Development of a Near-Bit MWD System

**Quarterly Report
April - June 1994**

William J. McDonald
Gerard T. Pittard

November 1994

Work Performed Under Contract No.: DE-AC21-93MC29252

For
U.S. Department of Energy
Office of Fossil Energy
Morgantown Energy Technology Center
Morgantown, West Virginia

By
Mauer Engineering, Inc.
Houston, Texas

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TECHNICAL PROGRESS REPORT

PROBLEM STATEMENT

The success of horizontal drilling in increasing oil and gas production rates in low permeability formations and in mitigating problems such as water-coning and sand production, has led to its industry-wide acceptance as a viable recovery technique.

Correspondingly, as horizontal drilling and completion technology has improved through evolution, the length of the horizontal sections has grown longer and the need for more accurate directional placement become more critical. The reliance on examining formation conditions and borehole directional data some 50 to 80 feet above the bit (see Figure 1) becomes less acceptable as turning radii decrease and target sands become thinner. This is because the impact of stand-off distance, namely, looking at what has occurred instead of what is now transpiring, can result in missing thin targets, falling outside of productive seams identified from gamma-ray logs, or dipping into the water or gas cap. Corrections may entail adding one to two hundred feet more drilling or in more critical instances, plugging back and redrilling the lower portion of the hole. Figure 2 illustrates some typical borehole guidance problems caused by monitoring hole conditions from locations spatially separated from the drill bit.

The above problems can be circumvented by placing the data gathering transducers and measurement-while-drilling telemetry system directly behind the drill bit. This requires design of a special bit sub which houses and protects the borehole environment measuring sensors and communication electronics from damage that can be caused by the torsional, axial and bending loads developed at the drill bit-rock interface.

Figure 1. Conventional MWD Drill-String Location

Figure 2. Borehole Guidance Problems

OBJECTIVE

The project objective is to develop a measurements-while-drilling module that can reliably provide real-time reports of drilling conditions at the bit. The module is to support multiple types of sensors and to sample and encode their outputs in digital form under microprocessor control. The assembled message will then be electromagnetically transmitted along the drill string back to a standard mud-pulse or EM-MWD tool for data integration and relay to the surface.

The development effort will consist of reconfiguring the AccuNav™ EM MWD Directional System manufactured by Guided Boring Systems, Inc. of Houston, Texas for near-bit use followed by the inclusion of additional sensor types (e.g., natural gamma ray, formation resistivity, etc.) in Phase II.

To maintain focus and provide the desired level of project control, work is divided into two phases. The current Phase I goal is to define system requirements followed by design, fabrication and testing of a functioning prototype. This minimizes risk to METC and allows demonstrating that the required form, fit and functionality have been achieved prior to embarking on a field test program. To minimize costs, the Phase I prototype will be configured with accelerometers, temperature and pressure. The accelerometers will provide us with inclination angle which, in conjunction with natural gamma-ray logs and resistivity, are the most sought after near-bit data elements.

Phase II will consist of incorporating a selected data suite (adding other sensors such as gamma ray) and performing a series of field experiments. Before proceeding to the field test stage, a series of vibration cycle and shock tests will be performed to identify areas to strengthen through redesign and packaging modifications. Pending success of the field tests, final design modifications will be implemented and the system commercialized.

SUMMARY OF TECHNICAL PROGRESS

Fabrication of Near-Bit MWD Prototype System

Fabrication of the Near-Bit MWD system continued in the period. All electrical components and the majority of the mechanical hardware have been received and inspected. System elements are shown fully packaged on the mandrel in Figures 3 and 4. Work is progressing well with expected completion of the Near-Bit prototype scheduled for completion in mid-July.

Figure 3. Near-Bit MWD Components (Side View)

Test plans for assessing the Near-Bit MWD performance and reliability have been prepared. The tests will be divided into two segments. Segment I will consist of placing the near-bit modules into an earthen borehole and measuring the unit's received signal strength as a function of transmitter-receiver standoff distance and borehole conditions (i.e., liquid-filled versus dry borehole.) Segment II testing will consist of incorporating the Near-Bit MWD system into the DRC rotary drilling unit. The module will be placed under rotary drilling load for a total of 100 hours. The unit's sensor data will be recorded in fixed time intervals and examined to assure its proper functioning. In addition, the unit will be removed from the stand at 10-hour time increments at which time the electronics will be removed from the sub and inspected for damage resulting from the applied drilling loads. Results of both test segments will be recorded and documented in the Phase I Final Report.

Efforts in the next quarter will consist of performing laboratory performance/reliability tests of the Near-Bit MWD prototype, documentation of results and conclusions and preparation of the Phase I Final Report and commercialization plan.

Figure 4. Near-Bit MWD—End View