drilling, subsea well, flexible riser and mooring system technologies.

These developments have enabled oil companies to achieve speedier and more cost-effective exploitation of offshore oil reserves than is possible with fixed platforms. Floaters have allowed exploitation of oil accumulations previously passed over as uneconomic or technically difficult to develop, especially those in deeper waters.

FPSs, which include floating production, storage and offloading vessels (FPSOs), semi-submersibles, tension leg platforms and spar buoys, have an important, environment-friendly advantage over fixed platforms. Because they can be removed from a depleted field and redeployed at another location in need of development, the problems associated with decommissioning traditional offshore facilities are obviated.

Offshore spur

Ship-shaped FPSOs, which account for two-thirds of floaters currently in service, have been in the vanguard of these developments and represent a quantum leap forward in offshore tanker loading technology.

The loading of tankers at offshore locations began in 1959 with the commissioning of the first single point mooring (SPM) buoy off the coast of Borneo for the export of crude oil. In 1972 an oil field in Tunisian waters was developed using the first floating storage and offloading (FSO) system. This comprised a storage tanker moored by means of a rigid arm to an SPM, an arrangement which allowed the offtake tanker to moor alongside the FSO. From there, it was but a logical progression to add a self-contained production capability, and the first FPSO entered into service in 1976 off Spain's Mediterranean coast near Castellon.

Owing to plentiful supplies of land-based oil, relatively few FPSOs were commissioned during the 1980s, but over the past decade activity in this sector has increased rapidly. Floaters currently account for 27 per cent of new oil field developments worldwide, in contrast to 2 per cent in 1991, and this share looks set to expand further.

Fleet forward

To date there have been 108 installations of FPSOs worldwide. For many of these projects the oil field has now been depleted and the vessel has been moved on to another location. There are now 74 operational FPSOs, while the current orderbook numbers 24 units. According to industry analysts Douglas-Westwood Ltd, there are a further 17 FPSO projects that are "probable" at this stage.

The North Sea is the busiest area for FPSOs but use of this technology off Brazil's coast in the Campos Basin region, along the West African coast and in the coastal waters of Australasia is expanding rapidly. FPSOs, for example, currently handle 50 per cent of Brazilian offshore oil production.

About two-thirds of active FPSOs are owned by the oil companies while the remaining third are owned by the project contractors who make them available under lease arrangements.

Prospects for the continued growth of this fleet are strong. A new study by Douglas-Westwood Ltd published this month looks beyond the current orderbook and 17 probable FPSOs and predicts that 134 new FPS projects will be launched by the end of 2006, of which 91 will involve FPSOs. FPSOs are expected to account for two-thirds of the \$32 billion spent on these new developments.

John Westwood, a partner at Douglas-Westwood, believes that of the 91 FPSO projects, 24 will be newbuildings, 35 will be conversions of existing tankers and 32 will involve the upgrading of FPSOs now in service. West Africa is expected to play host to 31 of the new FPSO projects while 30 will find a home in the Asia-Pacific region.

Indicative of the bright future in store for African floaters is the fact that in recent months four new FPSO vessels have started pumping oil from fields off the coasts of Tunisia, Nigeria, Angola and the Ivory Coast.

The Angolan project is utilising Mar Profundo Girassol, the largest FPSO yet built, as part of a \$2.7 billion project to develop the Girassol field in water depths of 1,350 metres. Mar Profundo Girassol, which was built by Hyundai Heavy Industries (HHI) and has the capacity to store 2 million barrels of oil, is building up to a plateau production capacity of 200,000 barrels per day (bpd) over a period of six months. The FPSO will boost daily Angolan oil output from 750,000 to 950,000 bpd.

Northern crucible

The North Sea, with its exacting physical and competitive economic environments, has stimulated many of the developments in FPSO technology. While the earliest vessels were able to cope with water depths of 150 metres, many newer FPSOs can accommodate depths of 1,000 metres. One of the FPSOs installed off the Brazilian coast is moored in over 1,800 metres of water and holds the record for the deepest water in which such a vessel has operated.

The oil-producing capacities of these vessels have also increased - 120,000 bpd now being commonplace, in contrast to 60,000 bpd 20 years ago. Some new vessels are being designed to handle up to 220,000 bpd.

Techniques for the transfer of oil from FPSOs to shuttle tankers have been developed and refined in the North Sea and adopted elsewhere. The most commonly used FPSO offtake system today is the transfer of oil through a flexible floating hose from the stern of the FPSO to hydraulically operated bow loading equipment on a dedicated shuttle tanker - the so-called 'tandem loading' arrangement.

FPSO mooring

The evolution of FPSO mooring system technology has also been driven by the demanding conditions of the North Sea. Turret mooring systems have been developed to enable FPSO vessels to come onstream quickly and at minimum cost. Because the FPSO is able to 'weathervane' through 360 degrees around the turret, this type of mooring effectively ensures that the vessel's bow is kept pointing into the prevailing wind and currents, thus minimising the impact of nature's forces and allowing operations in extreme sea conditions.

Often, thruster systems are also used to aid station-keeping and to control the vessel's heading. The anchor wires, flexible risers and control umbilicals from the seabed all reach the surface inside the turret.

External turret moorings, mounted at either the bow or stern of the FPSO, provide an adequate mooring system for moderate environments. In more recent years internal turret mooring systems have been developed - an arrangement which enables FPSOs to remain on location permanently, even in very harsh environmental conditions. Internal turret mooring has allowed offshore operators to develop deep water and marginal fields that would have been uneconomical or impossible to exploit with alternative technologies. Turret moorings are usually designed in such

away that the FPSO can be disconnected, either for oil shuttling duties or to avoid inclement weather, severe sea conditions and even icebergs.

In offshore locations where prevailing weather conditions are particularly benign, such as off West Africa, turret mooring may not be required. Instead, the vessel is kept on station by an array of moorings and anchors known as a spread-moored system.

Safety first

FPSO safety is a top priority for the maritime authorities of the coastal states sanctioning their use. For example, the hull must be designed for at least the expected life of the field - often 15 to 25 years - and constructed to standards that will permit the FPSO to remain at sea during this time without access to drydock facilities. Of special importance is how the vessel will survive a possible collision at sea. Normal maritime criteria are used such that the vessel will be able to stay afloat with any two hull compartments flooded.

Crude oil storage tanks are blanketed with inert gas, while oil and gas processing is controlled and monitored remotely. Shutdown systems are provided to close off the flow and contain hydrocarbons under pressure in an emergency and the vessel's flare stack can be used to depressurise the situation. The key elements of the vessel's fire protection system are protective coatings, blast or firewalls, water deluge arrangements in open areas and sprinklers in closed areas.

The accommodation block is mechanically ventilated and pressurised to provide a safe refuge for personnel. Emergency evacuation is primarily by helicopter from a helideck situated directly above the accommodation block, or by lifeboats and service craft.

Continuity of service is given high priority because of the financial implications of FPSO downtime. In recent years increasingly sophisticated software packages have been made available by the classification societies to assist FPSO operators in managing hull maintenance programmes and in keeping their vessels on station. As an example, Halliburton Brown & Root recently implemented an ABS Nautical Systems (ABS-NS) package to monitor the hull of Anasuria, a six-year-old, purpose-built FPSO it operates in the North Sea on behalf of Shell Expro. The software enables maintenance of information on the condition of the hull, including survey results, electronically and provides a sophisticated graphical representation of the hull and its structural components.

Newbuilds versus conversions

Early FPSOs were converted oil tankers and, from a purely economic point of view, conversions have the advantage over newbuildings due to the lower capital expenditure required. Depending on the particular application, an oil tanker conversion, including the ship purchase price, will cost in the range \$250-400m. In contrast, an owner is likely to pay over \$500m for an FPSO newbuilding. Time is also an important factor: conversions can be completed in 12 months while an owner must budget on double that time for a newbuild.

Because of the lack of availability of suitable second-hand tonnage, newbuildings have been increasingly favoured in recent years, especially where the vessel is to be operated in harsh climatic conditions where double hulls are favoured. Nevertheless, converted tankers are still expected to be chosen for 50 per cent of the many new FPSO projects due to be finalised over the next 10 years. Both converted and newly built FPSOs take much less time and money to commission than a fixed platform.

Preferred offshore choice

Improved understanding of the capabilities of offshore systems, coupled with increased confidence in their performance and reliability, have expanded the earlier role of floating production systems. From being principally a solution for marginal

fields, such systems are now strong contenders - and often the preferred choice - for major field developments in most offshore oil producing regions.

In recent years the industry has faced up to new challenges, as both water depths and production rates have increased. In addition, because flaring is no longer acceptable in many places, gas produced in association with the oil must be reinjected at the wellhead. FPSO technology continues to be upgraded as vessels are called upon to operate while handling higher pressures, more wells and increasingly severe climatic conditions.

New lease of life

A key attraction in the use of FPSOs to develop marginal fields is the ability to redeploy the vessel once the field is exhausted. As the characteristics of each field are invariably unique, redeployment necessitates upgrade work. The recent decision by Bluewater Energy Services BV of Hoofddorp in the Netherlands to modify its 60,000 bpd FPSO Glas Dowr for operation at the Sable Field in the Bredasdorp basin off South Africa is a typical upgrade project.

Engineering work includes the fabrication and installation of a gas compression module, a process separation module, flare structure and various modifications to the existing topside facilities of the FPSO. Sable's initial development plan includes four production wells, one water-injection well and one gas-injection well. Production is to commence by early December 2002.

The next challenge

Until recent months the US did not permit the use of FPSOs for developing its offshore oil reserves. However, following a risk assessment study which concluded that double-hulled FPSOs constitute no greater safety or pollution hazard than other, alternative means of offshore oil production, the US Minerals Management Service (MMS) has decided it will accept applications for FPSO usage in the deepwater areas of the Central and Western Gulf on a case-by-case basis. Thus, the Gulf of Mexico will provide the next test of the capabilities of the FPSO.

Historically, there has been no interest in FPSOs in the Gulf due to the relatively shallow waters in which most of the region's producing wells are situated, on the one hand, and fears of major accidents caused by hurricanes to which the area is prone, on the other.

Furthermore, the idea of a vessel storing large volumes of oil and transferring it to shuttle tankers in the vicinity of the country's coastline is anathema to many US environmental and citizen action groups. Another complicating factor is the US Jones Act which would require any shuttle tanker carrying oil from the FPSO to a US port to be built at a US yard and be owned by a US company.

As highlighted in the MMS risk assessment study, however, FPSOs have yet to be involved in a major maritime accident and an impressive safety record has been established. With interest in the Gulf of Mexico switching to deeper waters where the use of fixed platforms and subsea pipelines represents an expensive, often technically unfeasible, method of exploiting the important new oil field discoveries, FPSOs are likely to have a key role to play.

First in the Gulf

The environmental impact assessment on alternative production technologies carried out for MMS was based on a specific project under consideration. Thus, the recent ultra-deepwater discovery by Unocal in over 3,000 metres of water may be the first Gulf field to be produced with an FPSO.

While the Unocal project involves the deepest water, there are up to five other FPSOs currently under evaluation for use in the Gulf. Water depths in these projects range from 1,100 to 3,000 metres and the other operators considering the FPSO production system option include Conoco, Kerr-McGee and Ocean Energy. No FPSO

operating in the US Gulf will be allowed to flare gas during the normal course of operations.

In the Unocal proposal evaluated in the MMS environmental impact statement a permanently moored, double-hulled, ship-shaped FPSO with up to 1 million barrels of crude oil storage capacity was considered. Subject to the availability of such a vessel, most likely a newbuild, and US-flag shuttle tankers to serve it, the Unocal FPSO could be on station and producing by 2005, with as many as six subsea wells tied back to it.

Gomax shuttles

In 2001, in anticipation of the need for US-flagged and built shuttle tankers, Seahorse Shuttling and Technology, an affiliate of Conoco, formalised an alliance with Alabama Shipyard of Mobile, Alabama and Samsung Heavy Industries of Korea.

The three firms are developing a so-called Gulf of Mexico Maximum Cargo (Gomax) shuttle tanker and a shipbuilding technology transfer plan to enable the delivery of the first of a series of such ships by as early as 2004. The double-hulled, dynamically positioned vessel will have a capacity of more than 550,000 barrels of crude oil and a draught which will enable it to be accommodated at most US Gulf ports, where maximum water depths tend to be around the 15-metre mark.

Back to the future

The May 2002 FPSO report from Douglas-Westwood Ltd forecasts that the US Gulf will have one FPSO operational by 2006 but that that vessel is likely to be the first of many that will eventually be stationed in the area.

The latest report is as upbeat about the future potential for FPSOs as the previous May 2001 edition. Rather than diminish the prospects for such vessels, the events of September 11 have served to strengthen the need for offshore oil developments parts of the world less politically volatile than the Middle East.