Through tubing rotary drilling maximizes recovery

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THROUGH TUBING ROTARY Drilling (TTRD) has proven to be an important tool in maximizing remaining recovery through low cost infill drilling for previously uneconomic and therefore bypassed pockets of oil and gas.

The technique involves running a window milling assembly through an existing Christmas tree/completion and milling a window below the existing tailpipe. A slimhole wellbore is drilled into the reservoir. Usually a liner is then run, cemented and perforated. All of the operations are carried out through the existing completion, eliminating the time and cost associated with pulling the old completion and then running a new completion and tree when the drilling phase is complete.

In partnership with several clients, KCA DEUTAG has been at the forefront of the safe implementation of TTRD operations in the North Sea over the past five years. With many successful wells already drilled, there exists a wealth of experience that can now be applied to the industry's needs.

KCA DEUTAG has drilled wells with open hole sections in excess of 3,000 ft, at inclinations up to 90°, and from kick off depths in excess of 15,700 ft. Additionally, the company has completed wells with cemented and slotted liners as well as barefoot.

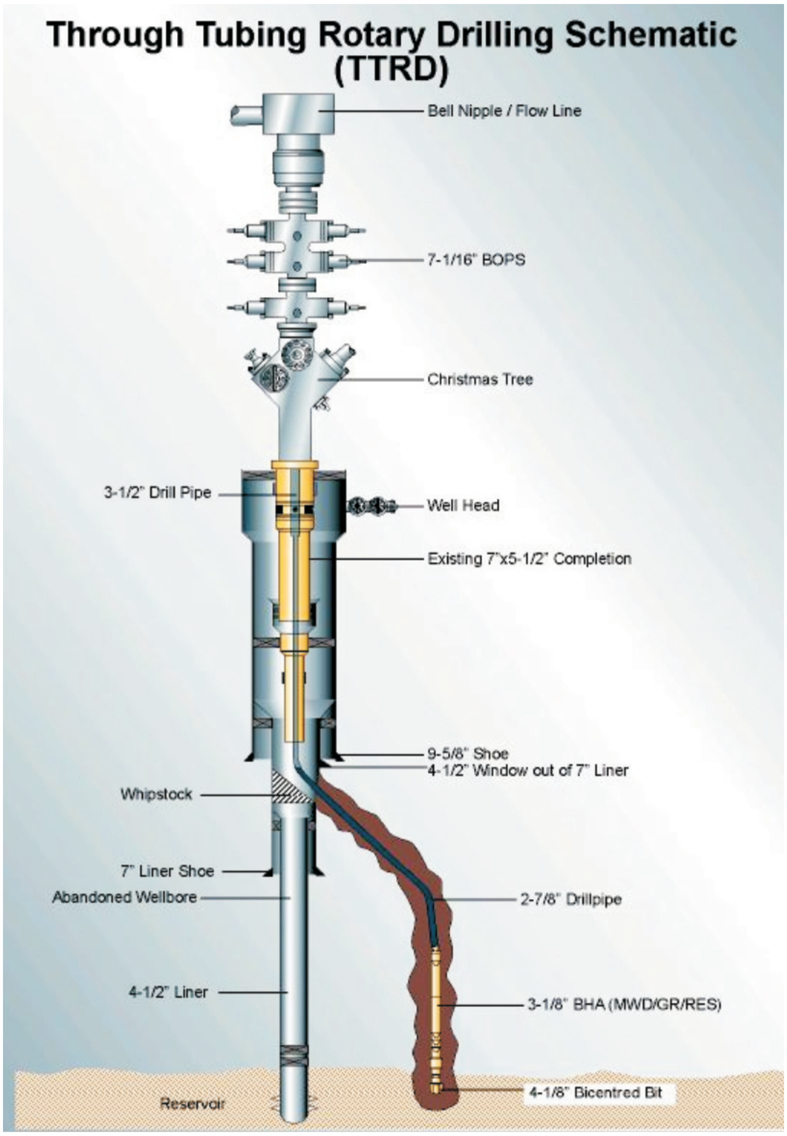
For example, in 2002 KCA began planning the conversion of **Amerada Hess'** North Sea Scott platform for TTRD operations. Before the conversion, there was a potential for only as many as three new conventional wells drilled from the platform. TTRD increased that figure to as many as a dozen new wells, increasing the life of the facility.

The following is a brief look at some of the important aspects in planning and preparing for TTRD operations.

WELL PLANNING

Resources that should be made available for planning a TTRD project will vary on the complexity of the well and the amount of detailed engineering required for both the well and the topside modifications. It is preferable to seek unbiased advice during the early stages of onshore planning on what technologies are suited to the particular challenges faced. During the detailed planning phase, when key suppliers have been identified, their experience and advice then becomes invaluable to the success of the project.

Planning a first time TTRD well is complex, as there are many new ideas and procedures to implement. The margins for error with torque, pressure and weight are much less when drilling slimhole. This requires very detailed modeling and sensitivity analyses



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EQUIPMENT

It may be the case that a significant number of topside modifications are required in order to implement TTRD. These requirements should be identified as early as possible in order to engineer a satisfactory solution.

It is important to identify at an early stage what equipment will be required, for example the available workstring tubulars (drillpipe or tubing) may be sufficient as an intervention string but may not be of a sufficient quality for TTRD operations. In this case a dedicated TTRD string may have to be sourced.

PWD subs should be run on all TTRD operations. The real time data can assist in appraising the crew's effectiveness in minimizing downhole pressure spikes caused by routine operations.

Bi-centered bits are generally favored for TTRD applications in order to open out the hole size and thus increase borehole to drillstring clearance.

Most drillers will not have used drilling tools of TTRD size in the past - a 2 7/8-in. drillstring was used on the Scott platform. Training needs must be identified at an early stage and addressed with both formal learning and the evolution of robust procedures.

Several options have so far been tried when selecting BOPs. The easiest and most efficient option is to use a 7 1/16-in. BOP and riser on top of the Christmas tree, leaving the tree in place. In order to protect the tree, a wear ring or sleeve should be employed (a wear ring, unlike a sleeve, will not affect tree functionality). To date on KCA DEUTAG operations, no discernible damage has been caused to trees when using wear rings rather than sleeves. Care should be taken when running well control subs or BOP test tools into the hole as they may not pass the wear ring restriction. A suitable test stump should be shipped with the BOP for offline testing.

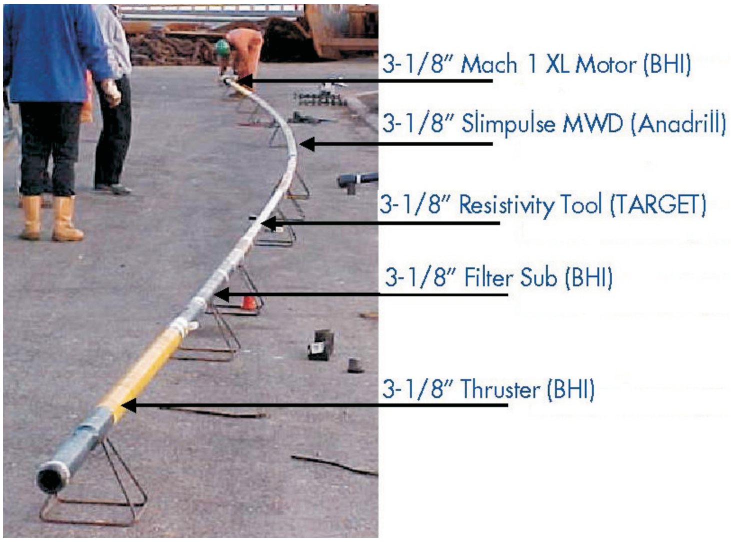
When specifying a 7 1/16-in. BOP, the ancillary equipment supplied (side outlet valves, HCRs, etc.) should be suitable for use with the smaller stack. Considerable delays can be experienced when stripping equipment from the 13 5/8-in. or larger rig BOP and then rigging it up to workover BOPs. As smaller BOPs are not capable of sustaining the bending loads associated with the conventional equipment the subsequent rig up of oversize equipment can be complex, involving Chicksan and scaffolding, resulting in additional slip and trip hazards.

To date, in the TTRD operations where serious well control problems have arisen no form of advanced kick detection had been utilized. The small alterations made to reduce the active tank capacity and extending the flow show paddle have not proven totally effective. Several systems are available from multi-sensor arrays to stand alone instruments to improve kick differentiation although the operation and limitations of such equipment must be fully understood by the drillers.

Notwithstanding the above, the volume of the active circulation system should still be reduced for TTRD operations to aid the accurate gauging of volumes.

TTRD TRAINING

In order to transfer knowledge to the drill crews and service company personnel it is imperative that enhanced pre-spud meetings are held. TTRD will be new to many of the team and as such it is vital that those undertaking the work understand the new procedures and processes necessary. The meetings should address not only the down hole issues surrounding the well, but also the risks associated with any new equipment.



It is helpful at the pre-spuds if the crew is already aware of what is involved in TTRD drilling thus maximizing the available time to concentrate on the upcoming operations and technical challenges. To this end it is recommended that prior to holding the enhanced pre-spuds, some kind of formal training is offered to the crew from Toolpusher to Derrickman level.

KCA DEUTAG offers its DART (Drilling & Advanced Rig Training) facility to aid crew training and to simulate the well prior to drilling, thus verifying the well design. DART is a virtual real time simulator that can be programmed with full details of surface drilling equipment, geology, pressure, fluids, casings, BHA's, etc, all tailored to represent the conditions of the well. Unwelcome occurrences such as well control, stuck pipe and many other situations can be simulated. Where difficult operations are identified within TTRD programs, the rig crew and operations management team can use DART to provide additional training and hands on experience in order to mitigate the drilling risks.

The simulator controls are a full scale exact copy of an offshore platform's rig floor and doghouse, with workstations for both the driller and the assistant driller complete with full surface readouts as would be expected.

WELL CONTROL

Much of the unplanned costs experienced so far with TTRD in the North Sea have been caused by a loss of primary well control. This loss of overbalance, or rather the time taken to deal with the ensuing influx, has often then led to problems of wellbore instability leading in some cases to the loss of the hole section.

In order to avoid the loss of primary control, and possible formation fracture resulting from high well kill pressures as happened in one of the wells drilled, attention should be focused on planning, procedures and equipment.

Among the items to be considered when planning the well, the pressure predictions received from the subsurface team should be as accurate as possible. If there is a history of under estimation in the field, this should be addressed and fully assessed for the possible risks to any upcoming TTRD operations.

Where ECD constraints are low, an increased trip margin can be built into the drilling fluid. While this will help to mitigate the increased risk of swabbing when tripping, it will not eliminate the problem altogether.

Up to date and well specific borehole stability and strength data will give the best idea of the kill contingencies available to the operations team should primary well control be lost. It is imperative that the kick tolerance calculation methods used are robust and fit for purpose. Given the increased risk of swabbing in influxes while carrying out TTRD operations, it is recommended to use a fully detailed model based around the bubble equation with sensitivity limits as required. PWD data gained while drilling the section can offer a valuable reference for rock strength assumptions prior to beginning any well control recovery operations.

When stripping, slim pipe is more prone to buckling than larger pipe sizes. Prior to commencing TTRD operations, the expected stripping forces should be calculated for a range of wellbore pressures and string depths. From the data an operational envelope can be produced to determine if and when stripping the slim pipe is a viable option. The results can be gathered to form a stripping contingency decision tree ensuring pipe buckling limits are not exceeded.

PROCEDURES

There are several conditions that should be considered during the drilling operation. For example, when tripping, it is preferable to avoid pumping slugs as they can destabilize the fluid system and are less effective in small diameter pipe. It is preferable to pump the string out of the hole to avoid swabbing. This should be addressed at the planning stage with the drilling fluid contractor as pumping out at reduced rates may induce some barite sag.

Because of the low shear rates inherent with TTRD, Drilling fluid properties, particularly density, should be monitored more closely than usual. Wellsite personnel should be made aware that significant deteriorization should be addressed prior to drilling ahead. Ultra low end rheology measurement can assist in identifying the onset of barite sag, thus allowing remedial measures to be taken at an early stage. A high pressure shear box arrangement can also be employed on surface to shear the pit inventory. Alternatively specialist formulations that are resistant to sag can be used such as low solid content brines or ultra small weighted particle OBM (Manganese Tetraoxide).

Trip, kick and stripping drills should be performed prior to commencing TTRD operations to ensure the crews are familiarized with the new equipment. The stripping drill should highlight the limitations of stripping with slim pipe and should therefore be conducted under a range of well pressures.

Any kick indications should be investigated fully and cross checked with other indicators given the increased seriousness of the consequences.

It is difficult to be prescriptive about the duration of flow checks given the difference in reservoir characteristics from well to well, although it is recommended that the flow check should always be thorough enough to afford absolute confidence to the driller that the well is static.

TTRD is an unfamiliar technique and therefore requires an increased level of risk assessment covering procedures, equipment and personnel. ■