Plunger Lift Applications for Horizontal Wells

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Outline

• Plunger lift background
• Horizontal well challenges
• Applications in the Marcellus Shale
• Newly-designed tubing plungers
• Casing plungers
• Future of horizontal plunger lift
Trends in Horizontal Wells by Rig Activity

Source: Drilling Contractor, Mar 2011
Well Types in Pennsylvania

Source: U.S. Energy Information Administration
Plunger Lift Background

• Plunger falls by gravity to the bottom of the well
• Plunger provides solid interface between gas heavier liquids
• Utilizes reservoir energy to lift plunger
• Fluid column lifted to surface
Horizontal Well Challenges

- Decreasing plunger fall velocity as well deviation increases
- Liquids slugging in and out of tubing
- Plunger type required for maximum fall
- The need to conduct well control operations
APPLICATIONS IN THE MARCELLUS SHALE

Based on SPE 147225
Typical Horizontal Well Schematic

- End of tubing (EOT) set at high inclination – between 50° and 70°
- X-profile nipple set at 10°– 20°
- XN – profile nipple set at EOT
- Standing valve seated in the XN nipple
Testing Program

- Experiment with plunger types
  - One plunger system
  - Dual plunger, tandem system
- Measure and determine fall velocities
- Determine fall depths and max inclination
- Demonstrate successful travel through X-nipple
- 7 test wells, 53 individual tests performed

TWM Analysis from Echometer Company
Findings – Plunger Types

- Must pass through X-nipple and maintain sufficient seal

- Short plunger selected
  - Run in tandem to increase likelihood of passing through X-nipple (impact of top plunger forces both through)
  - Smaller plunger believed to increase fall velocity, thereby increasing fall depth

- Collapsible spring-loaded pads
Findings – Fall Velocities

- Velocities increased past kick-off point
  - Drag force from gas flow decreases as inclination increases
  - Plunger now rests on low side of tubing and is not centralized in the wellbore
  - Testing shows drag reduction of 29% at KOP

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Findings – Fall Depths and Max Inclination

- Plunger decelerates to KOP, accelerates after KOP
- Velocity trend extrapolated to determine max fall depth
- Modeled to fall within 20 ft. TVD of perforations
Conclusions From Marcellus Tests

- Test wells show fall potential to 74°
- In all cases, plungers were still moving to the XN nipple at EOT.
- Models show potential of plungers to fall within 20 ft. TVD of the perforations
- High potential of plungers to fall closer to 90° if tubing set depths were adjusted.
NEW DESIGN FOR TUBING PLUNGERS
JackRabbit Plunger

- Continuous flow-through design
  - Does not require wells to be shut in
  - Avoids production interruptions
- Increased fall velocity
- Spring-loaded pads to pass through X-nipple
JackRabbit Test Well #1
JackRabbit Test Well #2
CASING PLUNGERS
System Benefits

• No tubing required

• No shut in time, 24/7 operating time

• Minimal loss of production when plunger is traveling

• Applications for vertical and horizontal wells
Plunger Design

• Positive seal with rubber cups – designed for vertical and low deviations, up to 40°

• Brush type – designed for high deviations/horizontal applications (has been tested to 60°)
System Specifics

• Lubricator
  – Hammer unions/swing system for replacing plunger
  – Automatic trap required to hold and release plunger
  – Two outlets required
    – 1) sales
    – 2) high flow

• PetroCasing algorithm design
Casing Plunger Candidates

• Marginal or depleted well
• Shows capability to produce under it’s own well pressure
• Casing pressure is greater than line pressure
  – 33 psi above line pressure required to lift one bbl/fluid – 4 ½ in. casing (compared to 74 psi for 2 7/8 in. and 108 psi for 2 3/8 in. tubing)
• No sand or salt production
Casing Plunger Experience in Horizontal Wells

- Approximately 30 systems in operation
  - West Virginia, Kentucky and Tennessee
  - All low volume/low pressure applications
  - Wells average 2 yrs of production before casing plunger is applied

- Typically installed with a series of standing valves to stage fluid up the hole
  - Improves fluid removal

- Plunger runs to first standing valve – around 40° depending on well profile and KOP.
FUTURE OF HORIZONTAL PLUNGER LIFT
What Are The Next Steps?

- Tests show potential of plungers to fall to higher inclinations than expected
- Plunger designs continue to evolve that increase fall velocity, inclination reached, and MD obtained.
- Use of standing valves is beneficial to improve fluid recovery
- Tubing programs can be modified as plunger performance improves
- Casing plungers are good options for some wells
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