Dual Stage Plunger Lift
Applications

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Wamsutter, WY - Greater Green River Basin
Wamsutter Field Description

- 170 of Marathon operated wells.
- Marathon operated production ~ 40 MMSCFD.
- Well age: 50 years to newly drilled.
- Standard completion – 4½” casing / 2 3/8” Tubing.
- To keep wells unloaded: typically add Foamers or plunger lift prior to depletion to critical rate.
- Wellhead pressure ranges from 80 - 500 psi.
- Gas rate ranges from 40 to 2300 MCFD, LGR from 10-50 BBLS/MMSCFD.
Wamsutter Reservoir Description

• Production from Almond & Lewis Formations (7,000 - 10,500’).
  - Lewis: shallowest, with lower volume, higher perm, lower pressure
  - Almond: deeper with higher volume, lower perm, and higher pressure.
  - 350-1900 ft gross interval.
  - Tight Gas
    - (Porosity: 8 - 14%.
    - Permeability: 0.002 – 0.1 md.
Typical Issues of Problem Wells

- High Flowing Tubing Pressure for Plunger Lift
- Low immediate pressure buildup once depleted. (1-4 hour builds)
- Casing pressure buildup limited by low pressure or depleted zones.
- Significant operator time required to keep well unloaded.
- Erratic production even on plunger lift.
Example of a Problem well
Siberia State 5-16

• Gross Interval 1261’
• Top Lewis Perforation: 9,349’
• Bottom Almond Perforation: 10,610’
• EOT @ 10,457’ (Middle of Almond)
• Flowing Tubing Pressure: 315 psi.
• +/- 100 Mscfd, 1 BLHCD, 3 BWPD.
Specific Issues to the SS 5-16

- Gas rate between 60-120 Mcf/day averaging 80 Mcf/day
- Significant venting
- Fluid production between 2-10 bbls/day of fluid
- Line Pressure of 400 psi
- Ideal production should be around 110 Mcf/day with 4 barrels of fluid.
- Additional 30 minutes per day of operator time.
Example of a Problem well

Gas Rate vs Time

Change from single stage to dual stage plunger
Example of a Problem well
Siberia State 5-16
Dual Stage Plunger
What is it?

• By adding a second set of plunger equipment and “staging” your lift cycle you essentially produce the well with two plunger systems.

• The system includes from bottom to surface

1. A typical bottom hole bumper spring
2. A solid ring plunger for the bottom stage
3. An ILA (see right) made up of two bumper springs (one facing up/one down) a sealing component, a check valve and a tubing stop.
4. Another plunger to lift for the upper stage (usually a double pad)
5. A Lubricator to receive the upper plunger.
SS 5-16 Specific Issues
Single Stage Conventional Plunger System

• Foss and Gaul Calculations for Single Stage:
  – Calculated Casing Pressure 1177 psi
  – Fluid Lift Per Cycle 1.43 bbls
  – Gas Used Per Cycle 19.6 Mcf
  – GLR Required 13.75 Mcf/bbl
  – GLR Actual 13.75 Mcf/bbl
Foss and Gaul single stage calculations indicate the following with the GLR available and the given line pressure:

- Casing pressure required: 1177 psi to lift 1.28 bbls per cycle, 6 times a day to keep the well unloaded.
- The well will operate on the edge, any fluctuation would cause a missed arrival or a shortage of gas.
SS 5-16 Specific Issues
Dual Stage Plunger System

• Foss and Gaul Calculations for a Dual Stage System:
  – Calculated Casing Pressure 1141 psi
  – Fluid Lift Per Cycle 0.62 bbls
  – Gas Used Per Cycle 7.62 Mcf
  – GLR Required 12.34 Mcf/bbl
  – GLR Actual 13.75 Mcf/bbl
SS 5-16 Specific Issues
Dual Stage Plunger System

- Two stages with the top stage only lifting the top 70% of the well and the bottom stage lifting the bottom 30% of the well.

- Foss and Gaul indications for dual stage:
  - Reduction in the necessary GLR
  - Excess allows stabilization, near wellbore unloading, and allows for slight fluctuation in system pressure.
  - Leads to the ability to clean the well up and to smaller loads
SS 5-16 2 Stage Plunger Cycle
Rate & Pressure vs Time

Time
Rate & Pressure vs Time

Time

BWPD  BLHCD  MSCFD  FTP  CP

Summary

• Single Stage Plunger Systems were no longer keeping wells unloaded.

• A second stage was added at approximately 70% of the length of tubing.

• A consistent increased production was observed.

• Operational efficiency improved.
Project Economics

- Project cost: $5,000 for two stage installation, $22,000 initial plunger and SCADA Installation.
  - 5 wells: 250 Mscfd total increase.
  - Average Incremental increase: 50 Mscfd.
    - Low of 25 Mscfd.
    - High of 70 Mscfd.
  - Dual Stage Payout: +/- 1 month.
Considerations for Applying 2 Stage Systems:

• Wells with GLR’s below necessary pressure and volume to lift a conventional plunger system.

• Field trials indicate that dual stage decreases lift gas requirements by 1-3 Mcf per Barrel.

• Plunger Wells with missed arrivals due to lower than required gas volumes for lifting a plunger from the bottom of the well.

• Plunger Wells that shut in on arrival due to significant inflow of fluid during the lift cycle.

• Plunger wells which are depleted to the point that casing pressure builds can no longer can lift the fluids.

• Wells that have previously been considered Rod Pump Candidates.
Keys to Successful Plunger Operation

• Frequent monitoring of plunger cycle trends.
• Plunger equipment and automation is mechanically sound and functional.
• Adjustment of plunger set points for changing conditions.
• Monitoring of plunger wear and changing warn out plungers.
• Catching missed arrivals early and making adjustments.
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