New completion tools, methods prove successful

COILED TUBING (CT) has been in use in the oil and gas industry since the early 1960s, but only in the past 10 years has it become viable for drilling. The application of coiled tubing drilling (CTD) is rapidly gaining acceptance because it can lower costs, improve well performance and meet site-specific specifications.

The "Coiled Tubing and Completions" session at the 2002 IADC/SPE Drilling Conference in Dallas, 26-28 Feb, explores the technology and its application.

The session is chaired by **J H Moss**, **ExxonMobil Development Corp** and **S D Gomersall**, **Schlumberger**.

MULTILATERAL ACCESS

The authors of IADC/SPE paper 74491, "Selective Coiled Tubing Access to All Multilaterals Adds Wellbore Construction Options," describe the ongoing development of a new lateral reentry system that provides access to all levels of multilateral wells. The paper was prepared by **H Wortmann**, **L Leising**, **P C Bunaes** and **E Nees**, **Schlumberger**.

The inability to selectively enter Level 1 and 2 lateral extensions (classifications of the Technical Advancement of Multilateral wells, TAML) has traditionally limited rig-based coiled tubing operations in these wells, according to the authors. Although coiled tubing as a means to work in live wells offers advantages in the late stages of well construction, until recently no reliable coiled tubing reentry technique was available.

The new system includes a reentry bottomhole assembly, which consists of a surface-controlled orienting tool and a controllable bent sub. The system identifies the window of the selected lateral before attempting reentry, and confirmation of successful identification and entry is visible at the surface through a software-displayed pressure log.

The technique does not require a wired coiled tubing string; the corrosion-resistant reentry tool is operated solely on flow and is conveyed with standard coiled tubing equipment.

Field examples demonstrate the success of this system in reentering a designated lateral on the first attempt for operations such as matrix stimulation and openhole formation wash treatments. Current developments enlarge the scope of applications to wellbore logging and high-efficiency wellbore fill and deposit removal.

With the introduction of a new reentry technique, operations such as openhole formation washes, selective matrix stimulation, production logs and nitrogen kickoff operations can be performed on coiled tubing in live, flowing multilateral wells, according to the authors.

The ability to access all levels of multilateral wells with coiled tubing adds a new planning and contingency option to the operator's and driller's decision matrix for the drilling and completion phase.

DEEPWATER FRAC PACKS

Tools and techniques developed while completing 81% of the horizontal open hole gravel packs in deepwater developments off Brazil and frac completions in deepwater Gulf of Mexico are described in IADC/SPE paper 74492.

The discussion covers well planning, pumping operations, frac pack design, multilateral applications, material selection, extended-longevity well screens, dynamically positioned floating rig operations and fluid systems that prevent formation damage.

"New Tool Designs Prove Successful for Deepwater Frac packs and Horizontal Gravel Pack Completions" was prepared for the Conference by **L E Hill Jr**, **Baker Oil Tools**; **A C Neto**, **Petrobras**; **C F Bayne**, **E E Ratterman** and **P D Baycroft**, Baker Oil Tools; and **A Amarai S**, **Baker Hughes do Brasil Ltda**.

Open hole horizontal wells are becoming a preferred completion in the deepwater market because the approach eliminates a liner and allows a larger wellbore at the reservoir. This method also provides extensive reservoir exposure. Linking this technology with multilaterals can significantly reduce the number of wells required to adequately drain a reservoir.

Thirty-nine openhole completions have been successfully performed in the Marlim and Roncodor deepwater fields of Brazil, the authors report.

Advanced technology helped install horizontal open hole gravel packs in Brazil's deep water.

These include completions in both horizontal producers and injectors. Four Level 5 multilateral well bores with open hole completions have also been successfully installed in the same fields.

Multilateral completions are classified by Levels 1 through 6, depending upon junction functionality. Levels 5 and 6 multilateral systems are the focus of this discussion. These levels provide pressure integrity at the junction. The Level 5 multilateral consists of a cased and cemented main bore and lateral with packer isolation assemblies to achieve pressure isolation at the junction.

Level 6 multilateral systems achieve pressure integrity at the junction without packers and seal bores.

The dramatic increase of frac packing in deepwater Gulf of Mexico has intensified engineering efforts to meet the demands specified by the operating companies for fracturing high perm formations.

Frac pack applications in deepwater can require pump rates of 40 bpm with proppant concentrations of 15 ppa.

Specialized tools and performance software have advanced to address the increasing demands and risk management required in today's deepwater market, according to the authors.

With well life completions and operational risk minimization being required for deep water, operators are choosing best in class sand control techniques and technologies for both open hole horizontals and hydraulic fracturing.

These latest technical advancements have enabled the application of well life sand control in low fracture gradient reservoirs with lateral lengths successfully gravel packed at lengths exceeding 2,576 ft in water depths of 6,163 ft.

Enabling low operational risks of frac pack completions and open hole gravel packing, it has become possible to successfully achieve well life longevity and optimum field economics required for deepwater field development.

POLYMER-FREE FLUIDS

IADC/SPE paper 74493 presents the completion procedures applied to a 4-well sub-horizontal gas reservoir development in the Norwegian North Sea using open hole gravel packing as the sand face completion technique.

"Polymer-Free Fluids: A Case History of a Gas Reservoir Development Utilising a High Density Viscous Gravel Pack Fluid and Reservoir Drilling Fluid," was prepared for the Conference by **G K Bye**, **Statoil ASA**; **E Morris** and **S Campbell**, **Schlumberger**; **D Knox** and **C Svoboda**, **M-I Drilling Fluids**; and **K O Tresco**, **TBC-Brinadd.**

Accepted operator practice is to drill these wells with conventional barite-laden water based mud and complete using the alpha-beta water packing technique, according to the authors.

Achieving a complete pack has historically been difficult, and post-gravel-pack stimulation is undesirable due to time required, corrosion potential and the low chance of success due to the high solids content of the filter cake. For this development, a gravel packing system utilising internal bypass "shunt" tubes and a viscous gravel pack fluid was recommended to ensure complete packing efficiency.

The use of shunt tubes removes the requirement for a filter cake sealed wellbore to maintain total returns, so a low-solids, chemically degradable filter cake could be applied.

This allowed the option for a chemical breaker to be included in the gravel pack fluid, the authors report.

The reservoir pressure on this field required relatively high density reservoir drilling and gravel pack fluids (1.65 sg/13.75 ppg). The authors describe the design and development work involved in formulating mutually compatible, calcium bromide based reservoir drilling fluid and a viscoelastic surfactant (VES) based gravel pack fluid.

These wells marked the first applications of a calcium bromide-based VES based gravel pack fluid and shunt tube gravel pack technology in the Norwegian sector of the North Sea, as well as some of the earliest uses of a biopolymer-free reservoir drilling fluid.

The wells were subsequently drilled and gravel packed with a high degree of success, the authors report.

FLOW CONTROLS

Since the installation in 1997 of the first intelligent completion in the North Sea, completion engineers have continued to discuss the pros and cons of remotely operated downhole controls.

The most controversial of downhole control mechanisms incorporates electronics, although both high temperature tolerance and effective debris management must be addressed.

The use of multiple and iterative methods of reliability testing of electronic controls in downhole environments has diluted this controversy and resulted in the increase in hydraulic alternatives. Operators promote reliability analyses for their downhole components and parent systems and particularly for the hydraulic sliding sleeve, the simplest of remote operated downhole controls.

In IADC/SPE paper 74494, author **R Prasad**, **Weatherford International Inc**, reviews the reliability of remotely operated downhole hydraulic control valves and compares them with more mature technologies, namely the downhole surface controlled subsurface safety valve (SCSSV).

By so doing, a case is made that, though downhole electronic systems will become more viable in the future, opportunities currently exist for the use of flow control tools having user-friendlier downhole telemetry systems such as simple hydraulics.

Mr Prasad's paper is "How Intelligent Should Well Completions' Flow Controls Be? A Review and Comparison with More Mature Technologies."

Reliability routines have been proven in other industries, and in other oil and gas sectors, to assist in evaluating the risks during the design and manufacturing processes of system components and their interfaces with both telemetry and mechanical hardware. The riskiest processes during well completion are those with unplanned incidents, notes the author.

Most of these contingencies have been identified and mitigated for mature technologies such as surface controlled subsurface safety valves (SCSSVs) through experience and through performance and reliability testing. Commonality between these SCSSVs and other downhole hydraulic flow controls lends a valid comparison for establishing the reliability of the latter systems, according to the author.

Thus, mapping the systems' failure modes and risks can help to define both design constraints and criticality of function. As the technology of downhole hydraulics proves more reliable, newer technological challenges arise, such as variable flow volume controls and their flexibility of optimization.

This stage requires more reliable interfaces and standards between providers of both wellhead control and downhole systems, and between production data and reservoir modeling.

SOUND CTD PRACTICES

IADC/SPE alternate paper 74495 presents a comprehensive review of sound practices to be followed in coiled-tubing drilling (CTD) operations on land-based and offshore rigs. "Sound Practices for Coiled-Tubing Drilling," was prepared by **T E Williams**, **Maurer Technology Inc**; **S L Ward**, **Advantage Energy Services Ltd**; **C M Hightower**, **Consultant**; and **R C Long**, **DOE National Energy Technology Laboratory**.

With a high priority on operational CTD safety, the authors describe in detail the pre-job planning process, operations execution process and post-job review process.

A flowchart containing 19 nodes leads the CTD planner logically through a feasibility study that determines whether the project should be attempted with coiled tubing.

The authors address, among other subjects:

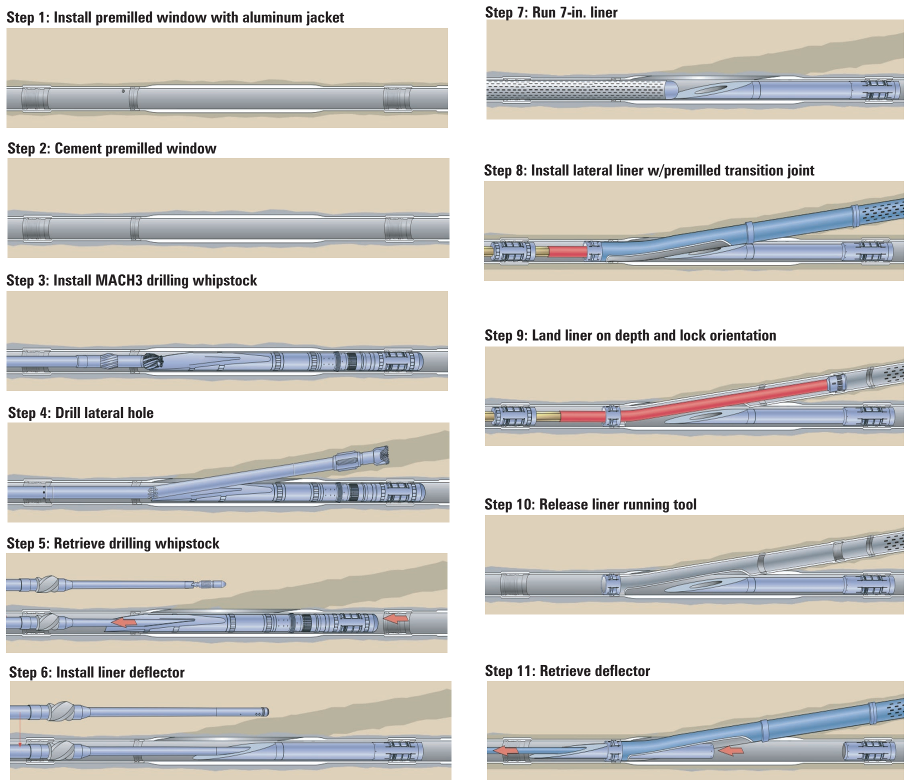
- Well and site preparation;
- CT equipment and capability assessment;
- Well-control equipment and procedures;
- Directional planning;
- Drilling fluids and wellbore hydraulics;
- Window milling;
- Openhole logging;
- Wellbore tubulars and wellheads;
- Liner cementing;
- Well planning;
- Operational procedures;
- Safety during operation;
- Maintenance.

Equipment available for CTD includes the most advanced CT units in the industry; however, many operational problems have been encountered. Most of these problems are not addressed in any current publication.

The **US Department of Energy**, National Energy Technology Laboratory (NETL) and the **US Department of the Interior Minerals Management Service (MMS)** have funded an industry effort to compile a comprehensive CTD manual that captures lessons learned by major oil companies and service companies who have led the way in CTD.

The manual will address many of the concerns expressed by the MMS in its April 3, 2000 MMS Safety Alert “Coiled Tubing Incidents,” by special focus on safety in CT operations.

MACH3 system installation



NEW LEVEL 3 SYSTEM

In the last 2 years, there has been a dramatic increase in the pace of the evolution of multilateral systems.

Many systems with new features and improved functionality have been introduced which have enhanced the application of multilateral technology.

The system described in IADC/SPE alternate paper 74496 is among the latest of these offerings.

“A New TAML Level 3 Multilateral System Improves Operational Efficiencies and Capabilities,” was prepared for the Conference by **J P Oberkircher** and **S Fipka**, **Sperry-Sun Halliburton Energy Services**.

This innovative new system is a TAML Level 3 system that has been designed to provide a simpler and faster method of completing multilateral junctions.

It will greatly reduce the amount of rig time required for multilateral junction construction, according to the authors, by eliminating the cementing and washover operations of conventional Level 4 systems.

However, the new system does not incorporate all of the features of conventional Level 4 systems.

The new system also is mechanically very simple to run, requiring a minimal number of trips to establish the junction and achieve mechanical integrity.

Primarily designed for heavy oil applications where ease of installation is a major issue, the system has potentially far reaching applications in the heavy oil market as well as other markets.

The new system includes an oriented, pre-milled transition joint that provides near full-bore access to the lower main bore.

This large joint will allow running in pumps and other artificial lift mechanisms larger than those that are now possible.

The transition joint is connected to a 7.00-in. lateral liner at one end, while the other end is “lapped” back into the main bore and locked into the upper coupling of a standard 9.625-in. RMLS pre-milled window joint.

The new system also incorporates a new latch collet design, as well as the new custom-designed Liner Setting Tool (LST). ■