

# Completions examines sand control, well cleaning

## EFFECTIVE SAND CONTROL

**THE CHAD DEVELOPMENT** Program presents a unique set of sand control completion challenges for Doba Basin Upper Cretaceous vertical wells. The development area contains three separate fields (Kome, Miandoum and Bolobo), with stacked reservoirs in these fields that have the following characteristics:

- Unconsolidated high permeability sands;
- Large average particle sizes;
- Broad particle size distributions;
- Sand layers separated by highly reactive shale;
- Separate oil water contacts for different sand intervals;
- Varying completion interval length, from a few tens of feet for a single sand to several hundred feet commingling several sands.

The challenge is to design an efficient and reliable sand control completion for each well given the unique characteristics. Selection of a completion method is based on well specifics and is jointly selected by a multi-disciplined completion team after careful review of geology, reservoir, completion and production issues.

To date, four types of sand control completions have been utilized: high rate water packs (HRWP); frac packs (FP); frac packs utilizing shunt tubes (FPw/Shunts); and open hole screen only completions (OH-SOC).

The authors will address the technical and operational hurdles associated with sand control completions in high permeability reservoirs and will also report on the results achieved with the various completion methods based on initial well test and clean-up data.

The authors will also address the multi-disciplined well completion team approach to design and installation of sand control completions.

*Effective Sand Control Completions in a Remote Location—Chad, Africa* (IADC/SPE 87199) **A D Witteveld, D W**

**Cutright, ExxonMobil Development Company; R C Ellis, Mullen Energy Corp; J E Hayes, Schlumberger.**

## COMPLETION PIPE DESIGN

Innovations in high performance tubular design as well as step change improvement to existing connector technologies has led to the development of a specialized drill pipe tubular with metal to metal pressure seal connections as a new completion pipe option. Maximizing



**The Chad Development Program presents a unique set of sand control completion challenges for Doba Basin Upper Cretaceous vertical wells. IADC/SPE 87199**

tool joint ID and shifting tube upsets to the exterior are options for minimizing flow restrictions, where high performance connections combine the robust configuration of a rotary shoulder connection with the pressure integrity of a premium connection. The dimensional flexibility of these durable streamlined welded high performance tool joints provides advantages not seen in typical API tool joints of threaded upset tubing connection configurations. Flexible connec-

tion configurations and optimized tubular design satisfy standard completion tubular profiles as well as very specific fit for purpose applications.

The authors offer solutions to completion engineers involved in planning and execution of critical completion operations in deepwater, extended reach and ultra deep wells. They will present key tubular design considerations for meeting torsion, tension, hydraulic, pressure integrity and pipe recovery method requirements of critical completion operations. Mechanical characteristics of assemblies and field performance of application specific completion assemblies are presented.

*Technological Advances in Completion Pipe Design* (IADC/SPE 87200) **B L Christian, M J Jellison, GrantPrideco; W T Walker, BHP Billiton; S J Tinker, BP Exploration; S Broussard, Sub Surface Tools Inc.**

## SCREEN COMPLETION

The authors will discuss the utilization and flexibility of expandable screens in open Hole environments and provide a case history of a significant world's first where a completion was set inside an expandable screen. The completion provided a single selective well, where one could selectively produce different zones in the reservoir. Isolation was provided by expandable packers in the open hole and a conventional completion packer inside the expandable pipe.

*World's First Completion Set Inside Expandable Screen* (IADC/SPE 87201) **M Gilmer, A B Emerson, Baker Oil Tools.**

## WELL CLEANING

The removal of drilling fluids from a cased well prior to installation of critical completion equipment often involves use of special fluids and equipment to ensure sufficient removal of both the drilling fluid itself and particles attached to the casing wall. Failure during this critical operation can lead to excessive complications in the completion operation, including stuck packers or formation damage due to particle invasion into the formation as a consequence.

The authors will outline the selections of casing cleaning tools and cleaning fluid systems designed to meet these technical objectives. They will describe how to select different scraping and brushing tools for the wells. The author will also describe in detail the displacement methods used to optimize removal of drilling fluid while producing as little drilling fluid slop volumes as possible.

This minimization of slop is necessary to fulfill national environmental requirements. The authors will present a detailed analysis on how casing cleaning fluids should be evaluated in the laboratory prior to the casing cleaning operation, and describe, through a selection of field cases, how the success of the casing cleaning operation can be monitored at the rig site.

*Well Cleaning Performance* (IADC/SPE 87204) **A Saasen, O Vikane, T H Omland, E Mathiassen, Statoil ASA.**

## **HELICAL BUCKLING OF PIPE**

It has been generally recognized that connectors should have some effect on the buckling of pipe. For example, the connector outside diameter may be as much as 50% greater than the pipe body diameter. As a result, the radial clearance of the connector can be substantially smaller than the radial clearance of the pipe body.

The author examines three-dimensional buckling of pipes with connectors with applied torque. The problem formulation is similar to Lubinski's buckling analysis: the wellbore is vertical and straight. The beam-column equations considered in the plane buckling analysis are used, but now there are deflections out of the plane.

A solution for helical buckling is developed that produces pipe sag, maximum dogleg angle, contact force, and bending stress magnification as a function of pipe effective axial force and torque. An application problem is solved and the relative effects of compressive axial force and torque on sag between connectors, contact loads, and maximum bending stress are examined.

Applications include the analysis of bottom hole assemblies, drill pipe, casing, and tubing. The solutions are simple enough that they are suitable for spreadsheet calculations.

*Helical Buckling of Pipe with Connectors and Torque* (IADC/SPE 87205) **R F Mitchell, Landmark Graphics.**

## **WELLBORE CLEANUP**

Many horizontal wells in Saudi Aramco fields are drilled using water-based mud. Generally, the drilling fluids are composed of xanthan, starch or cellulose polymers with bridging agents like sized calcium carbonate and salt particulates.

During drilling and completion operations it is essential to form a filter cake to control fluid losses, however, insufficient cleanup of the filter cake may lead to significant losses of well performance. Water jetting techniques were recently introduced to Saudi Aramco to cleanup the filter cake on par with enzymatic treatment.

In multilateral and horizontal wells with an openhole completion in carbonate reservoirs, an external filter cake cleanup process was performed separately in each lateral using water jetting technique and enzymatic treatment. The external filter cake was cleaned by high-pressure water jetting.

The polymer layer of the filter cake deposited in the main horizontal section was cleaned by a specific enzyme treatment. The bottom hole temperature for main, first and second lateral are 84°, 76° and 71°C, respectively. The length of the target zone for the main, lateral 1 and lateral 2 ranges from 3,000 to 7,000 ft. The reservoir pressure is 2,400-2,500 psi.

Fluid losses were monitored during cleanup of the filter cake by water jetting method and it was from 40 to 60%. Flowback samples were collected and the amounts of calcium carbonate and carbohydrates in these samples were measured to determine the efficiency of filter cake cleanup.

Field data indicates that utilization of this sequential cleanup technique is less costly and very successful in removing filter cake. The authors will present various aspects of water jetting, field data and lab results based on the analysis of well flowback samples.

*Wellbore Cleanup by Water Jetting and Specific Enzyme Treatments in Multilateral Wells: A Case Study*

(IADC/SPE 87206 – Alternate) **M B Al-Otaibi, H A Nasr-El-Din, M A Siddiqui, Saudi Aramco.**

## **MULTILATERAL WELLS**

The combination of multilateral and intelligent well system technologies can lead to future wells offering maximum reservoir and production efficiency.

Although both multilateral and intelligent well technologies have been available to the industry for many years, it is only recently that wells offering both capabilities have been installed. One reason for this hesitation in recent years has been the perceived risk of each technology and the concern with overall project risk when considering a combination of the two technologies.

But many of today's multilateral and intelligent well systems have evolved to the point that low risk, highly flexible combinations of these two technologies are fully compatible and feasible in a variety of well situations.

A cost-effective Technology Advancement Multilateral (TAML) level 3 junction system was successfully installed in three horizontal dual-lateral production wells in the Mukhaizna heavy oil field. The junction allows for installation of 7-in. liners in both legs and selective access to each leg while providing suitable barriers to sand production.

The authors will highlight a recent well installation in Oman that successfully utilized both multilateral and intelligent well technologies. The intelligent completion was installed in conjunction with a shrouded electrical submersible progressing cavity pump (ES-PCP) lift system, a world's first.

The single-valve hydraulic-operated system allows semi-selective zonal control and production testing for cost-effective reservoir management. In addition to offering the flexibility demanded of a high technology well, this well also shows that such a system can be easily installed with minimal risk.

*Multilateral/Intelligent Wells Improve Development of Heavy Oil Field - A Case History* (IADC/SPE 87207 – Alternate) **P J Rump, Baker Oil Tools; R Bairagi, J E Fraser, K Mueller, Petroleum Development Oman.** ■