Gas Slugging in a Horizontal Well fitted with an ESPCP

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Initial Installation – 75 BPD Pump 1

- Screened shroud (screen below motor)
- 75 BPD ESPCP
- 10 Hp Submersible Motor
- Drive & Control System (with telemetry)
- Hung on coiled tubing with rubber centralizers
Well Information

- Fayetteville Shale
- Horizontal
- Toe-up
- 5.5” Casing
Initial Operation – 75 BPD Pump 1

- Upon initial gas production, the system began tripping for overload
- Run time before tripping was relatively consistent in the range of 10-20 minutes
- Theorized that gas was building up in the heel of the well and periodically being released as a large bubble
- This large bubble enveloped the shroud and completely filled it with gas that was then drawn into the pump
Control Valve – 75 BPD Pump 1
Installed in Gas Discharge Line on Surface

Valve Open
100 psi casing

Valve Close
after 2 hours

Motor Start
after 2.5 hrs

Motor Stop
trip on gas

Casing Pressure Builds up with Valve Closed

Rising Casing Pressure Pushes Water Level Down

(5 MINUTE DATA LOGGING INTERVAL)
Lab Testing To Prove Slugging Theory

- Mounted a 6” tube at 85° from vertical, inserted a shrouded pump
- Air tank fed end of tube to simulate large gas bubble
- Gas trapped in the shroud - motor load looked like it did in the well

Trip due to gas

Restart – gas not cleared
Lab Testing To Prove Slugging Theory

- Tested an ESPCP with no shroud in same set up
- Handled substantially more gas – (70 psi vs. 25 psi feed)
- System tripped
Lab Testing To Prove Slugging Theory

- Inserted a pump with an inverted shroud
- Could not get pump to trip due to gas
- 2 air lines – 100 psi feed pressure
In January, the area was unseasonably cold, resulting in frozen pipes. Line pressure dropped. Operation changed after high motor load event. Pump was unable to surface water and level began to rise.
System Failure - 75 BPD Pump 1

• The pump was pulled and brought to the lab for testing and analysis

• We found substantial wear in this pump and it was no longer able to pump any fluid
  • Large number of run-dry events
  • Over-pressure due to freezing at surface
New Opportunity – 75 BPD Pump 2

- Incorporate learnings from lab testing
- Install new system with inverted shroud
New Opportunity – 75 BPD Pump 2

- Incorporate learnings from lab testing
- Install new system with inverted shroud

**LIQUID RESERVE IN SHROUD ALLOWS CONTINUOUS OPERATION THROUGH PASSAGE OF LARGE GAS BUBBLES**
New Opportunity – 75 BPD Pump 2

• When gas started flowing the pump was able to operate without the surface control valve

• The inverted shroud had the desired effect

• We still experienced tripping due to large gas bubbles, but pump restarted
Second System Failure – 75 BPD Pump 2

- 1 month of operation
  - water reaching the surface began to taper off
  - Within a few days, water was no longer reaching the surface
- Leak in the tubing string was discovered
To eliminate the tripping altogether, we made 2 modifications:

- Lengthened the inverted shroud to increase fluid reservoir
- Moved the pump assembly further up the well (75° azimuth angle)
Second Opportunity – 150 BPD Pump

- The longer inverted shroud provided more capacity to fend off a gas bubble
- The more vertical setting helped increase the speed with which a large gas bubble clears our equipment

Successfully eliminated tripping due to gas bubbles
Current Status

• Operating for more than 7 months
• Still occasionally incurring gas event causing a trip
• Made a control change to add a backwards “bump” to every start pre-lubricate after gas event
• Recent Bucket Tests show some wear but still pumping at 80% of catalog curve value at lowest speed
• Well leveled off and varies between 145 feet and 170 feet above pump – cannot pull it down further
• Gas production still good
Conclusions

A properly applied ESPCP system can work in a horizontal gas well

- Inverted shroud to fend off large gas bubbles – PC pump handles small bubbles well
  - Applicable to ESP’s to deal with large bubbles
  - Inverted shroud can trap solids – screen mesh can be varied

- Control system capable of monitoring and responding to a variety of system parameters

- Positioning above the bottom of the well can help in dealing with large gas bubbles and solids
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