Managing Bottom Hole Pressure in Unstable Reservoirs

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Agenda

• SCOOP field overview
• Initial well design
  – 1st well summary
• Earth model results
• New well design – eliminated drilling liner
  – Planning
  – Execution
  – Conclusions
SCOOP Field Overview

- Woodford Shale
- Springer Shale
- 2015 Plans
  - 30% of CLR D&C budget
  - 16 Rigs
Initial Well Design

- 13-3/8” surface casing
- 9-5/8” intermediate casing
- 7-5/8” drilling liner (contingency)
  - Needed 7-5/8” for 5” production casing
- 5-1/2” production casing
  - 5-1/2” X 5” contingency
- Curve in 100% Shale
- KOP - 11,000’ – 13,000’ TVD
Initial Well

• Started Curve with ~11.1 ppg MW

• Hole unloading MW raised to 11.8

• Lost BHA in hole

• Sidetracked drilling curve with 13.0 – 14.4 ppg MW
  – Nearly lost 2nd BHA in hole

• Ran liner to hold curve back

• Cut MW to 13.4 while drilling lateral
Appraisal Wells Key Improvements

• Have mud properties at desired properties prior to starting curve
  – 300,000 PPM WPS
  – 13.8-14.2 ppg MW

• Drilling at a positive azimuth in curve (5-10 degrees) helped with stability/running liner

• 7-5/8” flush casing was difficult to get into curve (7 wells drilled with this design)
  – After stimulating first few wells, confirmed could downsize to 7” liner and 5-1/2” x 4-1/2” Production Casing

• Once liner was set, MW could be dropped to avoid losses in lateral

• Performed third party mechanical Earth Model from logs and offset reports
New well Design – **Goal eliminate drilling liner**

- 13-3/8” surface casing
- 9-5/8” intermediate casing
- 5-1/2” production casing
- Still have 7” contingency liner
Earth Model

- Tight MW window in curve (60-70 degrees)
- Breakout threshold
- Breakdown < Loss vs. Loss < Breakdown
• Breakdown pressure in Lateral is less than Curve

• Drilling ECD near TD approaches breakdown pressures

• Mud weights often cut while drilling, then slowly raised for trips
Execution - Hydraulics

- Monitor ECD realtime – WITS into EDR
- Clean-up cycles based off ECD
- Validated modeling
  - Use most conservative model
    - Power Law
    - Herschel Buckley
    - Modified Herschel Buckley
Planning - Tripping

- With planned MW of 14.1 ppg bottomhole pressure should be able to be kept in manageable zone with proper practices

- Looking at ~65 degrees in Curve

- Maintaining a thinner low end rheology makes a large difference
  - 10% increase in 6 rpm can make .1-.15 ppge difference
### Execution - Tripping

- Plans developed based on that day's Mud report and sent to the rig prior to trip.
- Max Swab is normally planned <.3ppg.
- Max surge is to not exceed modeled ECD in the curve.
- Most modeling software does not model pumping out of the hole (net of ECD and swab).
- Example trip out plan:
  - Pump out to casing shoe
  - 30 fpm to 9,000’
  - 60 fpm to 7,000’
  - 100 fpm to 3,000’
  - 150 fpm to surface
New Well Design - Conclusions

- Same design as previous to 9-5/8” intermediate
- FIT 15-15.5 ppge
- Mud weights 13.8-14.5 depending on offset success
- Constant monitoring of PWD and cuttings returns is paramount
- Models revised throughout the well while drilling below KOP
- New design has been successful on 17 out of 19 wells attempted
Questions?