

# Completion session looks at milling, perforating

## MILLING ISOLATION VALVE

**AS WELL TRACTOR** technology evolved and confidence was gained during the last few years, the application of a cost efficient method for milling of specific downhole hardware (i.e. valves, plugs etc.) as an alternative to existing technologies has emerged.

The technology is specifically needed on offshore installations where the logistical challenges can be noticeable. The author will describe the operation and the process of developing the technology.

The development of wireline drilling utilizes the well tractor features to achieve weight on bit and reactive torque control, while designing specific bits for corresponding applications based on an approach of "surgical" intervention. The added advantage is that the risk of getting the toolstring stuck has been virtually eliminated by targeting a well defined area within the object itself.

The first operation milling of a blocked borehole with wireline was conducted in late 2003 on a newly installed platform in the North Sea. The total operational time in the well for the entire milling operation was nine hours from rig-up to rig down with the milling itself taking seven minutes.

*Milling of Isolation Valve With Wireline Conveyed Technology* (SPE/IADC 92024) **C Kruger, Welltec.**

## THROUGH TUBING SIDETRACK

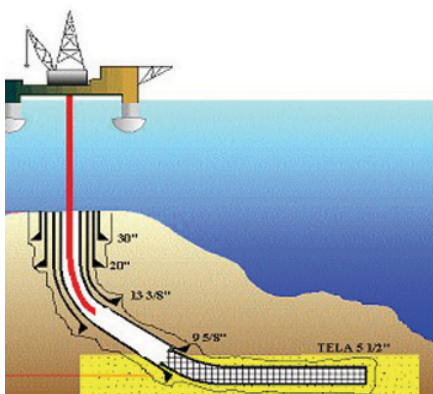
Low cost reservoir access is a key component to sustaining production from maturing fields. Coiled tubing drilling (CTD) and through tubing rotary drilling (TTRD) can achieve significant cost savings by sidetracking through existing production tubing.

However, the critical completion phase of these sidetracks is challenged by small clearances and equipment. During the course of completing over 450 CTD sidetracks through 4-in. and 3-in. production tubing in Alaska, a number of innovative completion designs have been developed to achieve zonal isolation, maximize production, allow for selective multilateral production, and preserve the parent wellbore for additional sidetrack opportunities.

The authors will detail specialized liner

cementing equipment and techniques and provide design and operational guidelines for several proven through tubing completion options.

Continuous innovation and close collaboration with the service industry has yielded successful solutions for challenge-



**Sand control options are a major issue in the Campos Basin offshore Brazil and gravel packing is a strong candidate if pressure loss issues can be overcome.** SPE/IADC 92428.

ing through tubing completions. These proven techniques have positioned CTD as the preferred method for reentry sidetracks on the North Slope and maximized reserves recovery. The completion options discussed in the paper may make low cost through tubing sidetracks more feasible for other mature fields.

*Unique "Through Tubing" Sidetrack Completions Maximize Production and Flexibility* (SPE/IADC 92392) **M O Johnson, BP; P G Hyatt, BP Exploration (Alaska); L L Gantt, ConocoPhillips Alaska; T O Stagg, Orbis Engineering.**

## COMPACTION CONSIDERATIONS

King West field is located offshore Louisiana in 5,430 ft of water. Due to the ultra-weak nature of the pay sands, reservoir compaction and long term completion integrity were ranked as the key issues for completion design.

A series of evaluations were conducted including assessing the reservoir compaction, mudline subsidence and associated long term casing and completion loading as a function of field life.

A spectrum of special hardware design accommodating compaction loading in completion string including telescope

joints in tubing and blank pipe, and different screen and base pipe designs were assessed and final design was based on the compaction loading assessment results.

The novel piece of the work is the 600 ft long numerical formation/casing/completion interaction model. It covers the interval between the FracPac packer and Sump packer, which are the contacting points through which the compaction load from formation and casing are transferred to the completion string.

The structure component modeled included the FracPac packer, the blank pipe, the telescoping joint, the base pipe and screen assembly, gravel pack, and lower sump packer. The model simulated compaction load transferred to the completion string due to the pressure depletion of the reservoir sands.

The assessment revealed that King West field is only moderately rated for the compaction load. The original completion was over designed for compaction load. The completion was redesigned and over \$50,000 was saved in one well due to the study.

*Compaction Considerations for Gulf of Mexico Deepwater King West Completion Design* (SPE/IADC 92652) **X Li, S M Wilson, BP America; S J Tinker, G J Simms, BP; M S Bruno, Terralog Technologies.**

## GRAVEL PACK PLACEMENT

The new scenario for offshore development in Brazil includes heavy oil fields in deepwater where 2,000 m horizontal sections are required. Sand control options are a major issue and gravel packing is a strong candidate if pressure loss issues can be overcome.

Gravel packing is today the most frequently applied sand control technique in Campos Basin. Due to critical conditions such as the deep and ultra deepwater and low frac gradients, a lot of precision is required to assure gravel packing success.

Most models available in the industry for horizontal gravel pack design are essentially empirical, resulting in imprecise predictions for extrapolated conditions.

These aspects were the main motivators for a research project including theoretical and experimental development. A

mechanistic model was developed to calculate the pressure loss during the displacement, including sand injection and alpha/beta waves propagation, taking into account fluid leakage, multi zonal isolation and beta wave pressure reduction optimization.

*Gravel Pack Placement Limits In Extended Horizontal Offshore Wells* (SPE/IADC 92428) **A L Martins, A Calderon, Petrobras.**

## VACUUM INSULATED TUBING

Deepwater completions often involve production volumes that expose wells to high pressures and elevated temperatures. For sealed casing annuli, transfer of heat from tubing to casing can lead to trapped annular pressure (TAP) buildup and eventually casing string collapse.

Vacuum insulated tubing (VIT) keeps the heat inside the production tubing and reduces the TAP severity. However, such completions pose significant challenges for selecting suitable VIT tubulars to ensure long-term reliability under combined loading.

The authors present a methodology and a software program for design of VIT strings, and findings of an evaluation program of VIT under conditions typical for ChevronTexaco's Tahiti project in the Gulf of Mexico.

A unified approach to the design and evaluation included a closed-form solution of the VIT stress-strain state under combined loading, a parametric finite element analysis with simulation of interactions within end connections, and a full-scale test of a VIT specimen under cyclic thermal and mechanical loads anticipated in field service.

*Vacuum Insulated Tubing Design and Performance Evaluation for Deepwater Completions* (SPE/IADC 92448) **J Nowlinka, J Xie, P Kis, C-FER Technologies; M E Gonzalez, R Hensley, ChevronTexaco; D D Williams, Shell E&P.**

## SELECTIVE PRODUCTION

The Snorre license in blocks 34/4 and 34/7 of the Norwegian North Sea was the first to install surface operated zonal isolation to allow selective production from different sections of the reservoir.

Downhole Instrumentation and Control Systems (DIACS) has been further developed and refined and is used today by many operators.

The Snorre field remains at the forefront of this development and the technology has been employed in a further 17 wells, both injectors and producers, across the field. The Snorre reservoir is highly heterogeneous and faulted and consists of layers with differential pressures of up to 150 bar. This has led to many instances of rapid water and gas breakthrough in individual zones, while other layers have remained largely undrained.

The use of DIACS has led to improved reservoir exploitation and has formed the basis for implementation of the concept as the preferred completion solution for the northern area of the field, via the Snorre B platform.

The authors will focus on the use and advantages of advanced completions from both a reservoir and production engineering viewpoint.

They will summarize experience gained with regard to mechanical aspects of the completion hardware, data collection and management, and discuss future plans and expected benefits of this type of completion system.

*Use of Advanced Completion Solutions to Maximize Reservoir Potential Experiences in the Snorre Field* (SPE/IADC 92255) **L T Skarsholt, A F Mithcell, A Bjornsgaard, Statoil.**

## FORMATION DAMAGE

One of the highest risks in well completions is formation damage caused by perforating. Fractured and compacted zones, perforation gun debris and broken formation blockages are common types of damage that can occur inside the perforation tunnel.

Reducing or eliminating initial perforation damage can result in a more productive well over its lifetime.

The authors examine a completely new technology for perforating wells in unconsolidated formations that eliminates explosive perforation discharges and the associated formation damage risk.

This new technology also reduces the cost of well construction by allowing the production liner, perforating, primary cementing, and sand control tools to be run in a single trip.

The tool system uses telescoping tubes that extend from the liner into the formation by hydraulic and mechanical pressure.

Once the tubes are extended (or telescoped), the liner is cemented in place.

The tubes form tunnels from the formation and contain sand-control media. This new completion method eliminates gravel packing and minimizes intervention in completion operations, saving substantial rig time.

The system does not require large fluid-pumping treatments or high horsepower, which simplifies operational logistics especially in remote or offshore environments.

The authors describe initial field test results of the new system, cost comparisons with existing methods, and expected economic benefits over the lifetime of wells in typical applications of this new technology.

*Novel Completion Technology Eliminates Formation Damage and Reduces Rig Time in Sand Control Applications* (SPE/IADC 92596-Alternate) **P M McElfresh, Baker Hughes; G L Garfield, Baker Oil Tools.**

## DRILLABLE PERFORATING

This case-history paper presents accounts of several field applications of a drillable perforating system (DPS) that has been used on 400 jobs in the Gulf of Mexico with a near-100% success rate.

The author describes the use of a system to perforate underbalanced, perform plug-to-abandon operations, block squeezes, and other operations.

The DPS can be used to cement and perforate in underbalanced conditions, limited-entry in-flow testing, cementing with clear fluids, and plugging and abandoning wells.

The author will present results that show the DPS to be an effective alternative to conventional perforation and squeezing methods now followed in the oil and gas industry.

In case histories to be presented, significant rig time was saved, along with savings in material and time to first sale after application. DPS offers several advantages over conventional equipment and techniques.

*Drillable Perforating System Saves Effort and Rig Time* (SPE/IADC 92279-Alternate) **J Ortiz, R L Hinkle, Halliburton Energy Services.** ■