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"Improved Directional Drilling Technology for the Bakken Formation"

Quarterly Report
September 30, 2009

Contract No.:	G017-37
Effective Date of Contract:	June 8, 2009
Contract Expiration Date:	June 30, 2010
Reporting Period:	June 8, 2009 to September 30, 2009

Non-Confidential Section

The intent of this project is to increase the efficiencies of horizontal drilling in the Bakken Formation through a redesign of drilling tools by including the use of miniature gyroscopes in the drilling assemblage. The result of the project will be a prototype miniature MEMS gyroscope demonstrated at temperatures typical in the drilling environment. High-temperature shock-resistant MEMS gyroscopes enable the directional sensor to be positioned next to the drill bit, resulting in a reduction of backtracking, more accurate navigation, and time-savings. During the past quarter, computer simulations were performed indicating that the gyro sensor design can withstand the harsh thermal conditions and operate successfully.

Non-Confidential Background Information

It is imperative to bring reliable, domestic hydrocarbon reserves on-stream to help the United States reduce dependency upon foreign oil. Hence, the Bakken Formation, with estimated reserves at 200-400 billion barrels of oil, is a critical national asset that needs to be developed to its maximum capacity. At present, only 1%-3% of Bakken reserves are anticipated to be recovered due in part to limitations with existing oilfield technology, including limitations in the accuracy of existing directional drilling technologies. The current technology, magnetometers, cannot be significantly improved since the errors are introduced by external sources.

Non-Confidential Project Results

The main focus of the last quarter was to design a basic MEMS gyroscope and perform temperature sensitivity analysis on it to study the effects of temperature. FEA modelers were used to study thermal-structural interactions for fixed-fixed flexure structures and simplified gyroscope frames.

In the first simulation, the fixed-fixed flexure, one of the basic and critical parts of the gyro was studied. This was performed for temperatures ranging from 0 to 200 degrees C. The maximum displacement observed is a 0.6% deflection of the total thickness of the structure.

As each study confirmed thermal compatibility, the next level of complexity was added to create a more realistic representation of the actual gyro. The same input parameters for the simulation were used. The results showed that the beams had much less out-of-plane deformation (maximum of 0.1%) along its length. Structural deformation of the device layer is reduced since the substrate will expand along with the flexure as opposed to the last study where the anchors were fixed.

The next step toward demonstrating the thermal robustness of the MEMS gyroscope design was to include a full structure simulation at a temperature of 200 degrees C. The total deformation at this temperature was considered negligible. All of these results confirm that the thermal effects the gyro would encounter in a drilling environment will not affect its performance.

Non-Confidential Upcoming Tasks

Upcoming work for the next period will include additional stress simulations of the gyro and then laying out the final gyro design. Design work on the capacitive readout circuit will begin, and a manufacturing process for the gyro will be finalized.