Increasing Deepwater Reservoir Recovery with Subsea Boosting Technology

Subsea processing is one of the most effective technologies used by operators to increase reservoir recovery. The traditional approach to subsea processing has been the installation of multiphase pumps in close proximity to the wells. Multiphase pumping, or boosting, improves the economics by reducing back-pressure on the reservoirs, increasing flow rates and total recoverable reserves.

More than 25 years ago, the first subsea boosting systems were developed by OneSubsea®, a Cameron and Schlumberger company, to provide cost-effective solutions for enabling the acceleration and prolonged production plateaus of subsea fields. Additionally, subsea boosting has enabled long step-out fields to be tied back to existing production facilities while creating greater potential for the development of marginally economical fields. Since then, the industry has seen many subsea pumps installed, with the first being on the Draugen field in 1994. That pump boosted the production 9 km to the main platform from the Rogn South satellite well and helped to successfully increase production by an additional 5,000 bbl of oil per day.

“Our portfolio of subsea boosting technology has proven to be a very effective tool to increase both production rates and ultimate recoveries from subsea fields worldwide,” says Jon Arne Sørensen, vice president of sales for OneSubsea’s Processing Systems. “Subsea multiphase boosting can enable both ultra-deepwater light-oil and heavy-oil production by adding energy to the wellstream.”

OneSubsea’s processing systems have successfully increased production rates from 30 to 100% for operators. OneSubsea multiphase pumps can deliver up to 200 bar delta P at considerable gas volume fractions (GVFs), and the single-phase pump design can deliver up to 350 bar of pressure, or 700 bar, if operated in series. All OneSubsea pumps are configured with an oil-filled motor mounted on top and the pump section at the bottom, in a vertical configuration. The pump and motor are fully encapsulated in a pressure housing designed for water depths up to 3,000 m and pressures up to 15,000 psi (1,034 bar). The compact design is ideal for subsea installation and retrieval by light vessels.

OneSubsea has more than 30 subsea projects across the globe that are currently in operation or have been delivered. As operators are exploring deeper waters with longer tiebacks, OneSubsea is leading the way having provided the longest step-out-to-date and delivering the optimal solution for different well conditions and other various development drivers worldwide.

**Gulf of Mexico: Jack and St. Malo Fields**

The Jack and St. Malo (JSM) fields are within 60 km of each other, located approximately 450 km south of New Orleans, Louisiana, in the Gulf of Mexico (GoM). Water depths are approximately 2100 m. JSM comprises three subsea centres tied back to a floating hub production facility with a capacity of 170,000 bbl of oil per day and 42.4 MMscf of natural gas per day.

OneSubsea was selected as the production and processing equipment provider in 2010 and 2011, respectively. In addition to 12 subsea trees, production controls, and four manifolds with associated connection equipment, engineering and project management, the scope of supply included several subsea boosting systems, specifically:

- Three pump stations with 3-MW single-phase pumps.
- Three pump control modules, associated control and instrumentation equipment.
- Complete topside power and control system.

The pump stations were installed and commissioned in 2014.

“For the ultra-deep waters and the reservoir conditions of the deepwater Gulf of Mexico, subsea boosting is a very effective tool to unload the high hydrostatic column and to provide an effective drawdown on the reservoir, hence the increased recovery effect,” Sørensen explains.

**GoM: Julia Field**

The Julia project is another field equipped with subsea boosting technology provided by OneSubsea. The Julia field lies in 2100-m waters in the Walker Ridge area, approximately 322 km south of New Orleans, Louisiana. First oil is expected in 2016, with initial production capacity of 34,000 bbl of oil per day.

In addition to the water depths and reservoir conditions, the Julia field has a very long tieback — a combination that will benefit even more from the additional energy that the pumps will contribute to the wellstream. When the OneSubsea single-phase pumps are installed later this year, they will help boost production from the Julia field to the JSM platform with the longest tieback, 24 km, and with the greatest
design pressure at approximately 13,500 psi (931 bar).

OneSubsea is providing:
- A pump station with 3-MW single-phase pump.
- One pump control module, associated control and instrumentation equipment.
- Topside power system.

West Africa: Girassol Resources Initiative Project
The Girassol Resources Initiative (GriRI) development is located in Block 17 offshore Luanda, Angola, in water depths of approximately 1430 m. Recoverable reserves have been estimated at 725 MMstdl of oil.

"The GriRI and satellite fields have all been in production for several years. As is typical for the area, the wells will start cutting water with the effect that the back-pressure on the wells will increase. This will in turn lead to reduced oil production," Svenjes says. "The OneSubsea multiphase pumps will offload or significantly reduce back-pressure compared to alternative methods like gas lift."

Total recovery will also increase due to the reduced back-pressure on the wells. West African fields typically span very large areas, greatly increasing tieback distances. The GirRI development has a long tieback distance at approximately 18 km. OneSubsea multiphase pumps have also demonstrated very significant positive flow assurance effect for these kinds of fields. They have been developed to handle hydrocarbon flow at high GVF up to 100% mechanically and to 95% operationally.

The project scope for OneSubsea includes:
- Two pump stations with 2.5-MW multiphase pumps, with the highest differential pressure supplied at 130 bar up to 60% GVF.
- Two pump control modules, associated control and instrumentation equipment.
- Topside power and control module.

OneSubsea delivered the pump system in the last quarter of 2014. The pumps are scheduled for installation and start-up in the second and third quarters of this year.

West Africa: Moho Project
The Moho development is located offshore Congo and operates in water depths of approximately 800 m. The Moho has a long tieback distance of 18 km with no requirement for a subsea transformer. The pump station is tied back to the ALIMA FPU, 7 km away.

OneSubsea was chosen as the processing equipment provider in 2013, with deliveries scheduled to be completed by the second quarter of 2016:
- One pump station with two multiphase pumps rated at 3.5 MW, with high differential pressure at 120 bar up to 50% GVF.
- One pump control module and associated control and instrumentation equipment.
- Topside power and control module.
- Two umbilical systems.
- One umbilical termination assembly with subsea transformers.

Norwegian North Sea: Draugen Infill Program
The number of mature oil fields in the Norwegian North Sea is increasing. Despite having some of the highest recovery rates in the world, North Sea fields can benefit significantly from multiphase pumps and subsea processing by using the infrastructure for new satellites and achieving increased recovery. The Draugen is one such field. The OneSubsea multiphase pump system will, according to the operator, contribute by increasing the recovery rates into the 70% range.

The Draugen field is located 140 km west of the city of Kristiansund in the Norwegian Sea and has water depths of approximately 350 m. The processing systems contract was awarded in 2012, which includes the following equipment:
- One pump station with two 2.3-MW multiphase pumps.
- One pump control module, associated control and instrumentation equipment.
- Three multiphase flow meters.
- One umbilical system.
- One topside power and control module.

A Unique Combination
OneSubsea is a global leader in subsea multiphase boosting, compression, and metering. The company has been operating in the subsea processing arena longer than any other company in the world, OneSubsea offers field-proven, turn-key solutions to enhance recovery systems for subsea oil and gas developments around the globe. With a unique combination of in-house knowledge and expertise, OneSubsea covers all of the key elements, from pump design to subsea station designs to multiphase metering. The boosting technology has been developed to meet increasing market requirements to enhance oil recovery in the most challenging environments.

OneSubsea delivers integrated solutions, products, systems and services for the subsea oil and gas market. The company offers a step-change in reservoir recovery for the subsea oil and gas industry through integration and optimisation of the entire production system over the life of the field. OneSubsea leverages Cameron’s flow control expertise, process technologies and world-class manufacturing and aftermarket capabilities, along with Schlumberger’s petro-technical leadership, reservoir and production technology and R&D capabilities.