HPHT and ERD demand special materials, methods

TWO DRILLING ENVIRONMENTS that can make special demands on drilling fluids, downhole equipment and well control were the focus of a session at the 2001 SPE/IADC Drilling Conference.

High pressure/high temperature conditions call for special materials and extra caution. Extended reach drilling calls for sophisticated processes.

Both these areas of increasing importance are the subjects of the Drilling Conference session to be chaired by **M Sheppard**, **Schlumberger Cambridge Research** and **O Al-Husaini**, **Saudi Aramco**.

TUBING FAILURE

SPE/IADC paper 67779, "Erskine Field HPHT Workover and Tubing Corrosion Failure Investigation," prepared by **D E Mowat**, **Texaco**, outlines the lessons learned from the first HPHT workover in the North Sea.

The paper details the investigation into the tubing corrosion failure and provides recommendations for future HPHT completions.

Production was lost from Erskine well 23/26b-W4 in December 1998 due to a slam shut closure of the subsurface safety valve (SSSV), caused by a leak in the control line operating the valve.

An initial investigation indicated that both the primary and auxiliary control lines were leaking and there was also tubing to annulus communication.

A workover was performed in July 1999 to restore the well to production.

The reason for the completion failure was found to be a rupture in the 5-in. Duplex Stainless Steel (DSS) tubing, approximately 200 ft beneath the tubing hanger.

The tubing on either side of the rupture showed extensive cracking, which was the result of localized "chloride stress corrosion cracking."

This was identified as the root cause of the rupture and subsequent loss of production from the well.

A new completion string was installed and the well successfully restored to full production.

Chloride stress corrosion was the result of a complex interaction with calcium chloride, additives and oxygen in the vapor space at the top of the annulus.

The authors cite these conclusions from an analysis of the event:

- Calcium chloride and small amounts of oxygen can create a very corrosive environment for DSS. Keeping oxygen out is essential. Bleed off procedures need to ensure oxygen is not allowed in to the annulus;
- Additives designed to inhibit corrosion in carbon steel can accelerate stress corrosion cracking in DSS;
- Alternatives to chloride brine (e g drill water) need to be investigated for new HPHT completions;
- The use of any completion fluid additives in an HPHT well needs to be very carefully scrutinized for its compatibility with the production tubing.

FAST TRACK PROJECT

During April-June 2000, **Veba Oil and Gas UK Ltd** drilled three appraisal wells in the Guillemot West/Western Extension as sole risk development pilot holes. The intention was to evaluate three structures and if successful, use the main part of the wells to drill the oil producers and water injector at a later date.

The wells would then be tied back to the Guillemot main field and produced via the **Triton** FPSO.

SPE/IADC Conference paper 67807, "First Time Operator Achieves Best in Class Performance in CNS," describes how the project was completed in 5½ months.

The paper was prepared by **S Redgrave** and **E Kipperman**, Veba Oil and Gas UK.

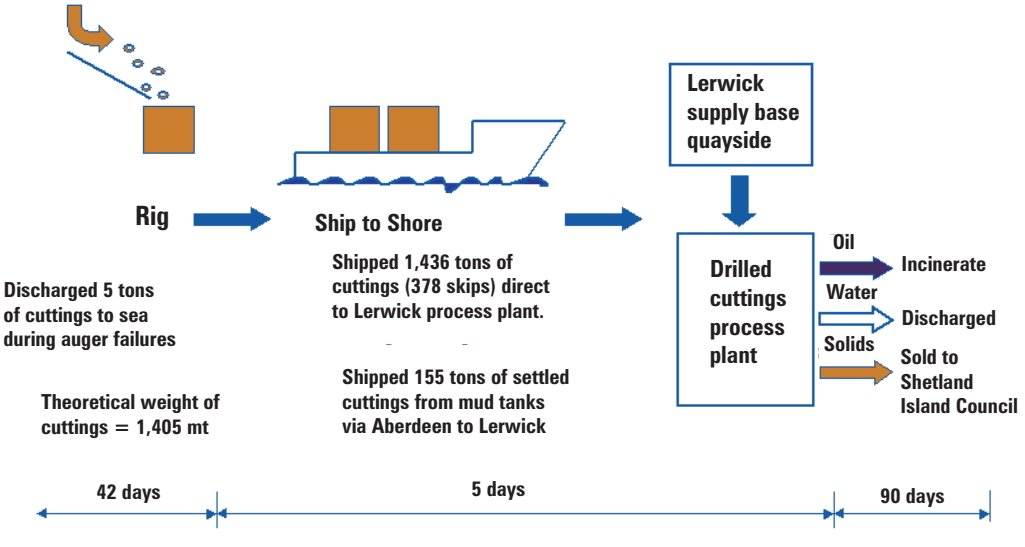
The wells were drilled under high angle, with 13⅜-in. casing set at 70 degrees inclination in water based mud, penetrating the reservoir in 12¼ in.

During the drilling of the 12¼-in. hole section, synthetic based mud cuttings were collected, and using skip and ship operations transported for disposal on land.

Inside drill pipe gyro runs were required to open up tight targets, and novel TLC (Tough Logging Conditions) tool combinations were run under high overbalance conditions. All the project objectives were achieved, according to the authors.

In the paper, the authors emphasize the "can-do" approach for this successful

Figure 1: Cuttings disposal - sole risk wells



fast track project—5½ months from start of planning to end of drilling. It involved consultations with the government, the solving of environmental issues, the contracting process, procurement of materials and new technical applications.

The team approach was the key to achieving Best-in-Class drilling performance.

VOLUMETRIC EXPANSION

Fluctuations in mud returns can often be misleading, particularly in high pressure, high temperature wells.

In SPE/IADC paper 67780, "A Practical Method for Evaluating Effects of Fracture Charging and/or Ballooning When Drilling High Pressure, High Temperature (HPHT) Wells," the authors present a method for better estimating volumetric expansion.

The paper was prepared by **O A Helstrup**, **M K Rahman**, and **S S Rahman**, **School of Petroleum Engineering, University of New South Wales**, Australia.

Fluctuations in the returned mud volume have often been observed when drilling HPHT wells.

There are several causes, one of which is due to an increased wellbore volume as a result of the high mud pressure required to control the well.

This, however, can give the driller the misimpression that the extra mud volume is lost to the formation due to wellbore breakout or fractures.

When the mud weight is reduced to prevent such a suspected mud loss, the formation quickly regains its original volume and the "lost" mud is returned.

This might again be misunderstood as a kick and the mud weight is increased immediately to prevent the suspected kick.

Repetition of this process a few times might eventually lead to an actual wellbore failure.

In their paper, the authors present a method to estimate the volumetric expansion of wellbores as a function of wellbore pressure and temperature.

The wellbore near-breakout/fracture pressure, which is of interest for this analysis, is established by considering different failure modes including helical shear, elongated shear and tensile fracture.

The increases in wellbore volume are estimated at this pressure as a limit below which the driller should not be fooled by the suspected breakout/kick situation and thus avoid wellbore failure.

The method is based on analytical and numerical approaches.

Analyses show that the diametric expansion of the wellbore may be in the range of centimeters at a critical pressure and temperature. Because of this, a deep well may consume a significant number of extra mud barrels before actual breakout occurs.

This might be alarming enough to lead the driller to suspect breakout/fracturing in the absence of any analytical guidance.

The authors provide a novel approach to analyze such a suspected situation during drilling at HPHT conditions.