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SUBSEA

Reviewing the basics of subsea pumping systems

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How much is enough? This is a difficult question to answer, regardless of the subject at hand. In the case of the upstream offshore oil and gas industry, pressure is often the subject, as it is the motive force behind the flow of hydrocarbons. So, how much pressure is enough to warrant full-scale development of a discovered reservoir? While each prospect is unique, and the ever-changing price of oil will continue to impact decisions on field viability, the advent of subsea pumping technology is changing the answer to that question.

Subsea pumps can be used to raise the rate of recovery, extend the duration of the peak production plateau, and reduce the final abandonment pressure, increasing the total amount of fluids recovered from the reservoir. They can make marginal pressure fields viable and can extend the useful life of existing brownfields, while also permitting tiebacks from longer distances or greater depths than would otherwise be impossible.

System configurations

Subsea pumps can be used to boost flow from an individual well, from multiple wells downstream of a drill center's gathering manifold, or from an entire field along a tieback flowline or within a riser. Pumps may be combined in parallel to improve total flow or in series to improve the overall pressure increase. The number of pumps and location(s) selected will depend on the specifics of the field and the type of pump(s) employed.

Historically, subsea pumps have been used to boost the entire production stream, generally multiphase mixtures of oil, gas, and water. In recent years, however, subsea pumps have been used in conjunction with subsea separation. When a subsea separation system removes the vapor components from the liquids, the pump provides boosting of the liquid components of the stream through a liquids-only flowline, with the vapor directed to a gas-only flowline. The separation process significantly reduces the risk of a hydrate plug forming in the flowline, but also reduces the energy available to transport the liquids to the surface. Therefore, subsea pumps are needed to provide the boost required to keep the liquids flowing back to the host facility.

Subsea pumps have also been deployed to increase recovery from a reservoir by adding pressure to the reservoir itself, rather than to the fluids produced from it. Subsea raw seawater injection systems use a pump to draw seawater through coarse filters for removal of large particulate matter, and then inject the filtered water directly into an injection well or wells. This provides pressure support to the reservoir as its hydrocarbons are removed.

System components

The primary components of a pumping system include equipment for power generation, power conditioning and control, and power transmission, as well as a retrievable pump unit and pump base skid, which ties into the production flowline system.

Topside power is conditioned by one or more variable frequency drives, or VFDs, to maintain the pump at a constant, safe operating speed despite the continuously changing density of multiphase well fluids flowing through the pump. While all currently installed subsea pumps utilize VFDs for speed control, variable speed hydraulic couplers mounted between the pump motor and the pump input shaft are an emerging technology that could one day replace VFDs and allow for fixed frequency power from the surface. This type of coupler has the additional benefit of permitting positive displacement pumps to stall at a given pressure, removing the risk of overpressure usually associated with that particular pump design.

As with a typical subsea system, topsides power is transmitted to the pump via an umbilical. Generally, the pump umbilical will be separate from any other umbilical used in the subsea development. In addition to power conductors, the pump umbilical will contain wires or optical fibers for transmitting control and data signals to and from the pump, tubes for delivery of lubricating and cooling fluid, and possibly tubes for delivery of methanol or other chemicals that may be required for the operation and maintenance of the pump(s) or base skid. Depending on the voltage and power requirements and the distance between the VFD and the pump, a subsea transformer may be needed as well, which can be costly. However, at this point, the power umbilical may very well be the most expensive component in the pump system.

Rotating equipment, whether subsea or topsides, has maintenance requirements, and subsea pumps are no exception. Therefore, pump skids are typically designed in two parts: a base skid which includes the tie-in to the production flowline and manifold valving for routing production fluids through or around the pump(s); and the pump(s) in retrievable frames. With assistance from a remotely operated vehicle, or ROV, each pump can be disconnected and retrieved from the base skid for maintenance work. Subsea pumps are often included in the overall system with a bypass to keep flow from stopping during maintenance or other downtime of the pump.

Latest trends

Subsea pumps have been serving the offshore industry for nearly two decades. As the quest for recoverable reserves extends ever outwards to deeper waters and longer tiebacks, subsea pumping and other increased oil recovery technologies will one day take their place in the base case scenarios of offshore developments. They will no longer be considered risky or merely planned for as future possibilities by adding extra space on the host facility and extra hubs on the seafloor. In preparation for that day, the industry must continue to expand its knowledge and push the envelope of technology development.

Subsea pumping poster

This issue of *Offshore* also contains the 2012 Worldwide Survey of Subsea Pumping Systems. The primary goals of this poster are to chronicle the development and developers of subsea pumping systems and associated equipment by providing a worldwide look at the status of the technologies. The poster also documents the continued commitment of oil companies to the application of these technologies. This is the fifth iteration of this poster in as many years. This year, the focus has been narrowed to target liquid boosting systems. For online access to view and download all five posters, please visit www.offshore-mag.com/maps-posters.

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