Small, Mechanically Assisted High-Pressure Waterjet Drilling Tools

DE-FC26-05NT15484

Goal

The goal of this project is to produce a high-pressure jet-drilling system that will dramatically reduce the torque and thrust required for drilling, thereby increasing reliability, drilling rate of penetration (ROP), and lateral reach.

Performer

Tempress Technologies, Inc.
Kent, WA

Results

Project researchers have:

- Completed review of the jet drilling system commercial market, configuration, and sizing, including integration with microhole-sized coiled tubing drilling (CTD) equipment.
- Completed modeling and designs for gas separator, intensifier, jet drill, and circulation in coiled tubing.

Benefits

The economic benefits of the high-pressure waterjet microhole CTD system are derived from both increased capabilities and reduced drilling costs. This drilling system will be able to drill deeper and farther in deviated wells than current coiled tubing technology because of 1) increased downhole power, 2) the ability to drill underbalanced, 3) improved cuttings transport, 4) reduced tendency to stick in the hole, and 5) increased drilling efficiency in pressure-sensitive shales. Other economic benefits result from the decreased hole size. When the volume of a 3½-inch diameter hole is compared with that of a conventional 8½-inch diameter hole, 83% less fluid is required to fill and circulate the microhole.

Background

Small downhole positive-displacement motors (PDMs) have limited power output and are prone to stall when run with aggressive polycrystalline diamond compact bits. PDMs are designed to operate at a limited pressure differential on single-phase, water-based mud. Also, as lateral reach increases, the thrust available for mechanical drilling drops due to coiled tubing friction and helical buckling. Drilling with high-pressure fluid jets makes more efficient use of available downhole power and has proven effective in most rock formations. High-pressure jet drilling dramatically reduces the torque and thrust required for drilling, thus increasing ROP and lateral reach.

Tempress jet drill (top). Sandstone showing, 1.165-inch diameter tool face and tight-gage hole (bottom).

Summary

This project involves the development of a downhole intensifier (DHI) to boost the hydraulic pressure available in conventional CTD to the level required for high-pressure jet erosion of rock. The first phase of the project consists of three major tasks:

- Analyzing the CTD system to define operating parameters for the drilling assembly (completed).
- Designing the downhole intensifier, jet drill, PDM motor modifications, and drillbit.
- Fabricating and testing components.

A review of high-pressure jet drilling and mechanically assisted jet drilling was carried out to define the bottomhole assembly (BHA) configuration and DHI performance specifications for CTD applications. Two BHA configurations were evaluated: mechanically assisted high-pressure jet drilling with the DHI deployed below a PDM drill motor and high-pressure jet drilling with the DHI deployed upstream of a rotary jet drill.

The analysis showed that high-pressure jet-drilling with a high-pressure drill motor and DHI could allow drilling at 3-5 times conventional drilling rates.

The project will provide both a mechanically assisted, high-pressure jet-drilling tool and a pure high-pressure rotary jet-drilling tool. Both tools will utilize a common DHI. The downhole intensifier and high-pressure rotary jet drill designs represent modifications of existing tools designed for coiled tubing scale milling. Researchers will work with PDM, seal, and bearing suppliers to provide high-load bearings and seals to maximize the pressure capacity of conventional motors and with a bit supplier to provide a custom dual-passage drillbit to provide both high-pressure jetting and mechanical cutting capabilities. The tools then will be assembled for functional testing. Endurance testing on two-phase flow will be carried out in a pressure-test facility with full power water and nitrogen pumpers.

The jet-drilling system is expected to provide sustained drilling rates of 80 feet per hour or more with a microhole CTD system, while providing over 100 hours of reliable motor operation.

Current Status (January 2006)

Design of the system components is complete, and the prototype tools are currently being fabricated. Tempress has obtained a no-cost time extension to accommodate delays in manufacturing and availability of test equipment. The prototype tools are scheduled for yard testing in spring 2006.

Project Start / End: 2-10-05 / 1-31-07
DOE / Performer Cost: $737,000 / $184,875
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