Horizontal, Multilateral Well Advances Addressed in Malaysia

Horizontal and multilateral wells took center stage at an SPE Applied Technology Workshop (ATW) held earlier this year in Penang, Malaysia. The workshop, titled "Maximizing the Value of Horizontal and Multilateral Wells: New Challenges, Technologies, and Approaches," gathered 70 participants from around the world for discussions aimed at addressing new applications of multilateral and horizontal well technologies.

The ATW included sessions reviewing lessons learned in drilling horizontal and multilateral wells, as well as the new technology offerings that promise to maximize oil and gas production from them. The specific range of topics included field-development planning, reservoir evaluation, the use of intelligent technology for efficiency gains, drilling and completion issues, and stimulation.

The ATW's opening session provided an overview of the development history of horizontal and multilateral wells within Saudi Aramco. Current well practices are built upon learnings from past experiences in the areas of reservoir characterization, well placement, well-structure optimization, and intelligent completions to yield maximum production benefit. The opening session also encouraged attendees to focus on tackling the challenges of applying this technology in today's energy and economic environment.

Technology Overview

The industry organization Technical Advancement of Multilaterals (TAML) opened the technology overview session with a review of its programs designed to promote global development and utilization of multilateral technology within the industry through open dialog and information exchange.

Apache Corporation next provided an operator's perspective of development strategies in planning horizontal and multilateral wells. Emphasis was placed on ways to maximize hydrocarbon recovery while also keeping costs to a minimum. Investment and asset development were analyzed through the entire asset lifecycle, from discovery to decommissioning. An operator considering a horizontal or multilateral completion solution must carefully evaluate the suitability of the design concept for each asset, from both a cost-effectiveness and safety/risk point of view.

Drilling and Completion

While discussing specific drilling- and completion-related issues, attendees agreed that a thorough understanding of how a particular drilling or completion design scheme may impact other disciplines is vital. For example, during the development plan for a multilateral well it is important to consider the geology and condition of the reservoir, as well as future plans for production, stimulation, and intervention. Field examples from both an operator (OMV New Zealand) and a service provider (Baker Oil Tools) illustrated the importance of having a multidisciplinary team work together to consider the various factors in their drilling and completion design, which are not limited to:

- Debris management
- Depth control and orientation
- Contingency plans and risk assessment
- Intervention and plug/abandonment
- Sand control: screen, openhole gravel pack or cased-hole fracture pack

Reservoir Modeling

In a reservoir-modeling session, Saudi Aramco presented a state-of-the-art approach using an integrated single-well/sector/full-field model to optimize reservoir performance. Several examples illustrated the efficiency of the approach for complex reservoirs with advanced applications.

StatoilHydro provided a field example of how swell packers can be used as inflow-control devices (ICDs) in intelligent wells to help optimize reservoir recovery in Norway's Troll Field. The ICDs delayed water breakthrough and increased total production with a more evenly distributed inflow profile along the horizontal laterals.

Modeling reservoir flow in naturally fractured reservoirs is always a challenge, but a presentation by Stanford University showed a promising approach employing unstructured gridding and discretization for fractured reservoirs.

Reservoir Surveillance

An overview of the unique challenges of production logging in horizontal wells was given by Texas A&M University. The overview also discussed the potential and operational fundamentals of the next generation of logging tools for horizontal wells. Particular emphasis was placed on the use of standard temperature-logging tools or downhole distributed temperature sensors to collect real-time temperature data that can be used to provide a better understanding of reservoir and well performance.

Petronas discussed the challenges of avoiding water production in horizontal wells, stating that accurate reservoir characterization upfront is critical. Because remedial operations to eliminate water producing zones are complicated and risky in horizontal laterals, proper well design must include means for preventing water inflow. The company has had suc-

cess employing ICDs to delay water breakthrough in their horizontal and multilateral wells.

Production Optimization

This session shared some powerful simulation-modeling tools designed to optimize the performance of horizontal wells and thus maximize revenue. SPT Group illustrated the effectiveness of dynamic modeling in optimizing production from horizontal wells; a series of case studies demonstrated how the information generated from a dynamic model was consistently validated against field data.

Schlumberger demonstrated how proper modeling tools could minimize uncertainties associated with setting flow-control valves in horizontal wells, thus helping to maximize the net present value of the investment. Next, a case study from Shell's Sarawak Field emphasized the importance of integrated modeling and production optimization to maximize the benefits of horizontal and multilateral wells. Finally, Saudi Aramco showed how to optimize horizontal wells equipped with ICUs using an ensemble Kalman filter method. The method is fast and efficient in identifying the optimization setting to maximize a theoretical net present value.

Stimulation

In the session reviewing stimulation of horizontal wells through hydraulic fracturing and acidizing, a new completion tool and procedure for multistage fracturing was introduced by Packers Plus. The presentation demonstrated through field data that the tool can simplify a horizontal completion and dramatically reduce installation time.

Texas A&M University led the discussion on acidizing of horizontal wells. The discussion covered the multiple physical and chemical phenomena involved in horizontal-well acidizing and highlighted several factors affecting the success of the stimulation technique, such as wellbore flow effect, reservoir heterogeneity, and the injection method used.

Intervention

Intervention is a critical subject during the entire lifetime of a horizontal well, a point clearly made during the session's opening presentation by Halliburton. Past, current, and future intervention methods were reviewed, as well as their unique functions. While considering a multilateral well, the operator must realize that the initial investment in a multilateral junction/completion design will increase upfront costs. However, it will be useful should future intervention needs arise, thus saving the project money in the long run.

A new multilateral-well testing method using reference laterals was presented by Saudi Aramco. The method can obtain the necessary information for production, intervention, and stimulation with a minimum of operating procedure and time, promising to open up new channels for well testing.

Monitoring and Control: Intelligent Completion Applications

WellDynamics opened the session on intelligent completions with a brief history lesson on the technology employed. They stressed that continuing advances in intelligent completions have the potential to lead the industry toward its goal of active reservoir management, provided the issues of downhole power and communication are addressed.

Shell highlighted the critical functions of intelligent technology to optimize production, provide real-time reservoir information, and provide well control. Fundamental dilemmas with the technology were also addressed, namely, that smart wells are complex, instrumentation is expensive, and agreement between a model's output and field data is difficult to achieve. A field case study illustrated how an intelligent completion helped an operator monitor gas production and reuse the produced gas for gas lift of the well.

Texas A&M closed out the session by reviewing the correct design of intelligent completions to ensure maximum benefit. The discussion addressed the questions of how much equipment and what level of sensors are sufficient for appropriate deployment, and highlighted that overdesign using higher grade or more equipment should be avoided. Once again, downhole temperature data from distributed sensors was discussed as providing invaluable reservoir information. **JPT**