

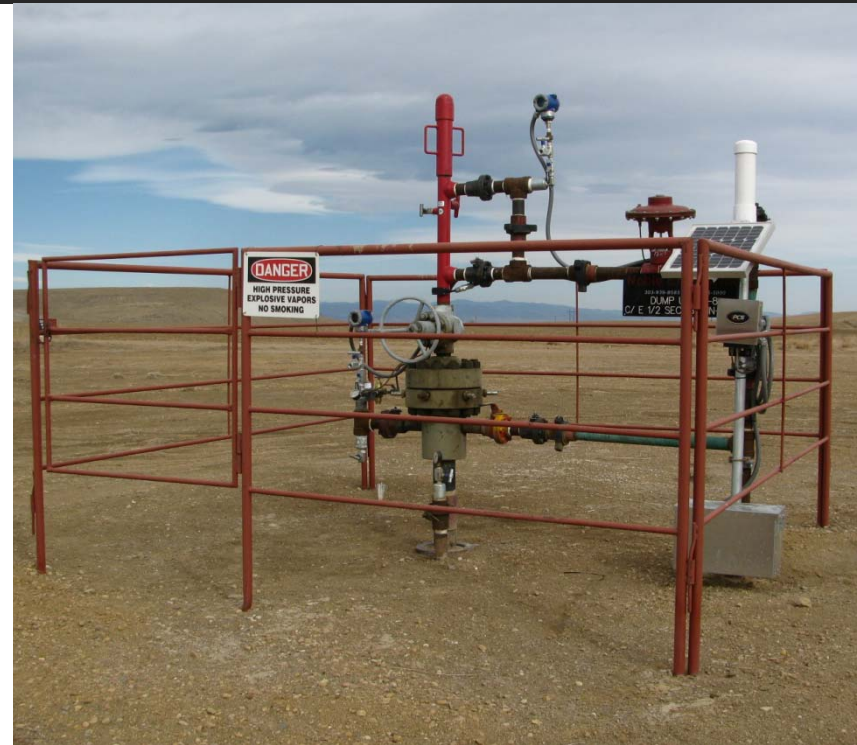


Multi-Stage Plunger Lift: An Economical Alternative to Pumping Units

Conventional Plunger Lift Overview

Performs best in wells:

- Producing primarily gas
- Producing at or near critical flow rate
- Accumulating large amounts of solids
- Producing light oil, condensate or water
- That are low volume or marginal
- That have tubing irregularities





Plunger Lift Advantages

- Efficiently removes accumulated liquids
- Can extend production to economic depletion
- Increases BHP drawdown to increase production
- Utilizes well's own energy; no power source needed
- Controls solid and hydrate buildup
- Performs well in deviations
- Low capital and operating costs



Plunger Lift Limitations

- GLR requirements and adequate associated gas: typically 4 Mcf to 1 Bbl ratio of gas to liquid needed
- Limited fluid removal volume
- Fall time is prohibitive in deep wells



Other Potential Lift Methods

Pump Jack/Beam Lift

Advantages

- Large fluid volumes
- Greater depths
- Requires little intervention
- Familiar to operators

Disadvantages

- High capital cost
- High operating cost
- Gas locking
- Challenging in horizontals

Soap Injection

Advantages

- Low capital cost
- Easy implementation
- Familiar to operators

Disadvantages

- High operating cost
- Not effective in oil

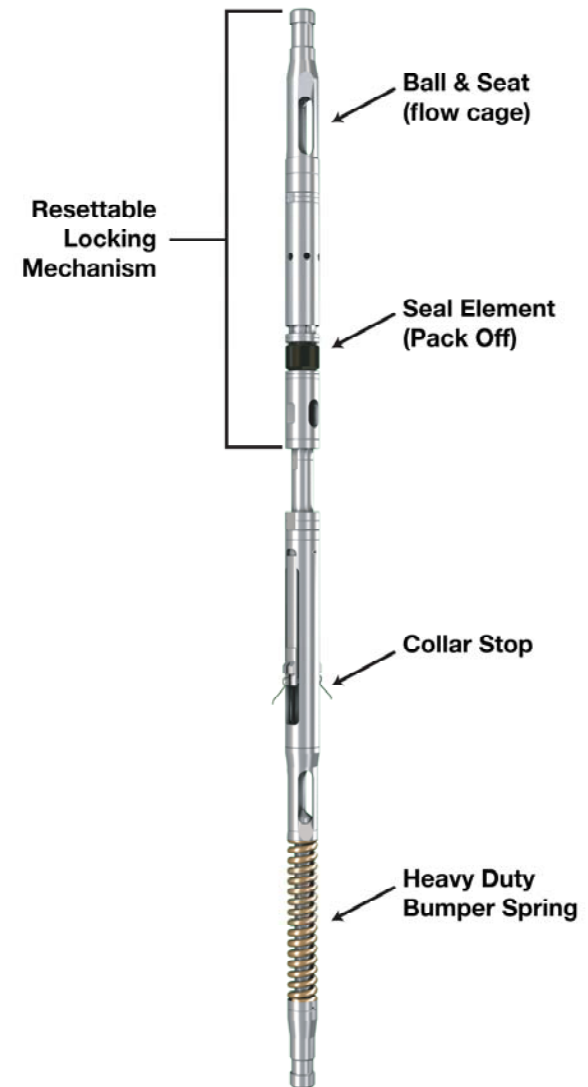


How Multi-Stage Plunger Lift Compares

- Can operate in GLRs nearing 1 Mcf to 1 Bbl gas to liquid
- Lower installation and maintenance costs (works with existing plunger lift equipment)
- Entirely mechanical; no power or fuel requirement
- Less expensive than pump jack; conservatively less than one-tenth of the cost
- Good performance in horizontal wells
- Better at removing solids and preventing buildup

The Multi-Stage Tool

- **Bumper spring** absorbs impact of arriving plunger
- **Collar stop** holds the tool in place in the tubing
- **Seal element (pack off)** ensures one-way flow of liquids and prevents slippage
- **Locking mechanism** holds tool in Open position until set
- **Ball and seat (flow cage)** and holds liquids for transfer to the upper plunger, which lifts and removes them





How Multi-Stage Lift Works

- Bottom assembly and plunger are installed.
- Tool is placed by wireline about 40-70% down the tubing, above the bottom plunger.
- First cycle: Bottom plunger carries fluids up to the tool. Tool holds the fluids above it.
- Top plunger is installed; it descends and lands at the tool.
- Next cycle: Top plunger delivers its fluids to surface. Bottom plunger delivers more fluids up to the tool.
- Plungers travel in tandem in subsequent cycles, delivering fluids first to the tool, then to the surface.

Pressure Vs. Delta Time

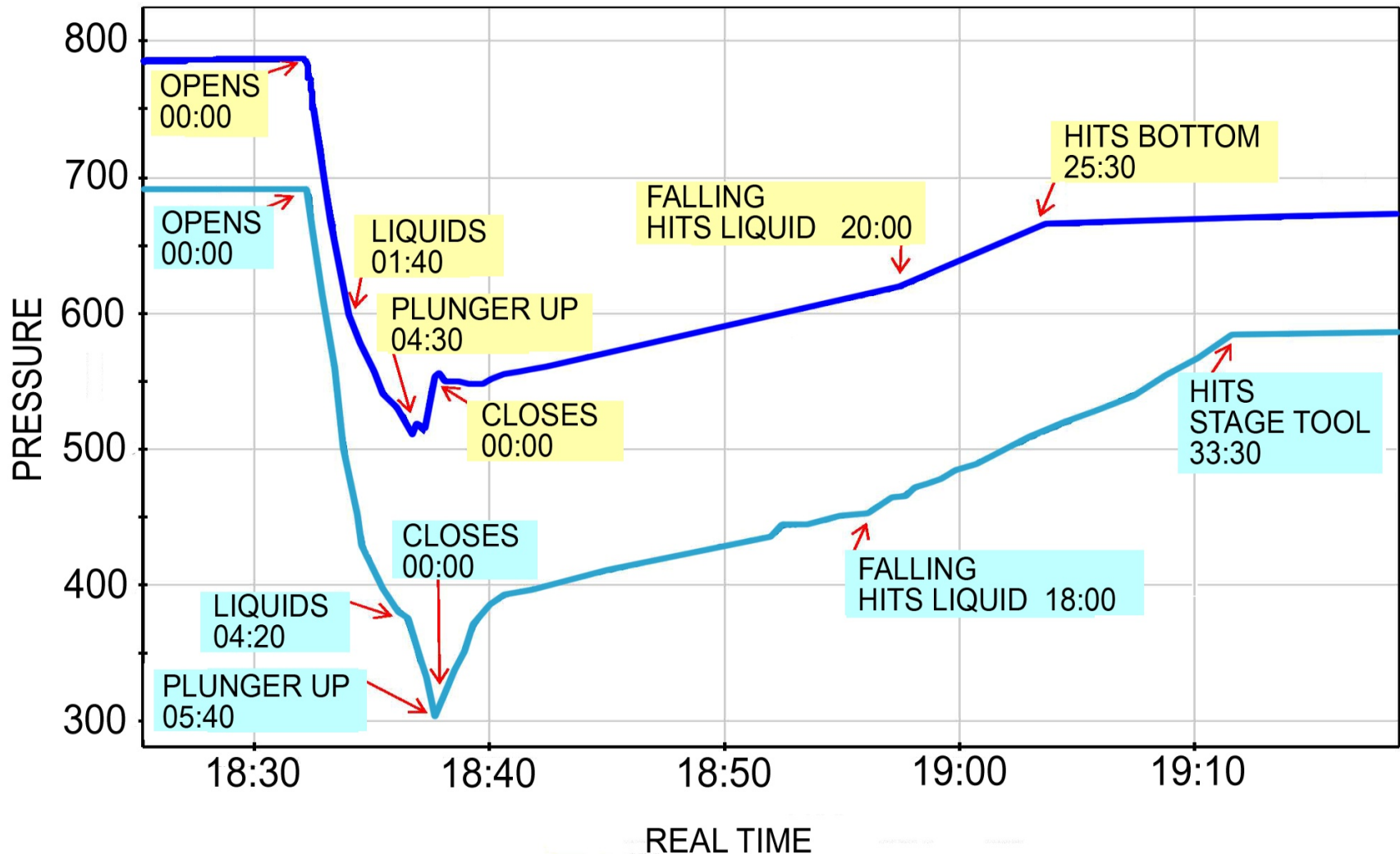


PRESSURE V. DELTA TIME

Bottom Plunger

Top Plunger

19676 - Pressure (PSIG)
19620 - Pressure (PSIG)





Case History A

Well A: Challenges

- Frequently loading up; no longer able to lift fluids on its own
- Plunger lift installed, but large amounts of liquids required long shut-in times
- When the plunger could run, tubing pressure often knocked down the separator
- Plunger was not able to cycle consistently
- Pump jack was considered, but cost was prohibitive



Case History A Results

- Multi-Stage Tool and upper plunger installed over existing plunger lift system
- Gas production increased from 17 to 124 Mcf/day
- After a few cycles, separator was able to function and consistent production was achieved

	Gas Production (Mcf/D)	Oil Production (B/D)
Before Stage Tool	17	12.6
After Stage Tool	124	12.6



Case History B

Well B: Challenges

- Inhibited by high production of frac sand and wax
- Plunger would not cycle consistently; well shut-in most of the time
- Pump jack installation and soap injection were considered



Case History B Results

- Multi-Stage Tool and upper plunger lift installed over existing plunger lift system
- After cleaning the tubing, sand production decreased
- Plungers began to cycle consistently and well was able to produce

	Gas Production (Mcf/D)	Oil Production (B/D)
Before Stage Tool	0	0
After Stage Tool	42	8.8



Comparison of Lift Options

Options	Advantages	Disadvantages
Multi-Stage Plunger Lift	Low capital cost Easy installation Familiar to operators	Can be labor intensive
Pump Jack	Familiar to operators Best reservoir drawdown	High capital cost Intervention often costly Challenging on horizontals
Soap Injection	Low capital cost Easy installation Familiar to operators	Expensive to operate Technology often not applied



Conclusion

- Multi-Stage Plunger Lift can cost-effectively increase production of gas and oil
- Extends range of plunger lift applications; possible in wells approaching 1 Mcf : 1 Bbl gas-to-liquid ratio
- Much more economical than pump unit (beam lift); installation and maintenance costs are significantly lower than beam pumping
- More effective in oil-rich environments than soaping



Contact PCS to Learn More

[Click here](#)

or email information@pcslift.com
to learn more about multi-stage plunger lift.

