Severe conditions challenge tubular design and use

GROWING USE OF EXTENDED reach drilling and increased deepwater activity have put new demands on the drill string.

A wide range of well tubular issues, running techniques and experience is explored in papers prepared for a "Tubulars" session at the 2001 SPE/IADC Drilling Conference.

J Smith, **Grant/Prideco** and **J Altermann**, **R&B Falcon Corp** were scheduled to chair the session.

TITANIUM DRILL PIPE

Use of titanium drill pipe to achieve weight and other advantages is the subject of SPE/IADC paper 67722, "Titanium Drill Pipe for Very Long Reach, Extended Reach and Deep Water Drilling."

Prepared by **J E Smith**, Grant Prideco; **J Rubi**, **RTI Energy Systems**; and **R B Chandler**, Grant Prideco, the paper discusses studies of titanium drill pipe and analyzes performance characteristics.

Rigorous studies have shown that 5-in., 5½-in., 5⅞-in. and 6⅝-in. titanium drill pipe have significant advantages over the same size steel drill pipe in very long reach extended reach and deepwater drilling programs.

Titanium drill pipe has a yield strength of 120 ksi and a density that is only 56% that of steel, resulting in a strength to weight ratio improvement over steel of 1.53.

The authors report on studies that analyzed an extended reach well typical of the wells being drilled today, an ultra-extended reach scenario and a deepwater extended reach well.

The studies showed that the use of full strings of 5-in., 5½-in., 5⅞-in. and 6⅝-in. drill pipe reduces rotating torque by 30-39% and hook loads by up to 40% in the most challenging ERD profiles currently in existence.

The use of titanium in full or partial strings allows running larger diameter pipe to much greater measured depths and expands the effective distance an existing platform can reach without upgrades to the hoisting or rotating systems.

Previously uneconomical reserves can be accessed without costly rig and platform upgrades by using titanium pipe. The lighter weight titanium enables the use of larger OD drill pipe for improved hydraulics and it potentially has a huge economic impact for deepwater structures where deck loads may have a tenfold impact on structure size and cost.

Reductions in drilling torque may allow the use of water based mud rather than oil or synthetic based mud that can result in higher well productivity and fewer environmental concerns.

Titanium drill pipe may also reduce riser wear and may have a significant advantage in reducing power consumption on the drilling platform.

LANDING TUBULARS

The increase in water depth of offshore drilling combined with longer ERD wells has lead to dramatic increases in the loads required to be supported by the landing tubulars.

In SPE/IADC paper 67723, "Landing Tubulars: Design, Manufacture, Inspection and Use Issues," the authors explore these concerns. The paper was prepared for the Conference by **J W Breihan**, Grant Prideco; J A Altermann, R&B Falcon Corp; and **M J Jellison**, Grant Prideco.

The quest for strings capable of handling loads in excess of 2 million lb is pushing the usable limits of high strength tubular manufacturing and handling devices. These landing tubulars are relatively new, non-standard and generally application specific.

As a result there are no industry specifications or guidelines relating specifically to these products. In this paper, the authors explore issues in three categories.

First, the requirements in terms of loading and geometric constraints related to efficient handling and optimal hydraulics are analyzed. Slip crushing, elevator lifting capacity and connections may become the limiting factors if the tubulars and handling systems do not take these issues into account during the initial design phase.

The authors also review physical properties that can be achieved in steel tubulars related to strength and ductility. Guidelines for tradeoffs between these two important properties relating to applications are discussed.

According to the authors, current specifications for drill pipe in many cases do not apply or are not adequate to insure the safe and reliable use of these special tubulars. The paper addresses specifications and inspection requirements for new manufacture of landing tubulars.

CASING RUNNING TOOL

In SPE/IADC paper 68049, "Casing Running Tool (CRT)," authors **J G Renfro**, **Varco International** and **C Chur**, **Deutag Europe** describe a new method for running casing using a top drive.

The tool they describe connects directly to the output shaft of a top drive and is self contained. It uses control signals already present on the top drive as well as the top drive control panel. The top drive pipe handler does makeup and breakout of the CRT.

The original concept of the CRT came from Deutag and was subsequently licensed to Varco International to be jointly developed. This joint development has also enlisted the support of **NAM** and three prototype test phases have been completed.

The first test was run on 13⅜-in. casing testing stabbing, torque control and stability of the rotating assembly

The second test was done on 9⅞-in. VAM-Ace 62.8-lb/ft Q125 casing. In total, 880 m was run using the CRT.

Makeup torque was 24,000 ft lb and was verified with casing tongs. Torque accuracy was measured and found to be within 3%.

Hands off stabbing was also tested successfully in winds to 15 m/s.

The third and last test to date verified the capability of the thread compensation during makeup and breakout.

During the last test, a fill up tool was mounted in the CRT and both filling and circulation were tested at 1,500 psi.

SANS CONDUCTOR

Economic pressures drove a cost cutting innovation in the Dutch sector of the North Sea. In SPE/IADC paper 67724, "Conductorless Exploration Well: Production Casing in the Sea," author **P Hoving**, NAM, describes the implementation of a new approach to exploration well design.

Driven by economic considerations, these wells are now planned as "throw away" wells; independent of success, the well is abandoned after a test.

In challenging the well design it was proposed that the first casing could also serve as a conductor since exploration well lifetime is relatively short (1-3 months). An opportunity to test this approach arose in early 2000 in exploration well G14-1.

The well was planned with only three hole sections to TD at +/- 2,700 m TVSS. Planned final hole section was 6 in., with potential for a 5-in. cemented liner. Intermediate section was 8½ in. with partially cemented 7-in. liner including integral tie-back packer.

Top hole section was 14½ in. to allow installation of a 10¾-in. casing based on the outcome of a design study, applying a minimum fatique life of 6 months.

The authors report that studies indicated a 10¾-in. casing tension requirement of 150 tons (200 tons riser tensioning system available). A slip-type elevator was used at 20 m below the Texas deck and 150 tons pull maintained.

The BOP's were suspended from overhead winches and load cells used for further control.

The conductorless operation proceeded without problems. The authors conclude that a conductor can be omitted from exploration wells in Dutch waters, resulting in:

- Less safety exposure to personnel (no handling of "big" conductor);
- Less environmental impact (no big pipe made and used and partly left in the hole);
- Less time spent (drilling/driving conductor and recovering conductor);
- Less money spent (no conductor and time to deploy).

SLIMMING DOWN

With the need to maintain competitive advantage in a low and volatile price environment, a cost leadership initiative was proposed to slim down Imo River 66 (EX-SDTQ-2) to achieve a 25% reduction in capex without compromising its off-take potential.

In SPE/IADC paper 67725, "A Novel Approach to Slim Well Delivery," the design and planning of the slim well is described by **O E Erivwo**, **O O Owoeye** and **V C Ogoke**, **Shell Petroleum Development Co of Nigeria**.

The novel approach was used in the 7⅝-in. by 5½-in. by 3½-in. single skin well configuration with 3½-in. expandable sand screens deployed in the horizontal section.

Conductorless drilling of "throwaway wells" used BOP suspended by overhead winches.

The EXX was expanded to 4¾ in., which maximized the completion liner size and minimized the drain hole annulus. That enhanced effective reservoir management.

The success of Imo River 66 resulted in a savings of $2.3 million, a 32% cost reduction. The well proposed with a potential of 3,000 bopd has already been tested to a post cleanup potential of 3,106 bopd at a lower bean size.

This success has provided opportunities for step change reduction in construction costs of future wells.

PIPE BUCKLING

SPE/IADC paper 67727 brings together several buckling and pipe deformation analysis themes. "Lateral Buckling of Pipe with Connectors in Curved Wellbores" was prepared for the Conference by **R F Mitchell**, **Landmark Graphics**.

Clearly, connectors should have an effect on the loading of pipe. For non-buckled pipe, Lubinski analyzed the effect of connectors on pipe in tension in a curved borehole and Paslay and Cernocky extended this analysis to pipe in compression.

Connectors have an effect on the buckling of pipe, but the effect of connectors has only recently received attention.

In previous papers, analytic solutions of the beam-column equations were developed in three dimensions, and critical loads for buckling initiation were determined.

Conditions for positive contact forces were determined and compared to previous buckling criteria, such as Paslay-Dawson.

In this paper, the wellbore curvature effects studied by Lubinski, Paslay and Cernocky are included in the buckling effects studied by the author.

The modifications necessary to the analysis of lateral buckling are made for a curved wellbore. The resulting model gives a buckling criterion similar to He and Killingstad's results for pipe without connectors.

The buckling model is integrated with the Paslay-Cernocky analysis to resolve some of the odd bending stress results developed by their model. Pipe deflections, contact loads, and bending stresses are determined with explicit formulas.

Sag between connectors is calculated so that pipe body contact with the wellbore between connectors can be determined.

Conditions for positive contact forces are determined and compared to previous buckling criteria, such as Paslay-Dawson and He-Killingstad.

Applications include the analysis of bottom hole assemblies, drill pipe, casing, and tubing.

The solutions are simple formulas that are suitable for hand calculations.