PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Petroleum Exploration and Production

06/2005

MICROHOLE SMART STEERING AND LOGGING WHILE DRILLING SYSTEM

PARTNERS

Baker Hughes Oilfield Operations, Inc.
Houston, TX

MAIN SITE

Baker Hughes Oilfield Operations, Inc.
Houston, TX

Background/Problem

DOE's Microhole Technology Initiative focuses on developing a suite of technologies for drilling ultra-small diameter boreholes and deploying related microinstrumentation in order to reduce the costs, risks, and environmental impacts of America's oil and gas wells.

State-of-the-art bottomhole assemblies available for coiled tubing drilling of a 3½-inch diameter microhole horizontal well tend to drill holes that are not smooth and straight. This leads to higher friction when sliding the coil, which limits the maximum horizontal extension that can be drilled with coiled tubing equipment.

Currently available coiled tubing bottomhole assemblies also lack formation evaluation and logging-while-drilling tools suitable for microholes. In order to keep the well within the target zone and above the oil-water contact, resistivity measurements taken during the drilling process are needed to provide instantaneous information about the distance to the water boundary. This allows the well to be drilled for maximum recovery and with minimum risk of water invasion. Furthermore, without the availability of formation evaluation sensors, trapped hydrocarbons along the well path are difficult to detect.

Project Description/Accomplishments

The objectives of this project are to design and build a 1) smart drillbit steering motor integrated with a high-performance downhole motor and a 2) logging-while-drilling formation resistivity evaluation sensor that provides real-time information about the rock being drilled.

A 2⅜-inch diameter rib steering motor (RSM) is being designed to serve a 3½-inch or smaller diameter hole. Modules are being designed so that they can fit seamlessly in the commercially available modular 2⅜-inch CoilTrak™, a coiled tubing drilling assembly. Hydraulically powered, moveable ribs on the RSM will generate steering forces in every direction, allowing smooth curves and straight borehole sections to be drilled.

A multiple propagation resistivity (MPR) tool also is being developed for microholes that will allow true real-time geosteering, with instantaneous steering actions based on resistivity and gamma measurements.

Project accomplishments include the development and evaluation of a number of RSM design concepts. One design has been selected for further detailed layout. The final designs of the following functional subassemblies have been made: the hydraulic system, motor section (rotor, stator, flex shaft), steering unit (rib body and steering ribs activated by a hydraulic piston), and bearing section (drive shaft and specialized axial

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PROJECT DATA

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Total Project Value
$986,084

DOE/Non-DOE Share
$737,000/$249,084

CUSTOMER SERVICE

1-800-553-7681

WEBSITE

www.netl.doe.gov

and radial bearings). The design of all these subassemblies and the complete RSM tool has been finalized, and all parts have been modeled in a 3-D CAD program.

The final design for the MPR tool also has been defined. The communication system to transfer resistivity information to the surface consists of a downhole transmitter and a surface receiver. Tests of the system verify that the required 400 kHz and 2 MHz signals can be used successfully in the transmitter-receiver array.

The next step will be to work through the detailed design process to reach a critical decision point: whether or not to enter into the manufacturing stage. A decision is expected by June 30, 2005. If that decision is a "go," then Baker Hughes INTEQ will manufacture two prototypes of each tool and test them in the lab, as well as in the field.

Benefits/Impacts

The advanced drilling, steering, and logging bottomhole assembly for coiled tubing drilling of microholes is expected to enable faster drilling, increased well path accuracy, improved hole quality, and longer horizontal sections. The improvements in drilling and logging-while-drilling will increase production while decreasing the number of wells needed.

Lower costs and decreased operating and environmental risks of drilling smaller-diameter holes with minimized drilling fluid volumes and smaller-footprint rigs should make the technology ideal for producing remaining oil in shallow, mature US reservoirs. This revolutionary new approach to drilling America's oil wells could spawn a wave of new step-out wells, lateral deep perforations, and deepened wells to improve recovery of domestic resources.

If the technology anticipated from this project is developed and deployed, it is estimated that as many as 5,000 new wells or re-entered wells per year are possible as a result.

Baker Hughes's 2⅜-inch CoilTrak™ coiled tubing drilling assembly. The project will develop a geosteering device and a resistivity module to add to this commercially available drilling assembly.