SUBSEA PUMPING TECHNOLOGY

Wet test of the Subsea Pumping Technology unit at an ROV test tank at Oceaneering's Morgan City, Louisiana, facility in 2020

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Back in 2019, Oceaneering won a Spotlight on New Technology Award for its novel Subsea Pumping Technology (SPT) designs. Since then, the company has built hardware around this concept and in 2020, started long term underwater system qualification testing in concert with a major operator.

Chemical injection is an important component of many field production strategies to ensure operational integrity management and flow assurance. Adding methanol, MEG and other paraffin/wax inhibitors are needed to improve well functionality and production performance.

For subsea tiebacks, the inhibitor chemicals are typically stored in tanks on the host platform and delivered to the subsea site through long umbilicals.

Applications that require high dosing of chemicals consequently necessitate locating large storage tanks on a platform that is often short of space. Such constrictions often mean that personnel are often in close contact with pressure-containing equipment.

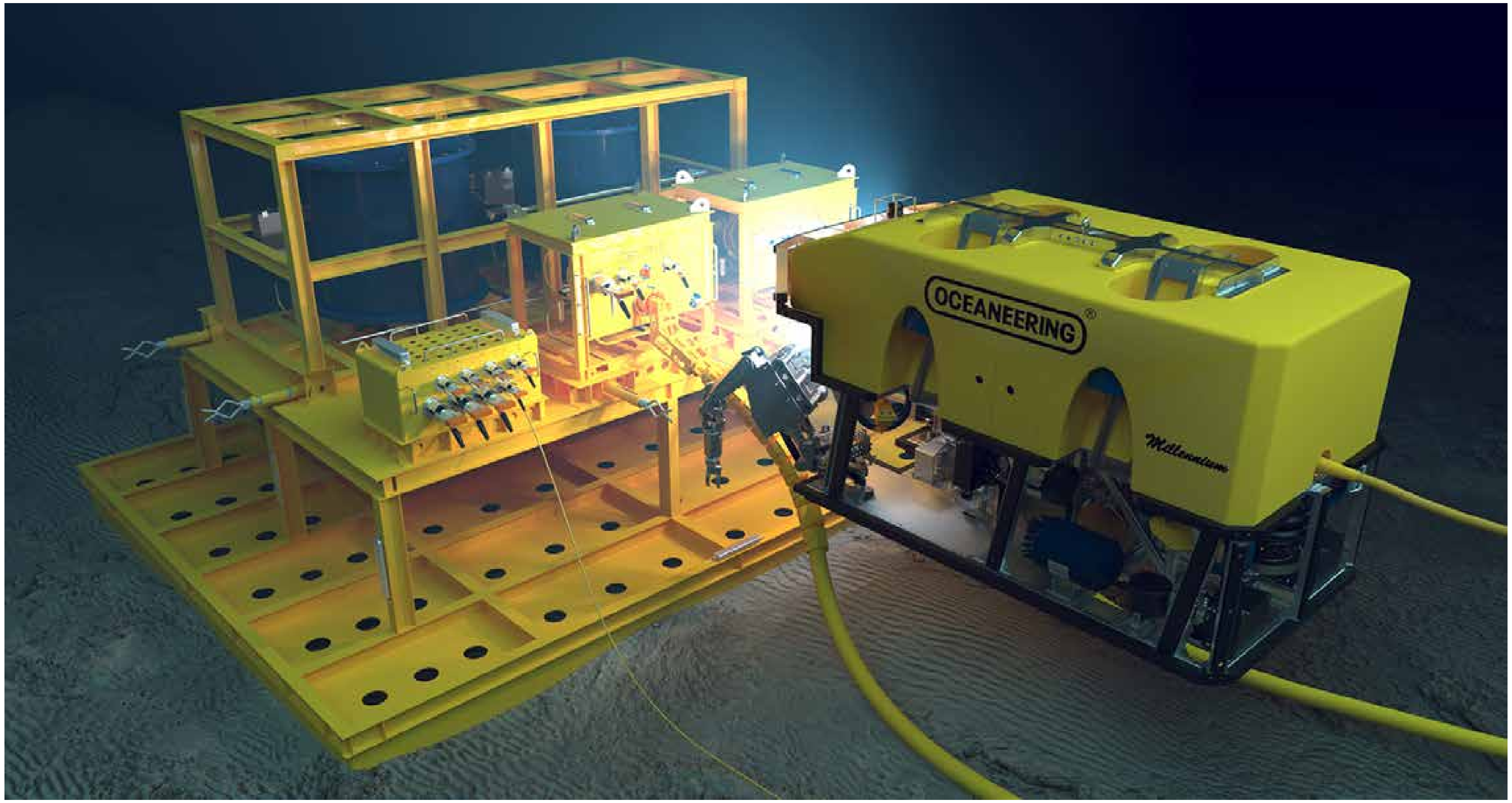
As the tieback distance grows, the cost of the umbilical increases accordingly. Oceaneering, themselves a global manufacturer of umbilicals, openly recognises that this has a significant impact on field economics.

Because of the materials and complexity, these umbilicals are expensive to manufacture and can have long lead-times of anything between 14 and 18 months. Up to now, there have been few alternatives.

“SPT essentially removes the reliance on such complex umbilicals, thus allowing operators to engage in longer tiebacks with much reduced capital expenditures,” said Michael Hearn, Sales and Business Development Manager with Oceaneering’s Energy Products group.

The SPT system that Oceaneering has engineered is based on relocating the pump from the remote platform to the local seabed site. The chemical injection fluid is stored in a tank farm also located subsea. At a stroke, this reduces or eliminates their topside footprint.

This means that the long complex umbilicals are no longer necessary as the wells can be fed by much shorter local lines.



Subsea Pumping Technology unit with an Oceaneering ROV subsea.

"There still needs to be umbilicals from the host platform, however, but these lines can be much smaller as they are not required to transport volumes of fluid," said Jake Schrager, Lead Engineer for SPT. "All the umbilical really needs is to carry power and control communications from the host. They can be less complex. As one of the major cost items, this immediately reduces both Capex and lead times.

"Calculating project economics is difficult because it always takes into account a large number of variables, but the sweet spot for using this subsea pumping technology is around 25 km. As the tieback distances increase, subsea pumping becomes more economic," said Hearn.

The layout scenario envisages one or more pump/storage units feeding into a single termination unit. This in turn is connected to the production facilities.

“The key to designing a universal system compatible with the maximum number of field scenarios is that is that it has to be configurable and scalable,” said Schrager. “We have designed three different types of pump modules which we can use depending on the application. Each serves a different purpose.”

The three pumps are Axial Piston, Triplex Plunger, and Diaphragm Pump. There is a pump for each application the client may need, ranging from 0-50 GPM (189 LPM) at a design pressure up to 15,000 psi.

The Axial pump plays the middle between the low dosage Diaphragm and the high-volume output of the Triplex and can deliver between the .2-8 GPM, said Schrager.

Each pump is equipped with onboard monitoring control systems that can supply instantaneous feedback to the topsides control station. This provides the operator with instant information on flow rates, ground fault monitoring etc to continually show the system status.

Each pump is equipped with a controls bottle for sending inputs and outputs back and forth from subsea to topside to control ethe pumps onboard the module. The controls bottle uses Rockwell plc architecture, which can be configured to work with any industry specifications, said Schrager. Communications for the SPT system can be done via fibre from the communications and power umbilical. Local sources can be done by Ethernet. Additionally, the controls system can be MODBUS configurable.

Fluid Storage Module
The fluid storage module is based on a steel drum enclosing a 1,000-gallon (3,785 L) bladder although this single unit can be scaled up or down depending on the operator's requirements.

The outer steel enclosure affords protection while the secondary containment system ensures that there is no leakage of chemicals into the ocean.

Level indicators ensure that the tank contains the correct amount of fluid. These levels of chemical are closely monitored such that if the pressure decreases or the rate falls unexpectedly, an alarm is flagged.

When depleted, the fluid storage tanks can be re-filled from the surface using a subsea hose connected to a diverless interface.

Alternatively, it may be cost-effective to simply replace the entire module from the surface. Once the tank is empty, the unit it is retrieved using a crane with a replacement sent down and latch on to the base, again diverlessly.

Subsea Pumping Technology unit mobilized for a system wet test at Oceaneering's Morgan City, Louisiana, facility in 2020

"While a single tank contains 1,000 gallons, we have designed a typical module as a two-tank unit able to provide 2,000 gallons," said Hearn. "Furthermore, for larger demand, it would be simple to manifold a number of two-tank storage units to provide 8,000 or 10,000 gallons."

"The technology has been seven years in making," said Schrager. "Throughout the development and testing phases, one of the technical challenges around the fluid storage tank has been operating it in a high-pressure environment. We had to develop a robust testing programme to ensure that the bladder was capable of a wide range of applications.

"In the testing programme, we have especially concentrated on ensuring its integrity. Part of the reliability testing has included filling the bladder up and then emptying it," said Schrager.

"We carried out 47 fill-empty cycles to test the integrity but in real-life operational conditions, we would certainly start to think about replacing the module well before this point."

The wet test also validated the interfaces between the pump modules and the fluid storage modules. The valves had to prove they can terminate the flow and restart the system as commanded from the topside master control system.

The final design can withstand a broad range of chemicals up to a depth of 10,000 ft. It will not collapse but self-compensates for the pressure differentials at extreme levels.

"We see the system being suitable for intervention in both Brownfield and Greenfield applications. It can be used to meet a short-term need by providing a temporary solution to enable production during long term infrastructure development," said Hearn.

Alternatively, it can be used to supplement existing services when previous architecture did not fully consider the demands.

"The design is entirely congruous with the general move toward unmanned or subsea factories that many companies are proposing," Hearn said. It is compatible with all-electric technologies currently being implemented."

At present, the testing phase is at an advanced stage of completion and has achieved a technology readiness level of five to the system and six for the fluid storage modules.

Oceaneering plan to go into phase two level testing to optimise and enhance reliability.