High-Temperature Battery for Drilling Applications

DE-FC26-06NT42946

Goal

The goal of this project is to develop prototype rechargeable batteries capable of operating in a high-temperature environment to power a variety of emerging measurement-while-drilling (MWD) and other logging equipment in deep wells.

Performer

Electrochemical Systems, Inc. (ESI)
Knoxville, TN

Results

The seal assembly for the high-temperature battery was designed and successfully tested on compatibility with cathodic mix.

Benefits

By offering a reliable and rechargeable battery for operation in extreme temperature environments, this project will support development of the kinds of durable MWD tools seen as essential to cutting costs and reducing risks in drilling deep natural gas wells.

Background

MWD and logging-while-drilling (LWD) tools are powered by an autonomous power source that most often is a battery. Present tools operate at temperatures below 150 ºC mainly because their components, including the battery, cannot operate at higher temperatures. Drilling and logging services need high-temperature batteries that increase the temperature limits and improve the safety of batteries.

Geothermal and deep oil and natural gas fields require high-temperature drilling systems that can reliably operate at 150-230 ºC and can survive to 250 ºC. The complexity of these formations (the majority of new deep wells are highly deviated) typically requires the use of MWD tools during drilling, which in turn require high-temperature-capable battery power. The cells to be developed during this project should be capable of providing power in such deviated wells where conventional wireline logging is difficult.

The lithium-magnesium/thionyl chloride battery, which was developed under a Halliburton Company-DOE Battery Engineering collaboration, offers the best high-temperature, gas-compatible, lithium-based chemistry for the oilfield. However, safe use of this battery chemistry has been limited to 200 ºC and there is little likelihood of increasing the operating temperature or of increasing cell safety beyond this temperature. Polymer-based battery chemistries were considered an option but subsequently rejected as an alternative to existing chemistries because they tend to fail when soaked at high temperature. As well, these lithium-based batteries are primary batteries. Rechargeable cells are preferred to primary cells because they offer the opportunity for more jobs per cell, which in turn lowers life cycle costs, reduces environmental problems related to disposal, and opens the door to new applications.

Summary

This project was initiated in October 2006. Phase I had already been successfully completed via an earlier project supported by Sandia National Laboratories, performed from July 2005 to January 2006. DD size test cells were built and their electrical performance tested over a temperature range from 125 ºC to 250 ºC. Test results demonstrated the feasibility of the high-temperature cell for deep drilling application.

Current Status (February 2007)

Phase II of this research (the current project) encompasses the development of a seal compatible with the current cathode mix and the employment of finite element modeling (FEM) to evaluate the seal design. A dummy cell will be constructed to permit the evaluation of seal performance under vibrating conditions. A DD size cell incorporating the final seal will be constructed, with expected capacity of 3-5 ampere-hours. The electrical performance of the cell will be tested from 150 ºC to 250 ºC while vibrating. The final prototype cell will also be demonstrated to be capable of being recharged.

The seal for this battery was constructed employing compatible materials with the cathodic mix. Compatibility testing of the seal with this mix under the most stringent conditions—such as exposure to cathode composition of fully charged cell at 250 ºC for more than month—indicated no leakage. Next, the seal will be submitted to FEM to indicate distribution and intensity of stresses and their consequence on the integrity of the seal.

Funding

This project is funded under NETL's Deep Trek program, designed to improve high-temperature, high-pressure well economics.

Project Start: October 1, 2006
Project End: September 30, 2007

Anticipated DOE Contribution: $350,233
Performer Contribution: $188,587 (35 percent of total)

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