High Temperature Capacitor Development

DE-FC26-06NT42945

Goal

The goal of this project is to design, develop and test a prototype for a new class of high-temperature high-voltage all-solid electrochemical-electrolytic capacitor for use in downhole electronics for deep drilling and logging applications. The capacitor to be developed will exhibit a low equivalent series resistance (ESR) and will be capable of operating at temperatures exceeding 400° F and pressures exceeding 20,000 psi; a goal is to extend the operating temperature to 450°F.

Performers

Giner, Inc., Newton, MA 02466
Evans Capacitor Corporation, East Providence, RI 02914

Results

This project began in September 2006. A Research Management Plan has been completed, and work has begun on the development of capacitor specifications and high temperature electrolytes.

Benefits

Demonstration of a new capacitor capable of operating reliably under HPHT conditions will enable more efficient and cost effective logging and measurement-while-drilling (MWD) operations to be conducted during the drilling of deep wells. This in turn will enable more rapid and reliable detection and identification of underground events such as kicks, as well as more reliable transmission of sensor data to the surface. In addition, use of capacitors that are designed to operate at HPHT conditions will minimize the possibility of capacitor failure during operation. All of these impacts will result in safer and more cost effective deep drilling operations.

Background

Electronic components such as integrated circuits are frequently the weakest link in a logging tool's operational performance under high pressure - high temperature (HPHT) conditions. Typically, most electronic systems in logging tools are built from commercially available high-temperature components built to US military specifications. However, the temperature ranges under which these components are capable of operating reliably do not reach the high temperatures encountered during deep drilling operations.

During this project, the operating temperature of an existing high voltage, all solid electrochemical-electrolytic capacitor, manufactured by Giner, Inc., will be increased by modifying the component's structure and packaging. The new capacitor design will offer a solution for high efficiency, high reliability capacitors for new HPHT applications, as well as constituting an alternative for "drop-in" replacement of capacitors currently in use on already developed circuit boards.

Summary

This project is comprised of two phases. The primary tasks for Phase I include the following:

- Conduct initial investigations to modify the internal anode structure and porosity of the tantalum anode of the existing capacitor in order to accommodate high-temperature electrolyte within the pore structure.
- Identify and develop low-cost, highly conductive high-temperature electrolyte materials.
- Develop and apply innovative techniques to improve the electrode-electrolyte interface contact in order to lower the ESR and utilize the surface of the electrode.
- Fabricate, characterize and test high-temperature, high-voltage all-solid electrochemical-electrolytic capacitor cells that demonstrate the feasibility of the design approach.

Based on the success of Phase I, the primary tasks of Phase II will include:

- Miniaturize the overall high-temperature capacitor footprint.
- Refine the design (based on Phase I results) to improve capacitor performance, including redesign of both materials and procedures if necessary.
- Select packaging options and design specifications.
- Fabricate prototype devices and conduct laboratory tests to demonstrate and validate performance, including energy storage and discharge, unattended operation, heat buildup and dissipation, and endurance

Current Status

Work is underway to modify the existing capacitor to accommodate high-temperature electrolyte within the pore structure.

Project Start: September 19, 2006
Project End: September 18, 2008

DOE Contribution: $517,033
Performer Contribution: $237,180

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