Case Studies and Best Practices for Installation of Open Hole Multi-Stage Completions Systems in Wells Drilled Underbalanced

SPE/IADC 168952

- D.J. Snyder, Packers Plus Energy Services
- Brittany Miller, Packers Plus Energy Services
- Lonnie Jeffers, Packers Plus Energy Services
Outline

- Underbalanced drilling versus conventional drilling
- Open hole multi-stage systems overview
- Topic introduction
  - Air-drilled and nitrogen-fractured wells
  - Low bottomhole pressure (BHP) wells
  - Low circulation wells
  - Wells drilled underbalanced for reservoir conditions
- Discussion
Underbalanced Drilling

- Unique drilling technique
- Pressure inside wellbore is kept lower than the fluid pressure of the formation

Conventional Drilling

- Popular drilling technique
- Pressure inside wellbore is kept higher than the fluid pressure of the formation
Open Hole Multi-Stage System Overview

- No cement in horizontal
- Zonal isolation with hydraulically set packers
- Ball-actuated stimulation ports to access the formation
- Immediate flowback after stimulation
- Eliminates use for coiled tubing and wireline operations
Installation Procedures

1. TD and POOH Drilling BHA
2. Gauge/Reamer Run
3. M/U to prod. liner/casing and RIH OHMS Assembly
4. Displace to completion fluid
5. Drop ball to close Toe Circulating Sub
6. Apply pressure to set LHP (test) and packers
7. Release from LH and POOH Workstring
8. Remove Drilling Rig
9. Apply pressure to open Hydraulic fracturing port
10. Rig up frac equipment
11. Frac Stage 1
12. Drop balls to open fracturing ports and frac additional stages
13. Flow back and clean-up
Introduction

Four different types of underbalanced drilling and completions where open hole multi-stage systems have been installed:

• Air-drilled and nitrogen-fractured wells
• Low bottomhole pressure (BHP) wells
• Low circulation wells
• Wells drilled underbalanced for reservoir conditions
Air-Drilled and Nitrogen-Fractured Wells

Lower Huron and Chattanooga Shale reservoir characteristics

• Shale formation has low permeability
• Reservoir is underpressured
• Many naturally occurring fractures and faults
• High clay content
• Challenging to use cement
Air-Drilled and Nitrogen-Fractured Wells

Operations

• Long string monobore completion
• Run in on casing (no drill pipe used)
• Run in operationally the same as “typical” open hole multi-stage system (OHMS)
Air-Drilled and Nitrogen-Fractured Wells

Advancements / Challenges

• Longer lateral lengths
• More stages – more completions equipment
• Increased emphasis on torque and drag modeling
Air-Drilled and Nitrogen-Fractured Wells
Long String System versus Packer with Latch

Long String System

Packer with Latch
Low Bottomhole Pressure (BHP) Wells

Cleveland Sand reservoir characteristics

- Weight of natural fluid overcomes the pressure of the reservoir
- Fine-grained, tight gas formation
- Low permeability
Low Bottomhole Pressure (BHP) Wells

Challenges

• Near-wellbore permeability poses a problem
  • Specialized drilling foams have been used
• Formation integrity and lost circulation are an issue
  • Condition well before installation
• Energized fluids are used to complete wells
Low Circulation Wells

Marmaton and Mississippian Lime

- Highly naturally fractured
- Cement job is unlikely
- 115% increase in production with one operator
Low Circulation Wells

Operations

• Lost circulation can be an issue
• Before toe balls are seated, stop and check fluid levels
  – Fluid may be lost from annulus to formation
• Need to ensure hydraulic calculations are correct
  – Premature activation of equipment possible if not monitored
Wells Drilled Underbalanced for Reservoir Conditions

Cleveland Sand, James Lime, Niobrara, and Bone Spring

- Low formation pressure
- Tight reservoirs
- Higher porosity for unconventional
Wells Drilled Underbalanced for Reservoir Conditions

Operations
• Spot heavy fluids to do gauge run
• Minimize circulation while RIH

Equipment
• Rotating head
•Floats used in open hole multi-stage system are essential
• Differential pressures may need to be calculated many times during a kick
• Snubbing unit has been used to ensure tools get to the bottom
Discussion

• Air-drilled wells
  – Reduce fluid contact with formations

• Low bottomhole pressure (BHP) wells
  – Compatible with energized fluids often used in low BHP wells

• Low circulation wells
  – No cement required to complete

• Wells drilled underbalanced for reservoir conditions
  – Proper installation and pre-job planning a must
  – Help reduce lost circulation and formation integrity issues
Acknowledgements

The authors would like to thank the management of Atlas Resource Partners, L.P. and Packers Plus Energy Services for their permission to publish this paper.