RFID Actuated Tools: Drilling Reamer Update

DEA Quarterly Meeting
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Team Presenter: Phil Snider
RFID Drilling Reamer Development

● Collaborative effort:
  – Marathon
    ▪ Funding, applications, actual wells, intellectual property
  – Petrowell / iiiTec Aberdeen
    ▪ Electro-mechanical engineering specializing in RFID
  – Weatherford
    ▪ Electronics packaging, drilling reamers, global infrastructure
      – Key advantages are:
        • The control module is a separate component from the drilling reamer itself (mechanical or RFID actuation possible)
        • Not displacing an existing tool portfolio.
    ▪ Other ‘building blocks’ for future RFID adaptation

● Marathon’s main application: Deepwater
  – Development began with the 12 ¼” size
Brief Background

- This is a Type II RFID application (radio frequency identification)
  - Reader tools are downhole
  - RFID Tags or unique codes are conveyed into the well
  - Tool performs operations when correct code identified and communication occurs.
    - Communication speed is a function of:
      - Antenna length
      - Antenna power
      - Tag and reader frequency
      - Distance between the antenna and the tag
      - Tag orientation
        - Generally drop several tags
      - Velocity of the tag
        - Design the systems to operate at high pump rates
Why interest in an RFID Drilling Reamer?

- Tool can be opened and closed as many times as desired.
- Multiple tools can be run; reducing trips
  - Open and close any tool in any order
- Operational advantages, including being able to circulate with the tool closed again.
  - For example, inside casing when pulling out of the hole
- Full ID through multiple tools
  - Allows logging, back-off, etc.
  - No pressure loss
Software / Electronics: Some Key Points

- **Tools designed to only operate on the first unique code**
  - a handful of chips can be dropped
  - Addresses the issue of tags accidentally being re-circulated through the mud system

- **Downhole electronics reliability**
  - A big issue for drilling applications
    - Higher shock and vibration than RFID completion tools
  - Good industry understanding due to prior tools
    - Rotary steerable, MWD, LWD, etc.
  - Design methodology remains confidential
Gaining Marathon Confidence for Acceptance in Deepwater Applications is Necessary

- New drilling reamer / new service provider
  - Liked the tool design
  - Had confidence in the service provider’s personnel.

- RFID reliability
  - An unknown and a concern
Gaining Confidence in Design and Reliability

Conventional Drilling Reamer
- Numerous Trials (long horizontal surface blocks)
- Numerous Trials (Catoosa)
- Numerous Actual Jobs

RFID Drilling Reamer
- Extensive Surface Testing
- Extensive Spencer Road Rig Testing
- North Dakota Field Trials

Hard Rock versus Gulf of Mexico
- Numerous North Dakota Jobs

All Very Successful
Accomplished in North Dakota  H&P Rig 257 (Bakken)

- Field was drilling 13 ½” surface holes to ~ 2,200 feet
  - Formations fairly similar to Gulf of Mexico
    - Perhaps a little harder, and occasional boulders.
  - Built out 12 ¼” X 13 ½” drilling reamers
    - Special cutter block assemblies

- Drilled three wells
Bernhart 14-7H

- Pump Open Controller
  - 12000 series RipTide dressed with an unlocked, pump open controller.
  - 450 gpm required to positively deploy & fully open the cutter blocks.
  - Spudded well with cutter blocks positively closed & recessed at 250 gpm and drilled 12 ¼” hole down to 120 feet.
  - Increased flow rate to 525 gpm at 120 feet and simultaneously drilled and under-reamed 12 ¼” X 13 ½” hole down to 2024 feet.

- Progressively increased flow rate
  - 525 gpm @ 120 feet
  - 811 gpm @ TD
Alton Christensen 21-18H

- Ball Drop Controller
  - 12000 series RipTide dressed with a shear pin locked, ball drop controller.
  - 450 gpm required to positively deploy & fully open the cutter blocks.
  - Spudded well with cutter blocks positively closed & recessed at 326 gpm and drilled 12 ¼” hole down to 219 feet.
  - The activation ball was dropped and seated, pumps were turned on and standpipe was brought up to 1746 psi. Pins were successfully sheared and the cutter blocks positively deployed & fully opened. Flow rate was brought up to 637 gpm and the hole was simultaneously drilled and under-reamed 12 ¼” X 13 ½” hole down to 1674 feet.
  - Progressively increased flow rate
    - 326 @ 108 feet
    - 773 @ TD
Bakken Field Tests  H&P Rig 257
12000 series Drilling Reamer 12 ¼” X 13 ½”

- Casey Kukla USA 21-6H
  - Flow Shear Controller
    - 12000 series RipTide was dressed with a shear pin locked, flow shear controller. Flow rate used to shear pins and unlock the cutter blocks.
    - 450 gpm required to positively deploy & fully open the cutter blocks.
    - Spudded well with cutter blocks positively closed & recessed at 330 gpm and drilled 12 ¼” hole down to 158 feet.
    - Pumps were turned on and standpipe was brought up to 1746 psi. Pins were successfully sheared and the cutter blocks positively deployed & fully opened. Flow rate was brought up to 637 gpm and the hole was simultaneously drilled and under-reamed 12 ¼” X 13 ½” hole down to 2300 feet.
    - Progressively increased flow rate
      - 336 gpm @ 108 feet
      - 813 gpm @ TD
Varied Bit Types
  – Mill tool and PDC

Varied Stabilization and Positioning

Numerous learning’s relative to deviation tendencies and cutter damage.
  – Not part of this presentation.
RFID Controller Drilling Reamer

- Extensive Surface Testing on components and fully assembled tools
  - Shock, vibe, temperature, batteries, time
  - Exact methodology cannot all be shared.
    - High confidence if surface testing is successful, downhole testing will be successful

- Spencer Road Test Rig
  - A 12000 series drilling Reamer fitted with an RFID controller was successfully flow tested at high GPM and at 1000 feet depth.
  - 15 open-activation & closed-deactivation cycles.
12000 series RipTide RFID

- RFID controller
- Reamer body 12 ¼” X 13 ½”
- 12 1/8” IBS
Edward Darwin 14-35H

- RFID Controller
  - 12000 series RipTide with RFID electronically actuated controller.
  - RFID tags were used to unlock and re-lock the controller
    - 450 gpm required to positively deploy & fully open the cutter blocks.
  - Spudded well with cutter blocks positively closed & recessed at 290 gpm and drilled 12 ¼” hole down to 220 feet.
  - RFID tags programmed with the OPEN command were pumped down to the RFID controller and the cutter blocks were unlocked and positively deployed & fully opened. Flow rate was brought up to 595 gpm and the hole was simultaneously drilled and under-reamed 12 ¼” X 13 ½” hole down to 300 feet.
Bakken Field Tests  H&P Rig 257  
12000 series RFID Drilling Reamer 12 ¼” X 13 ½”

- Edward Darwin 14-35H
  - RFID Controller
    - RFID tags programmed with the CLOSE command were pumped down to the RFID controller and the cutter blocks were re-locked and positively recessed & fully closed. Flow rate was brought up to 595 gpm and the hole was drilled at 12 ¼ to 500 feet.
    
    - RFID tags programmed with the OPEN command were pumped down to the RFID controller and the cutter blocks were unlocked and positively deployed & fully opened. Flow rate was brought up to 595 gpm and the hole was simultaneously drilled and underreamed 12 ¼” X 13 ½” hole down to a TD of 2654 feet. (also back-reamed the 500 foot to 300 foot section)
    
    - RFID tags programmed with the CLOSE command were pumped down to the RFID controller and the cutter blocks were re-locked and positively recessed & fully closed. The BHA was tripped out of the hole to the surface casing shoe.
    
    - RIH, Pumped OPEN command and backreamed from 220 feet back to surface casing shoe. Again pumped CLOSE command and POH, visually verifying fully closed with pump test at surface. Pump OPEN command at surface and visually verify proper actuation with pump test at surface.

- Progressively increased flow rate
  - 290 gpm @ 220 feet
  - 903 gpm @ TD
What’s Next: RFID Drilling Reamer Project

❖ Additional North Dakota Field trials
  – Additional runs
  – Incorporation of additional features allowed by having a downhole computer system

❖ Subject RFID Control Module will work with 10-5/8” to 16” drilling reamers.
  – Covers a lot of Marathon’s Gulf of Mexico applications

❖ Next: 8500 series

❖ Then: 6000 series
Conclusions

- RFID Actuated Drilling Reamer is becoming a reality
  - Chips capable of being read at 1300 GPM.
  - Rated to 300 degrees F.
  - 2 week battery life

- Surface testing methodology is satisfactory

- Now have a high level of confidence as other drilling tools are progressed.
  - Likely less shock and vibration as compared to under-reaming.
    - Circ subs, drilling disconnects, expandable stabilizers and cutters, etc.
  - Significant learning’s relative to lithium batteries

- Downhole computer systems will allow further improvements and technology development

- Different operational scenarios are beginning to be considered
  - Such as multiple under-reamers, combine with variable stabilization?
Points of Contact for Further Questions:
Primary Technology Development Team

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