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Deepwater offloading solution evolves

Direct offloading concept inspired by marine life offers flexible oil transfer from ultradeepwater fields.

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The U.S. Energy Information Administration places Brazil's total presalt reserves at more than 50 Bboe. To support production growth in the region, Petrobras and its partners are deploying a large number of converted and newly built FPSO vessels to work in the Campos, Santos and Espírito Santo basins, where offloading technology will play an even greater role in transporting crude oil resources produced and stored on these units to the export market.

A dynamic positioning (DP class 2+) loading and stationkeeping unit (HiLoad DP)—now in its second iteration—was developed over the course of 14 years to provide a direct offloading method that could result in considerable cost savings while exporting oil, gas and condensate from remote ultradeepwater areas.

Technology development

Traditional offloading of crude oil from FPSO unit to tanker is carried out in tandem configuration or via a remote mooring buoy solution, typically using either conventional tankers or DP shuttle tankers. For ultradeepwater fields like those in the Santos Basin, the cost of a mooring buoy solution can be high.

Inspired by the remora fish (also known as suckerfish) that attach to larger marine animals for transport and sustenance, the HiLoad system was conceived as a solution that would enable the safe offloading of crude oil directly from moored FPSO vessels onto conventional tankers, from Aframax to very large crude carrier (VLCC) size. The HiLoad DP unit allows oil to be exported directly from an FPSO vessel without need for transshipment of the oil or use of remote deepwater catenary anchor-leg mooring buoys connected to the FPSO vessel.

The unit also can provide stationkeeping to any nondedicated tanker or barge without the need for modifications to the hull structure or associated equipment, such as mooring lines. Traced to its Latin root, the name "remora" means "holding back," and the unit does just that by attaching to and keeping conventional tankers in position when loading from offshore installations.

The HiLoad DP unit, pictured in calm waters, was developed to withstand harsh environment and extreme metocean conditions. (Source: Remora AS)

A total of 100,000 engineering hours were spent on seven model tests carried out between 2001 and 2010 with varied weather conditions representing the climate on the coast of Brazil and West Africa to validate system functionality and to obtain the most reliable hydrodynamic data for the HiLoad DP unit. A number of advanced computer simulations were carried out during initial development to study the positioning ability of the DP loading unit while connecting with tankers of varying size—80,000 dwt, 150,000 dwt and 250,000 dwt. Results from wind tunnel testing were used to calculate and simulate the required thruster forces for different environmental conditions.

Second generation on order

Classification societies are an integral part of independently qualifying new technologies and work closely with industry and regulatory bodies to verify functional specifications and technology readiness and to uphold applicable safety standards.

As a first step in this third-party verification process,

approval in principle (AIP) covers the basics of the concept design. ABS granted AIP for the first HiLoad DP in 2003, performed a generic drawing review to determine the applicable notation and rule set for a HiLoad unit operating in Brazil in 2012 and this year granted AIP for the new HiLoad DP BR unit design.

In mid-2013, Remora was contracted by BG Group to perform a FEED study for the next generation of HiLoad DP units. The new HiLoad DP BR design will include increased engine power and the capability to maneuver vessels larger than Suezmax size (tankers with a carrying capacity between 120,000 dwt to 200,000 dwt), such as VLCCs with carrying capacity of 320,000 dwt, in Brazil's Santos Basin environment.

FEED was undertaken to develop a new unit design that could stationkeep a VLCC next to an FPSO vessel, while at the same time offloading directly to the VLCC in at least 95% of the weather conditions experienced in the Santos Basin.

Few HiLoad DP units will be capable of performing all of the offloading required for the 15 FPSO units that will be working in the Santos Basin by 2018. Combining this DP loading solution with conventional tankers provides operators with a safe and highly flexible option.

How it works

The HiLoad technology's proprietary high-capacity fender or friction attachment system consists of heavy-duty suction cells that are capable of transferring several thousand tons of friction force between the HiLoad DP unit and the conventional tanker.

Like the suckerfish's mechanism, the L-shaped unit attaches to a larger host—in this case an oil tanker—by docking onto the bottom of the tanker using the installed ballast and friction attachment system. The hydrostatic pressure acting on the bottom of the unit is transferred to the tanker hull through the fender system, and the attachment force on the fender system is increased, varying as a function of the draft of the tanker. The HiLoad DP takes control over the tanker and its movement, feeding it through an oil transfer line hooked to the FPSO unit.

As a tanker approaches the FPSO vessel, a DP operator calculates the optimum mating coordinates with the corresponding heading based on the latest current, wind and wave information. The operator informs the tanker master, who brings the tanker into position with the defined approach route while the operator monitors the approach so the tanker can be positioned at a safe distance from the established mating point. The unit automatically follows the tanker and connects to it while it is in forward movement.

The HiLoad DP No. 1, which received AIP from ABS in 2003, departed the Norwegian port of Kirstiansund in southern Norway on the Teekay *Navion Anglia* shuttle tanker in August 2013, bound for Brazil's presalt fields. Working under a 10-year charter contract with Petrobras, the unit completed first offloading from the Campos Basin in June 2014. (Source: Teekay Corp.)

Alternate scenarios

Operators worldwide have a growing need for direct offloading systems in deepwater and ultradeep water as more developments come online and as safety standards become more exacting.

For example, in both production and emergency scenarios, a direct offloading system might function as a standby unit that could be deployed in emergency situations to offload liquids from existing platforms during pipeline disruption (e.g., during hurricane conditions) and for use in steady-state oil production operations.

Today there are many challenges associated with FLNG offloading in the developing deepwater areas where long-term FLNG options are being considered. Enabled for tandem offloading of crude oil, gas and condensate, the HiLoad DP technology has potential functionality as an FLNG offloading solution for future installations. A sister company to Remora called HiLoad LNG AS will be handling the market for offloading LNG through a HiLoad DP LNG unit.

New destinations

To support an international crude oil trade in the coming decades, there is a need for direct FPSO export solutions, particularly in deepwater and other remote access regions. The HiLoad DP BR loading unit will be another standalone option using technology inspired by marine life to provide easier transfer of crude oil from floating production units to conventional tankers destined for international ports. EP