ECD Reduction Tool

R. K. Bansal, Brian Grayson, Jim Stanley
Control Pressure Drilling & Testing

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Presentation outline

- Description of the ECD Reduction Tool (ECD RT)
- Lab test results
- Field test results
- Forward plan
- Summary
ECD Reduction Tool (ECD RT)

- **What?**
  - A downhole tool for reducing the equivalent circulating density (ECD), hence the bottomhole pressure, while drilling.

- **Why?**
  - Wherever high ECD is a problem:
    - You want to drill with a lighter mud to minimize chances for mud loss but you risk fluid influx when circulation stops. It is a common problem where difference between pore pressure and formation fracture pressure is small, or
    - You want to use a heavier mud to improve wellbore stability but you can’t due to increased risk of mud loss, such as in ERD wells (small difference between collapse pressure and formation fracture pressure).

- **Where it is run?**
  - High in the drillstring, in the vertical section of the well close to surface.
Major benefits of ECD reduction

- Improved wellbore stability by tolerating higher static mud weights
- Extended hole intervals and reduced number of casing strings
- Reduced impact of uncertainty on casing setting depth by widening the usable PP/FG margin
- Reduced lost circulation and differential sticking
Description – 8.20” ECD RT

- Modular design - 3 primary components
  - Hydraulic turbine drive
  - Annular pump
  - Sealing element

- Total Length ~ 30 feet.

- Tool diameter 8.20 inch.

- Applicable in 9-5/8” (47# or lighter) and 10-3/4” casing pipes.

- Normal circulation rate 500-550 gpm; 600 gpm max.
Operational Advantages

- Portable tool; Requires no rig modification
- Drill string component; Quick rig-up / rig down. Only a short trip of 7 stands is required to add the tool in drill string.
- For use on land and offshore applications
- Use for planned and or unanticipated problematic intervals of the well
- Does not impede mud pulse telemetry
- Does not affect normal drilling operations
Flow loop tests

- Performance characterization
- The effect of LCM in the drilling fluid
- The effect of reverse flow (bull heading)
- The effect of gas in the return fluid
Annulus pressure reduction as a function of circulation rate and mud weight

- 14.5 ppg
- 16.5 ppg
- 17.8 ppg
- 19.2 ppg
- 10.4 ppg

Circulation rate, gpm

Annulus Pressure Reduction, psi
Projected ECD reduction versus depth

\[
\text{ECD Reduction} = \frac{\Delta P}{.052 \times \text{Depth}}
\]

Circulation rate: 525-550 gpm
Extra standpipe pressure (SPP) requirement

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Full scale technology tests

Primary Objectives

Quantify pressure reduction

Measure transient pressure spike at the start of rig pumps

Quantify Surge and Swab effects

Demonstrate compatibility with mud-pulse telemetry

Assess longevity of the tool at normal circulation rate
ECD Reduction demonstrated in technology trial
Field trials conducted

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<tr>
<th>Objectives</th>
<th>Achievements</th>
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<tr>
<td>Quantify ECD reduction</td>
<td>Demonstrated expected ECD reduction</td>
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<td>Evaluate operational procedures</td>
<td>Did not impede normal drilling operation</td>
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<td>Cuttings flowed through the pump easily</td>
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<td>Mud pulse telemetry worked normally</td>
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<td>Assess reliability</td>
<td>Reliability proved to be a weakness. Maximum drilling achieved was 500-ft of 8.75” hole. Focus of recent development was to improve longevity and reliability.</td>
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Drilling operation was monitored by standpipe pressure, hook load, real-time ECD and fluid return.
ECD reduction in Arkoma field trial

[Graph showing circulation rate over time with marked ECD and normal ECD levels]
Forward Plan - Next Field Trial

- Plan going forward is to run a successful field trial and we are actively looking for an opportunity.

- Casing size 9-5/8” (47 lb/ft or lighter) or 10-3/4”

- Circulation rate between 475-550 gpm; mud type and weight do not matter.

- Ability to drill ahead 1500 to 2000 ft with the ECD RT located in the vertical hole. ECD RT starting location is 650-700 ft from surface.

- Instrumentation for real time display of downhole pressure, ECD and circulation rate.
Summary

- ECD RT potentially offers significant benefits to drilling operations
- The concept of ECD RT has been proven in field trials
- The present design will function in 9-5/8” (47# or lighter) and 10-3/4” casing pipes and handle up to 600 gpm circulation rate
- Looking for additional field trial opportunity to prove reliability and longevity of the tool.
- Likely to develop other sizes subsequently.