High Temperature 300° C Directional Drilling System

May 19, 2010
– Timeline
  • Project Start Date: 12/29/2009 (6/15/2010 est.)
  • Project End Date: 12/28/2012 (6/14/2013 est.)
  • Percent Complete: 0%

– Budget
  • Total project funding: $6,363,900
  • DOE share: $5,000,000
  • Baker Hughes Share: $1,363,900
  • Funding 2009: $0
  • Funding 2010: $690,000 (est.)

– Barriers
  • EGS Well Construction Capability:
    – The inability to drill and complete wells meeting EGS requirements (high temperature, high flow rate, low cost) results in a greater risk of impairing production or even losing wells when drilling
Relevance/Impact of Research

• Objective:
  – provide a directional drilling system that can be used at environmental temperatures of up to 300° C, and at depths of 10,000 meters.

• Drilling System Components:
  – Drill Bit:
    • Will investigate PDC, Roller Cone and Impregnated Diamond bits, matched to motor and fluid
  – Steerable Motor
    • Will investigate PDM (positive displacement motors), technical fallback is turbine but issue matching with drill bit.
  – Drilling Fluid / Equipment
    • Will develop a drilling fluid & lubricant for 300C

• Impact
  – Capability (directional wells) and efficiency (goal is 50 hours plus on-bottom).
Scientific/Technical Approach

- Project divided into 3 phases for each component:
  - **Concept**: with go/no-go decision point after 1 year
  - **Design**, manufacture, assemble and laboratory **system test**
  - **Testing**: controlled, commercial

- **Bit Concepts**:
  - Roller Cone
    - Challenges: seal technology
  - PDC Bit
    - Challenge: Compact thermal stability
  - Impreg bits
    - Challenge: Drilling efficiency
Scientific/Technical Approach

- Positive Displacement Motor
  - Challenge: Elastomer, bearings, material corrosion

Components of a Mud Motor

- Top Stabilizer
- Top Sub
- Power section
- Stator
- Rotor
- Adjustable Kick Off (AKO) Deflection Device
- Bearing Assembly
- Bearing Housing Stabilizer (Integral or Screw-on)
- Drive Sub with Bit Box

190 C
Scientific/Technical Approach

• Drilling Fluid Challenges:
  – Thermal stability of products and drilling fluid system
  – Stability of rheological properties / mud gellation
  – Stability of filtration control products / poor filter cake quality & high fluid loss
  – Loss of lubricity
  – Contamination – Ability to tolerate a moderate amount of contamination (drilled solids, salt, hardness, cement, CO₂ and H₂S)
  – Increased mud weights for hole stability at greater wellbore depths and possible abnormal pressure
  – Suspension of weighting agents
  – Lost Circulation
Accomplishments, Expected Outcomes and Progress

• Progress:
  – Early days, signed patent waiver received, putting together team and resources.
  – Principal investigators / project managers
    • **Aaron Dick**: Principal investigator, technical lead drill bit and material science. Extensive experience in drill bit design, especially seal technology, materials.
    • **Carsten Freyer**: Project management, inter-divisional geothermal programs. Extensive project management experience in MWD systems.
    • **Mike Otto**: Technical lead, drilling fluids. Over 30 years experience, primary expertise with HTHP fluid applications including geothermal drilling fluids.
    • **Kyle Taylor**: Technical lead, steerable motors. Extensive MWD and wireline mechanical design experience, including both mud motors and turbines.
Project Management/Coordination

Major Project Deliverables & Milestones

1. DOE Award
2. Project launch during Q2 2010
3. End of prototype testing during Q2, 2013
Future Directions

• FY10:
  – Assemble teams, develop working concepts
  – Analysis of hard rock drillability data
  – Conceptual layout of bits
  – Laboratory Evaluation of Drilling Fluid
  – Evaluate Waste Management Equipment
  – Laboratory Verification of Drilling Performance
  – Evaluation of Alternative Downhole Drive and Steer Concepts
  – Match Motor Performance with Drill Bits

• FY 11:
  – Prioritize Motor/Steer Concept Opportunity
  – Provide 300C DDS Integral Concept
  – GO/NO-GO Decision in Q2 FY 11 (1 year into project)
Objective:
- provide a directional drilling system that can be used at environmental temperatures of up to 300° C, and at depths of 10,000 meters.

Drilling System Components:
- Drill Bit, Steerable Motor, Drilling Fluid / Equipment
- Development of 3 prototype systems with field testing

Impact
- Capability (directional wells) and efficiency (goal is 50 hours plus on-bottom).

Risk
- Materials (elastomers, or absence thereof)
- Complex system at 300C

Currently starting teams, locating resources
GO/NO-GO decision point after 1 year in a 3 year research project.