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# Through-tubing rotary drilling intervention system coaxes more oil from aged reservoirs

By Bjarne Neumann, FMC Technologies

IN AREAS OF the world where the biggest oil and gas discoveries are already drilled and producing, the push continues for increased oil recovery (IOR) efforts. The North Sea is just such an area.

Existing technology promises only a typical recovery rate of 20% to 70% for oil wells and 60% to 80% for gas wells. For subsea wells, the percentages are even less optimistic than for platform-operated wells.

Hunting undiscovered reserves in undeveloped reservoirs is always an option for increasing production, but what about all the oil and gas still in the reservoirs that have already been discovered? Some estimates show there being as much as one-third to one-half of the original oil in place as it reaches current industry standards of maturity.

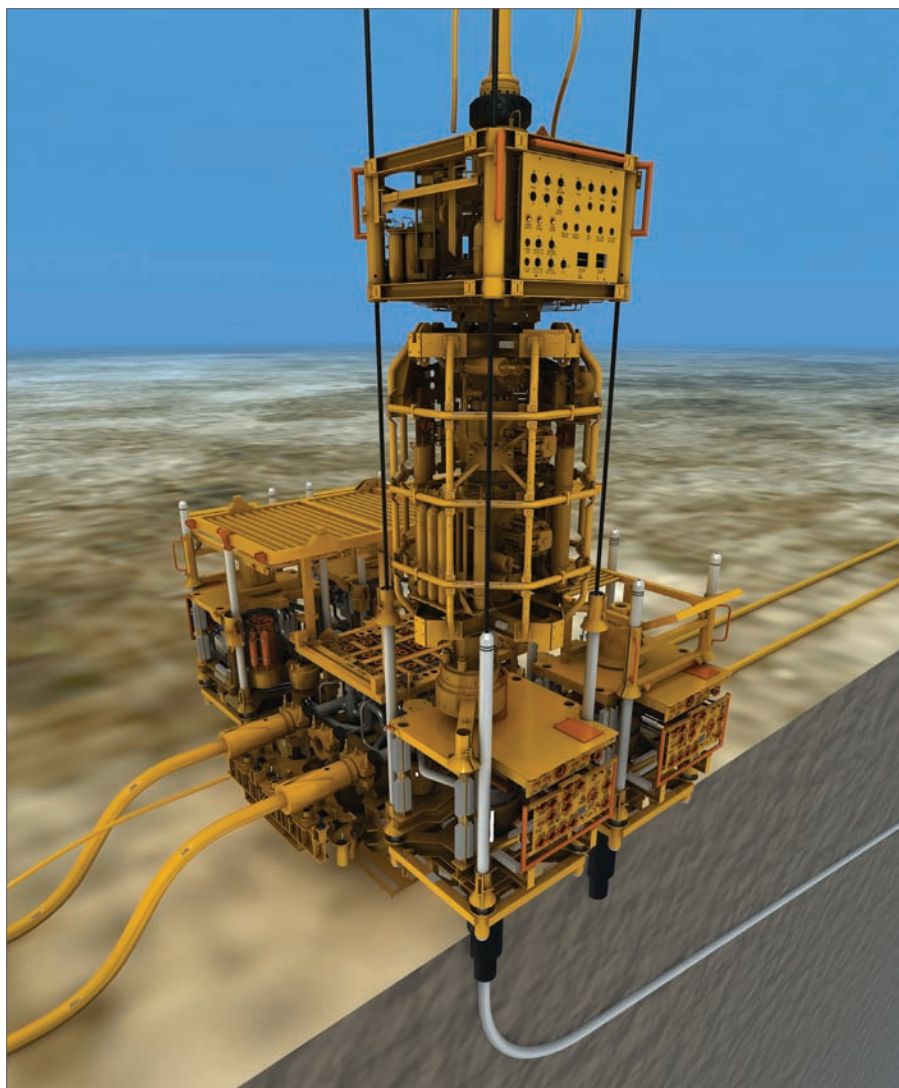
As the number of fields drilled with subsea developments increases, and the need to boost production remains ever-present, innovative technology to help operators produce more hydrocarbons out of existing reservoirs remains one of the industry's top priorities.

One such innovation is the through-tubing rotary drilling (TTRD) intervention system, which was developed jointly by FMC Technologies and Statoil. This technology has seen a recent success in Statoil's Åsgard Field in the North Sea.

TTRD was initially a response to Statoil's technology development program. Part of this strategy was the development of low-cost drainage points for wells using technology to create inexpensive sidetracks through existing producers. The resulting technology is the TTRD, a system that enables a simpler and more cost-effective method of sidetrack drilling through subsea wells.

## HOW IT WORKS

Sidetrack drilling by use of conventional rigs and a BOP system can be a costly and time-consuming process on subsea wells. Rig dayrates on these projects can be high and the weather is often uncooperative. Accessing additional hydrocarbon reserves through traditional sidetrack wells often means racking up the




**With the TTRD system, developed by Statoil and FMC Technologies, a sidetrack can be drilled from an existing well without pulling the tubing. The TTRD system configuration allows drilling, testing and completion to be performed using only one system. The illustration above represents the TTRD system's deployment in Statoil's Åsgard Field.**

time and expense of pulling the tubing completely out of the hole, and replacing it. To justify this cost, additional reserves must be large.

The TTRD system makes it possible to enter a well and drill a sidetrack from the parent well without having to pull the tubing. A sidetrack well can be drilled from deep within the current well through the installation of a whipstock at the selected depth and the milling of a window in the liner. Because sidetracks are drilled below the production packer with the drill pipe conducted through the tubing, neither the tubing nor the subsea tree needs to be removed.

Both the whipstock installation and the window milling can be done in one run which saves time and expense. The sidetrack well can be drilled using the existing subsea tree that is already installed on the well. TTRD system configuration allows both drilling and well testing and completion to be performed through one system, which, compared with traditional methods, require the installation of two individual systems.


Once the TTRD rig is mobilized, both TTRD and well interventions can be carried out. The new stack configuration opens the door for improvements in other operational sequences, and may




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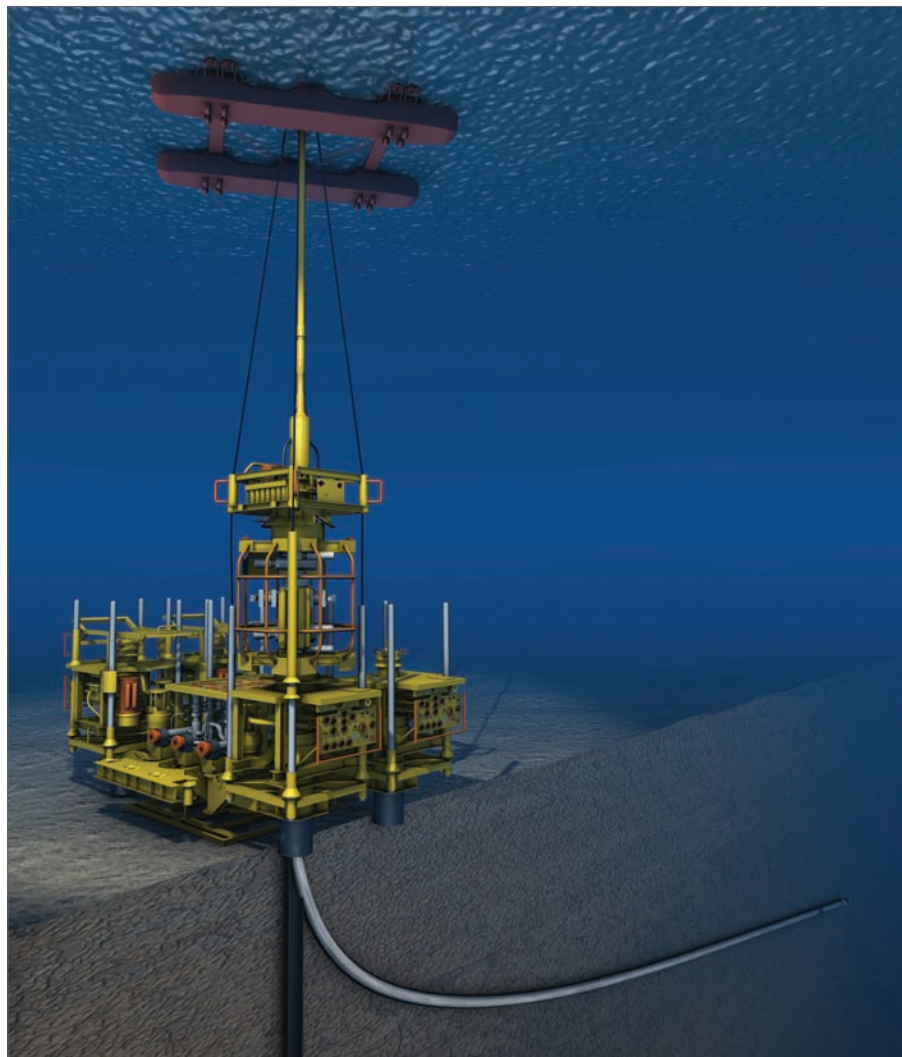
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A conventional rig was used for TTRD Åsgard this time, but Statoil has said that the result of this technology will be even better on a purpose-built rig. Statoil began searching for such a unit in late 2009, with the ambition that the new unit be in place in 2013.

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also adapt to new drilling techniques in the future.

Drilling, completion and well testing of a sidetrack using conventional-drilling BOP would normally require an additional HP riser to be installed during the intervention and well-testing phase. With TTRD, this is no longer necessary. Interface for topside pressure-control equipment is provided via a high-pressure stab sitting on top of the SBOP. This leads to a significant reduction in time spent running and handling the riser during mode change, an important safety improvement due to slimmer design and weight.

Additionally, the TTRD system has fewer components and fewer weather-critical operations. The design of the emergency disconnect feature allows high-angle release subsea, a significant improvement compared with conventional drilling equipment.

The development of the TTRD technology allowed some typical subsea problems to be addressed, namely the protection of the completion and the horizontal subsea tree. In subsea wells, damage in these areas have been a persistent problem, and the incidence of damage has been found to be unacceptably high.

Compensating measures to reduce the risk of damage were taken during the development of TTRD, resulting in further innovation.

The main tools developed as a result of these measures include fit-for-purpose protection sleeves for the seal areas in the completion; non-abrasive hardbanding; bottomhole assembly designs that are not aggressive to the completion or the subsea tree; and a crown plug with elastomer instead of metal-to-metal seals, capable of sealing on a damaged seal area.

Overall cost savings when TTRD is used to drill a new well compared with the costs associated with drilling a new conventional well are substantial. Typical costs for a new subsea well can range from \$40 million to \$50 million. The new drainage points created for Statoil using TTRD are estimated to cost \$10 million.

These cost savings mean smaller reserve pockets are more economical, and existing wells will have a longer life and a longer revenue stream. Additional benefits of TTRD include reduced fatigue exposure to the well head and more efficient operations with less handling of heavy equipment.

### STATOIL'S ASGARD FIELD

The development of TTRD through partnership between FMC Technologies and Statoil was the direct result of a need. For Statoil, more than 40% of its oil and gas production is produced from some 500 wells in subsea fields. If the company could increase its recovery from these existing wells in an economical way, its production would increase immediately. The first field on which TTRD was tested was the Åsgard Field in the North Sea.

The Åsgard Field and its subsea installations comprise 56 wells in 16 templates tied together by 300 km of in-field flowlines. The Åsgard A oil production ship started production in May 1999, while gas production from the semisubmersible Åsgard B began in October 2000. Total crude oil production from the Åsgard Field is 200,000 bbl/day of oil.

Well P-4H was drilled in September 2001 and was completed and put into production the following month. Due to high gas/oil ratio (GOR), the well was closed in November 2005. An RLWI vessel attempted to decrease the GOR by perforating formations in 2006. During perforation, the tool string was lifted due to flow and the cable was broken. The perforating string and 35 m of cable were left in the hole and the well was shut in.

Drilling using TTRD technology was planned on the P-4H well with the objective of producing the Tilje formation. Simultaneous perforating and production of the Ile formation were also planned. The whipstock was set at 3,900-m MD and a sidetrack was drilled to approximately 5,700-m MD. The total

drilled length was 1,800 m and is said to be the longest sidetrack ever drilled.

Preliminary results of initial well flow and testing indicate pressure, quality and flow rate are above Statoil expectations. A rate of 1,500 cu m/day versus steady production expectation of 800 to 1,000 cu m/day was observed at a pressure of 230 Bar. The P-4H well is now estimated to produce additional oil valued at \$237 million.

### FUTURE OF TTRD

So far, TTRD has been applied only to existing wells that have been shut in or have ceased to produce. In these cases, the existing wellbore has been abandoned and the sidetrack has been drilled to another part of the reservoir where hydrocarbon pockets still remain to be tapped.

A conventional rig was used at Åsgard this time, but Statoil has said that the result of this technology will be even better on a purpose-built rig. During autumn 2009, Statoil started searching for a rig that could be tailored to such operations, and their ambition is that the new rig will be in place in 2013. ♪

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