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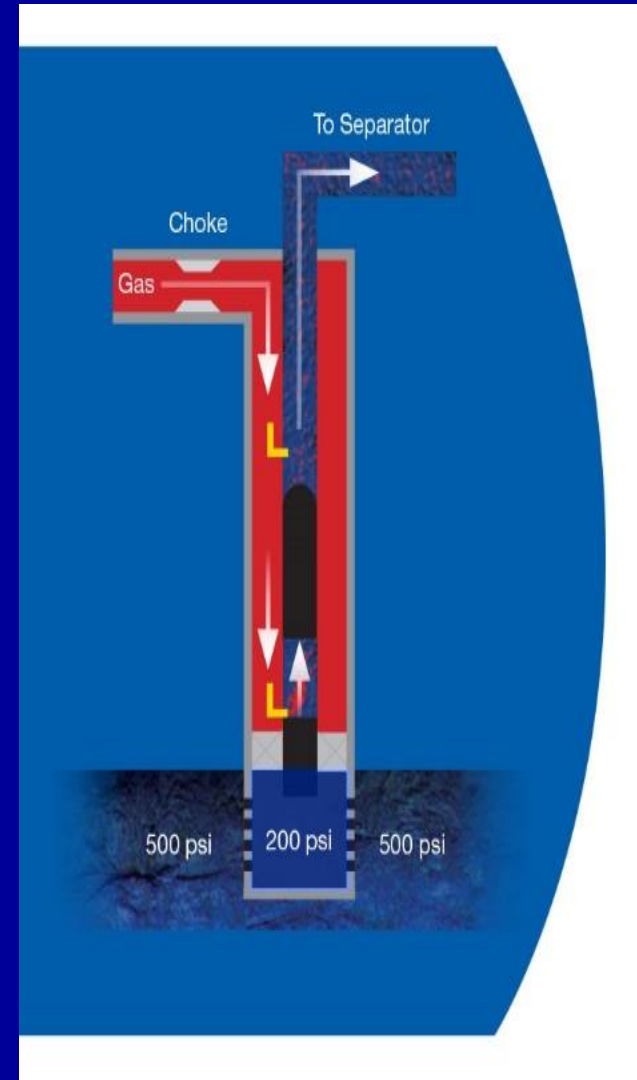
Intermittent Gas Lift Utilizing a Pilot Valve

- Matt Young Technical Sales Manager



Intermittent Gas Lift

Intermittent gas lift is an artificial lift method in fields where formation pressure has dropped to a level where continuous injection gas lift is no longer sustainable or very inefficient. Or in fields with high formation pressure but very low productivity.

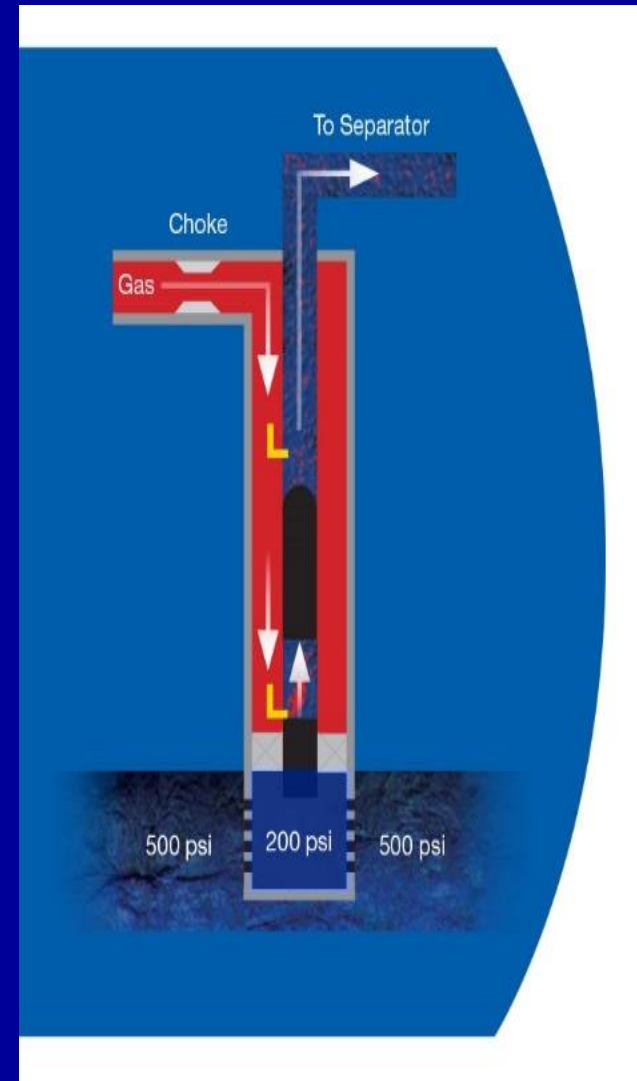


Intermittent Gas Lift-Basic Features

Injection gas is periodically injected into the flow string at a depth close to the perforations, and is used to physically displace a liquid column. The liquid column is allowed to accumulate above the pilot valve during the non-injecting cycle of the system.

When the proper amount of gas is injected below the liquid column, the liquid slug is lifted up to the wellhead and into the flowline.

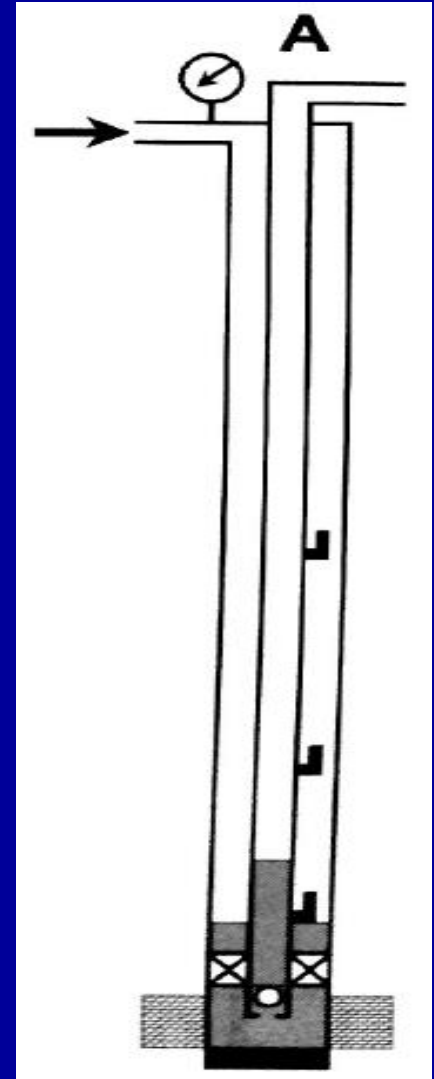
Well production, therefore, occurs in a periodically repeating cycle. The basic mechanism for fluid lifting is the physical displacement of the liquid slug by high pressure lift gas.



Pilot Valve Gas Lift-Operations

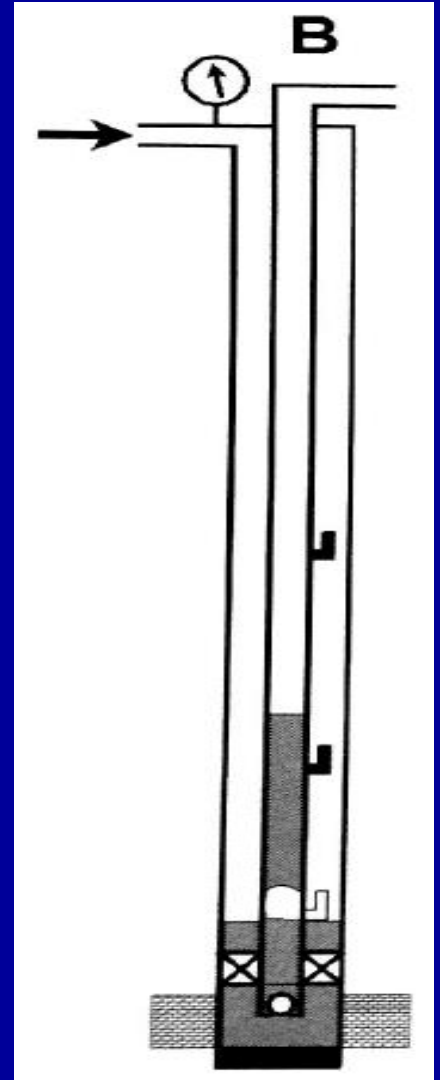
The well has a pilot valve with a standing valve at the bottom of the tubing string, unloading valves can be placed above the pilot valve to help unload after a work-over completion.

A. Injection gas is continuously injected into the casing/tubing annulus at a controlled low rate <400 mcf/d. The pilot valve is closed with formation fluid accumulating above the valve. Casing and tubing pressure at the valve depth increase until the desired slug length is accumulated, then the pilot valve opens, and injects gas below the liquid column.



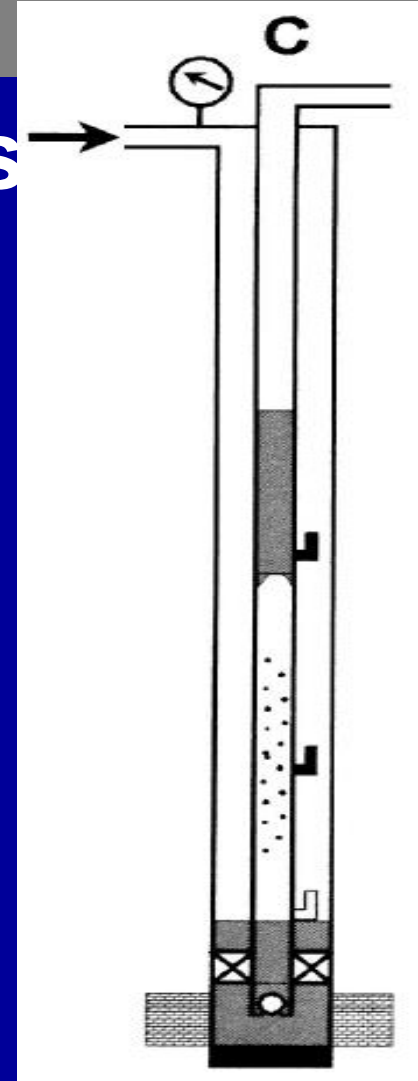
Pilot Valve Gas Lift-Operations

B. Injection gas at high pressure (200-300 psi ΔP) enters the tubing string at a instantaneous rate, creating a large gas bubble below the liquid slug.



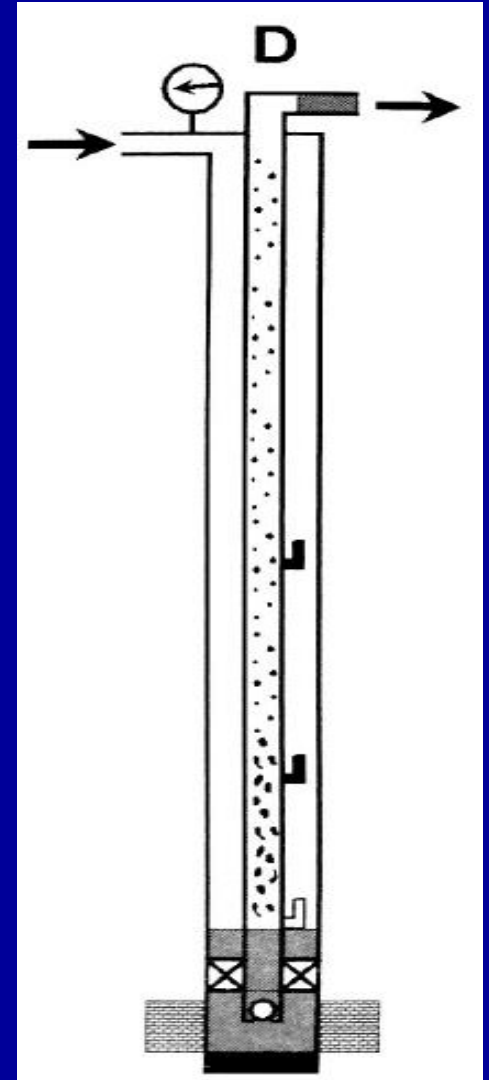
Pilot Valve Gas Lift-Operations

- C. The gas bubble propels the slug upward along the tubing string to surface. Once unloaded at surface the tubing pressure bleeds down to separator pressure.
- D. At this point in the cycle, the lowest FBHP is achieved due to a wet gas gradient plus wellhead pressure acting on the reservoir.



Pilot Valve Gas Lift-Operations

E. Once the fluid slug and gas bubble is unloaded to surface, well inflow through the now open standing valve begins and the pilot valve closes. The cycle then repeats itself.



Pilot Valve Gas Lift-Applications

Intermittent gas lift can be used as an alternative for positive displacement pump applications, as it is able to achieve similar FBHP.

The approximate maximum fluid rates for intermittent lift at different tubing sizes:

- 75 bfpd for 2 3/8"
- 125 bfpd for 2 7/8"
- 200 bfpd for 3.5"

Total recovered fluid is based on number of cycles per day, and how much fluid can be recovered with each cycle.

Pilot Valve

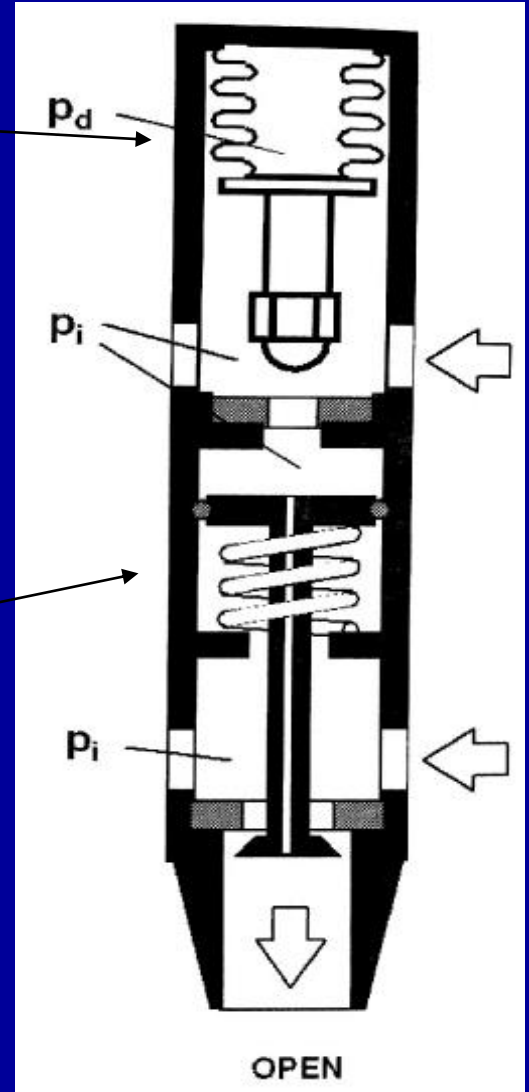
A pilot valve contains two valves in one:

A. The Pilot Section

B. The Power Section

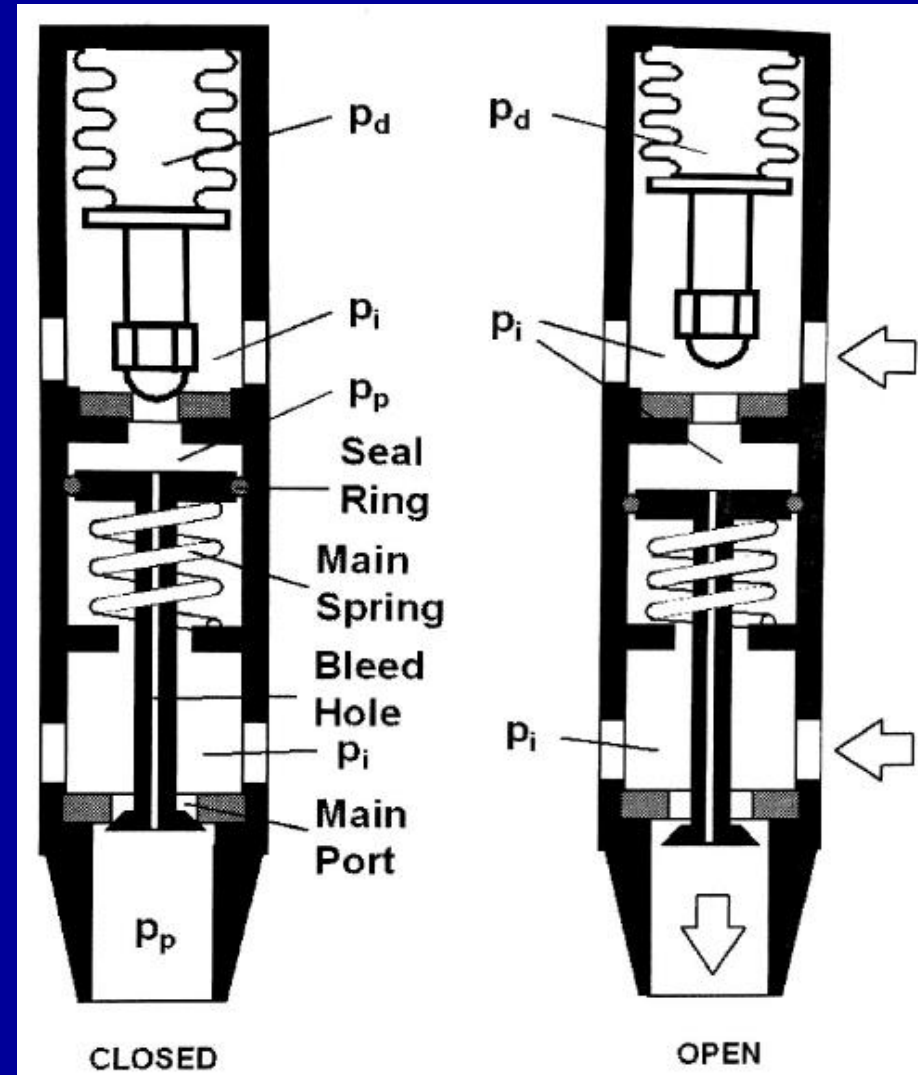
Pilot Section

Power Section



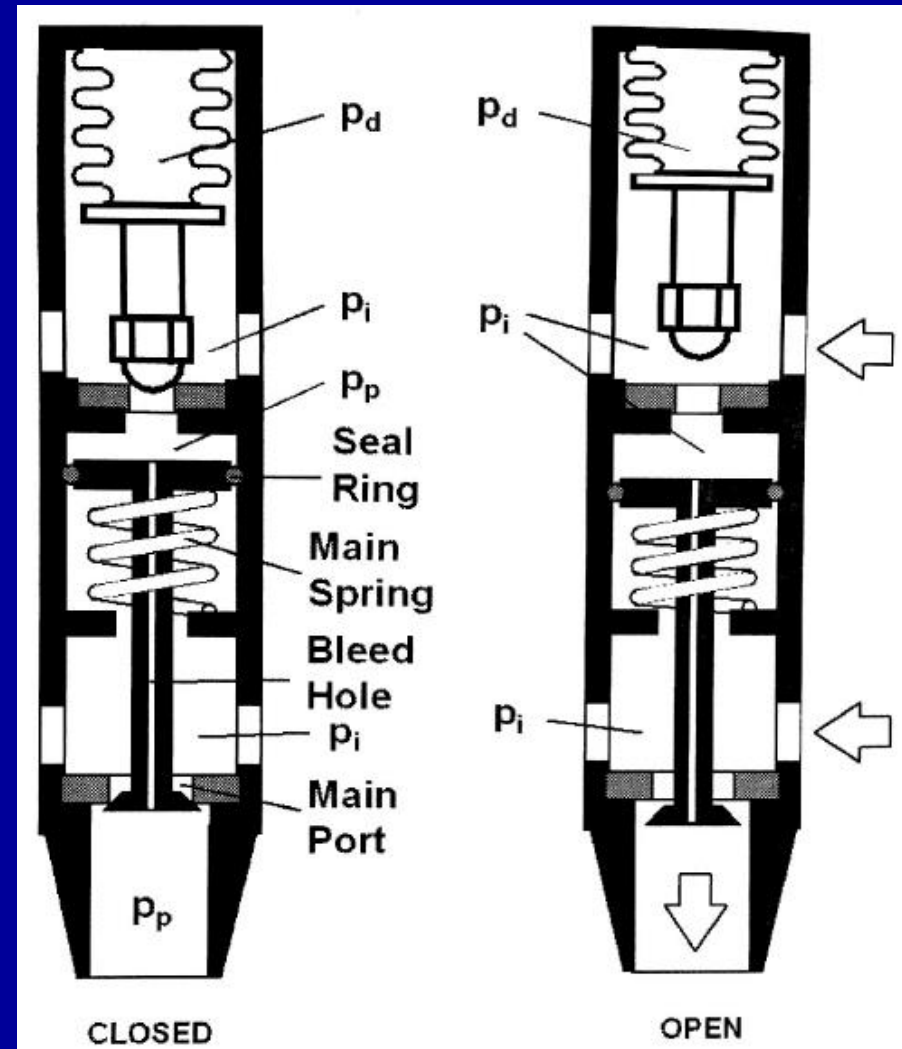
Pilot Valve

In the closed position, both the pilot and power section are closed. The bleed hole in the power section allows tubing pressure to act on the pilot section port. Once the injection and tubing pressure equal the required opening force, the pilot section opens and injection pressure fills the power section area.



Pilot Valve

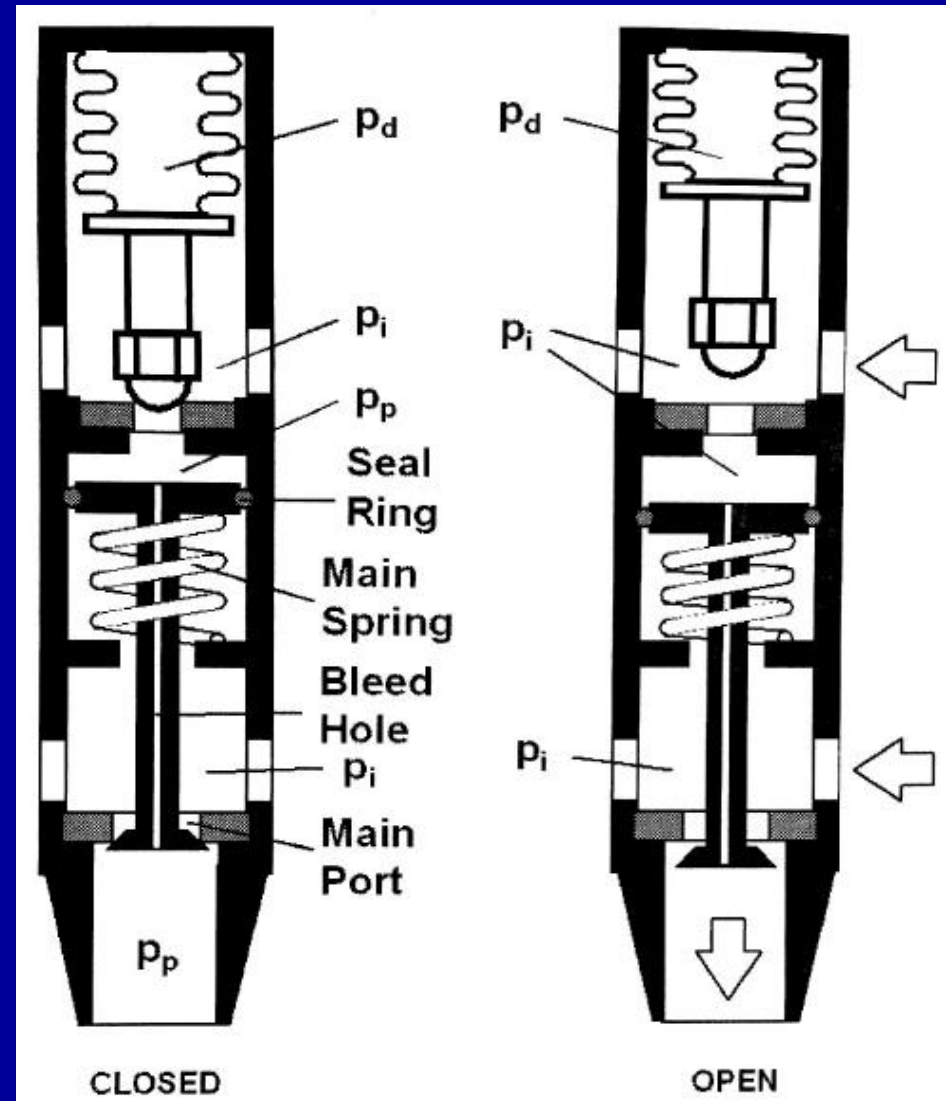
In the open position, the injection pressure acting on the piston area compresses the power section spring, causing the main port to open, and discharges injection gas rapidly into the tubing below the liquid slug. The large differential (200-300 psi) across the piston, allows for the piston to snap open and injection gas instantaneously passes through the main discharge port.



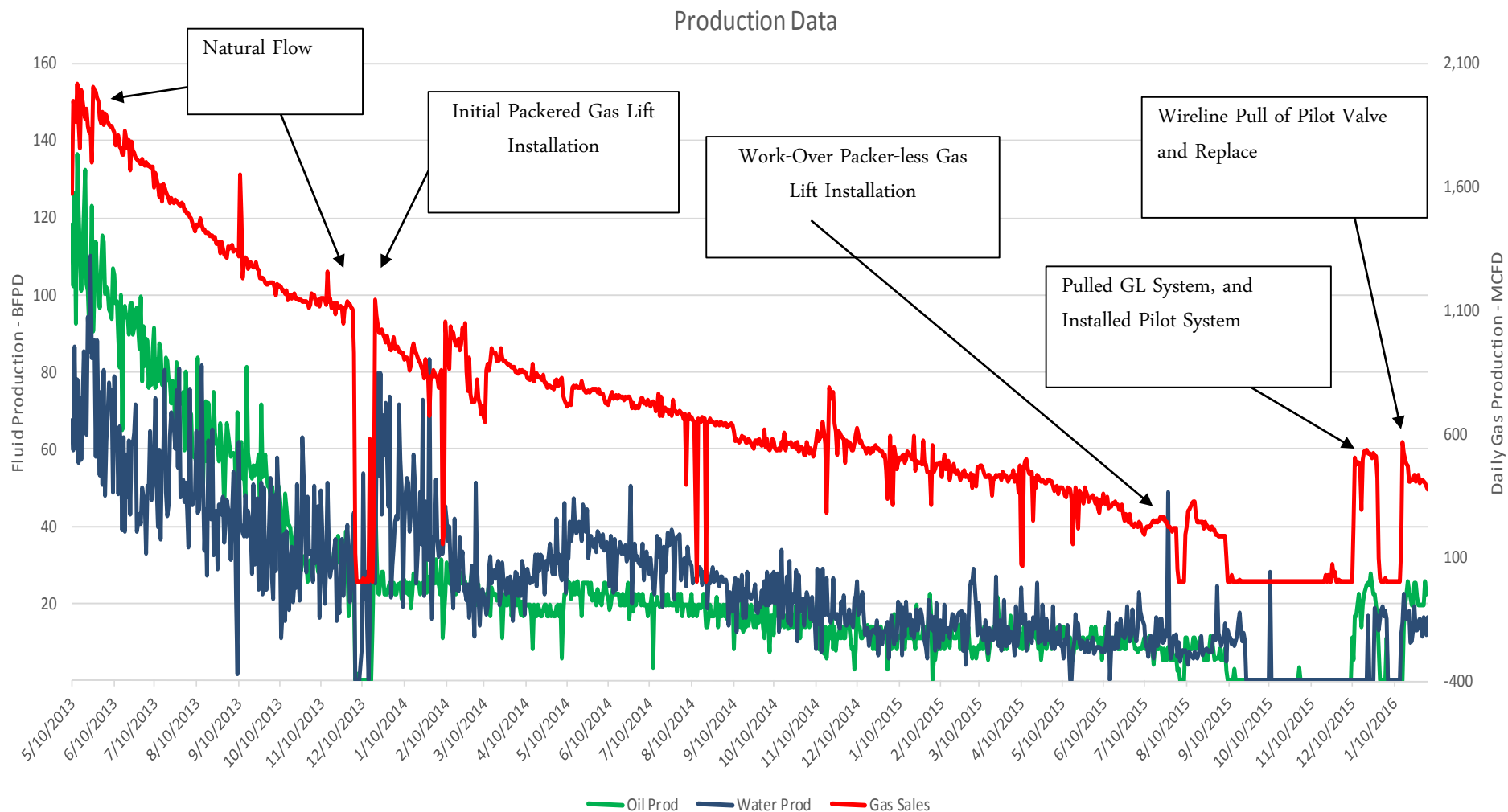
Pilot Valve

While the liquid slug is traveling to surface, the injection pressure and tubing pressure is decreasing until it reaches the closing pressure of the pilot section. Once the closing injection pressure is reached, the pilot section closes. This reduces the force acting on the power section piston, and the power section closes stopping injection into the tubing.

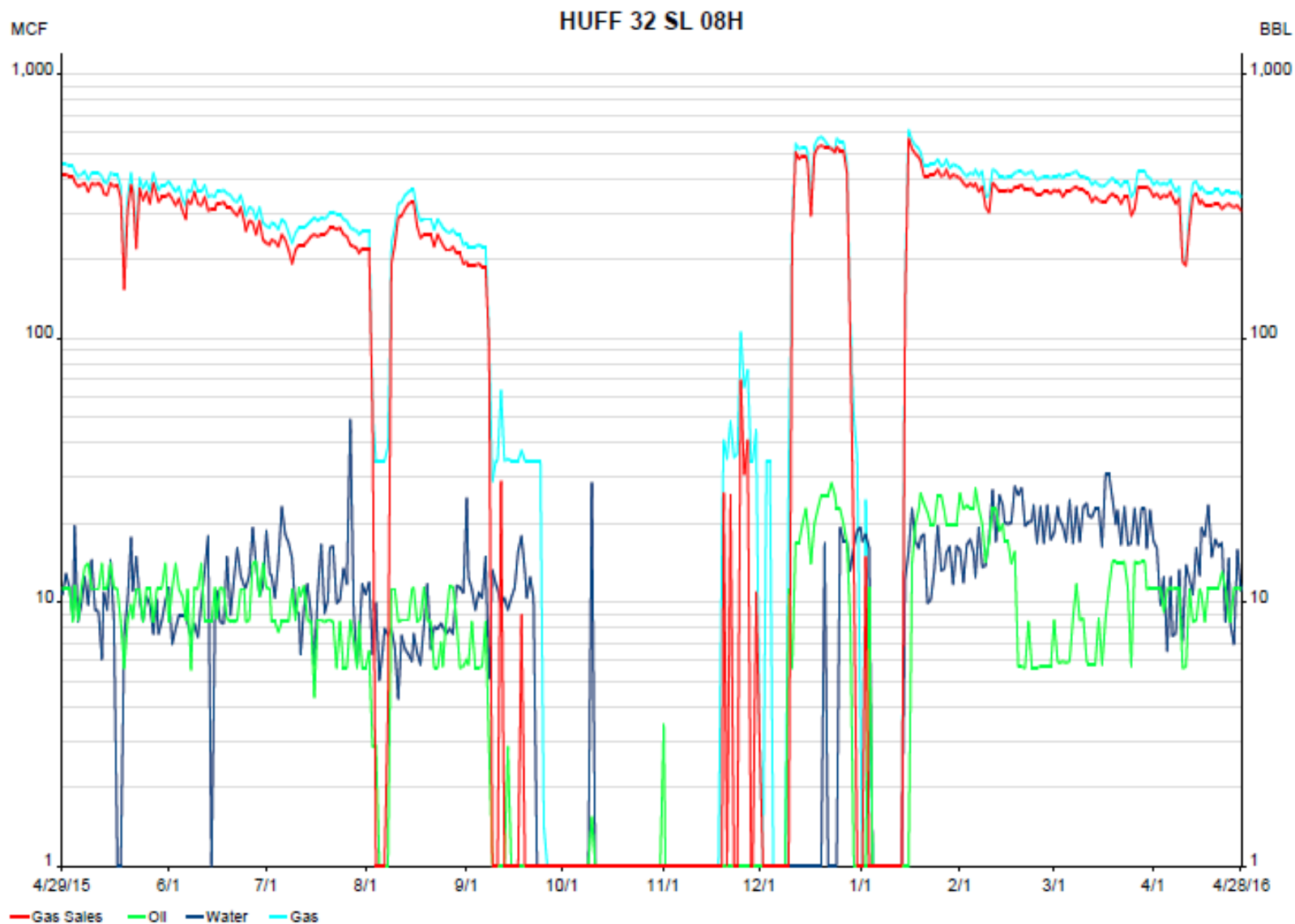
During this phase, the casing pressure begins to build until it reaches the opening pressure of the pilot section.



Huff 32 SL 08H Production – Total Production

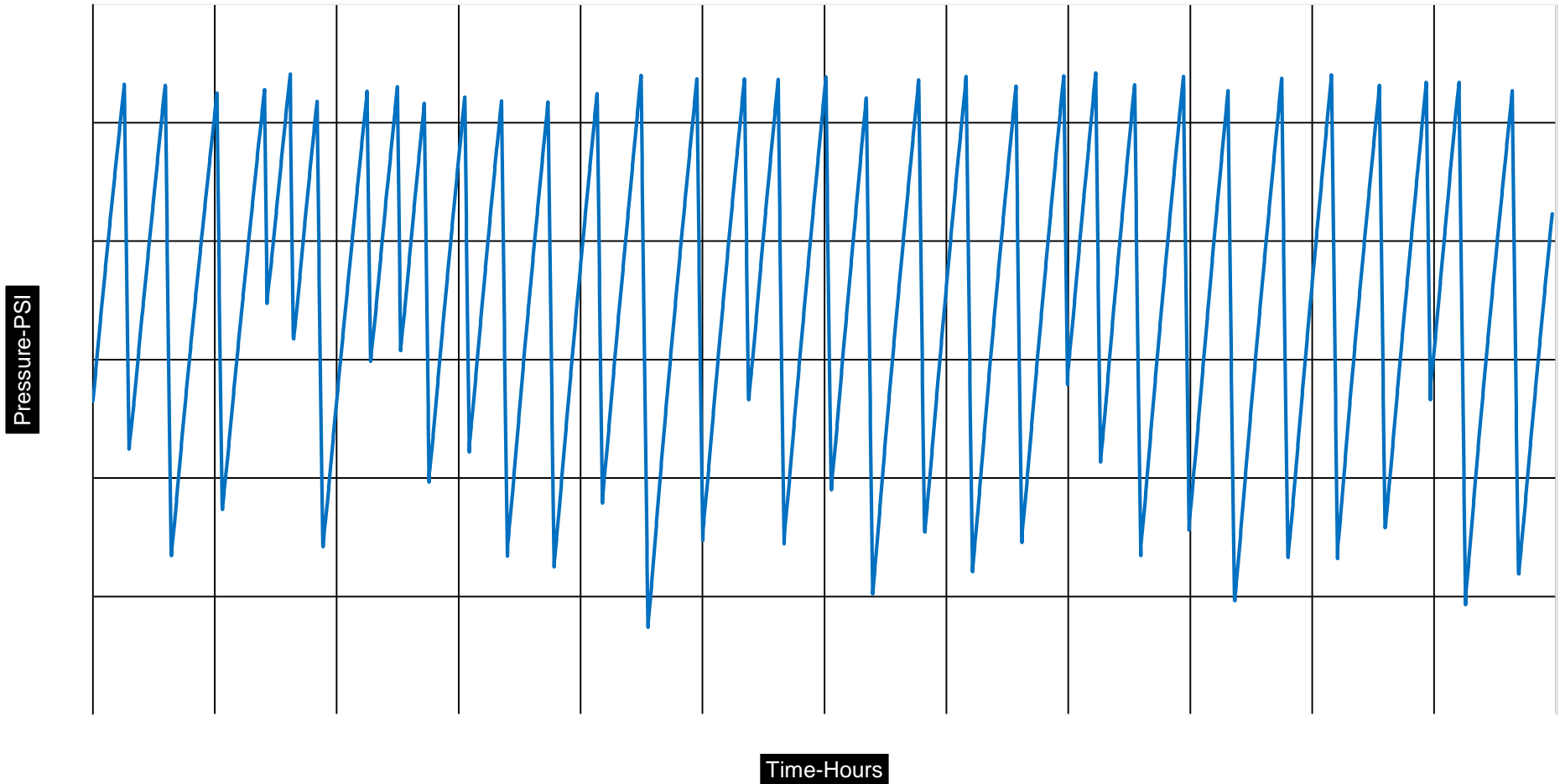


Huff 32 SL 08H Production – Total Production



Huff 32 SL 08H Injection Pressure Cycles

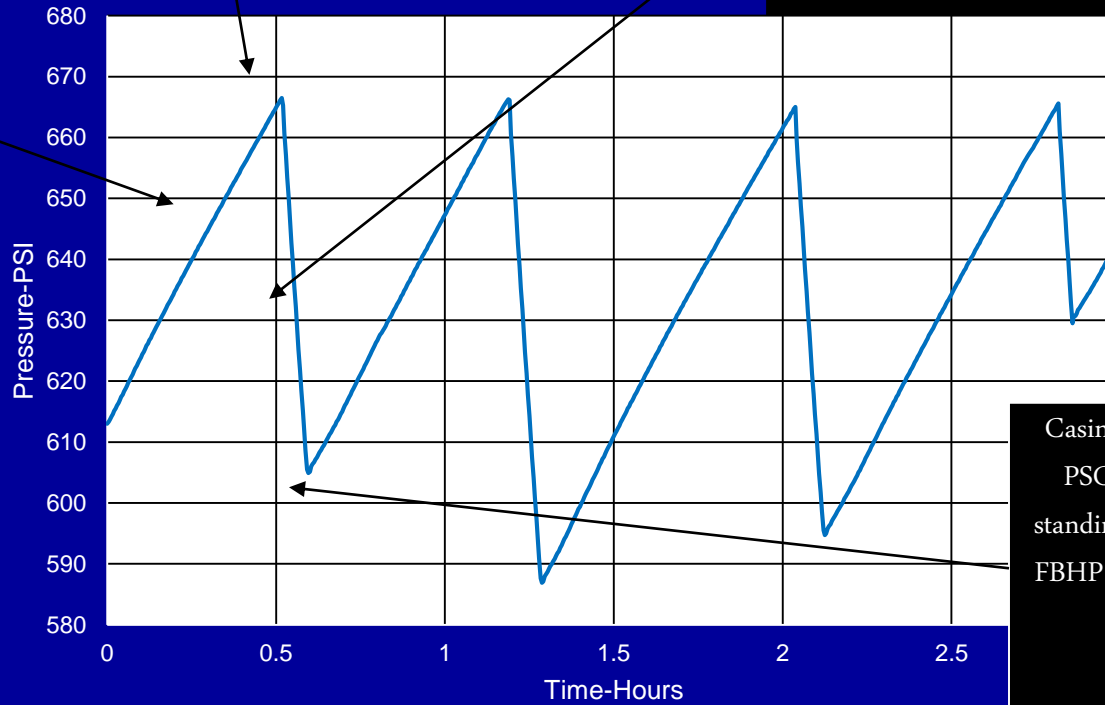
Casing Pressure Cycles



Casing pressure plus tubing load achieves the valve PSO.
Standing valve closes, once injection enters the tubing string.

The pilot valve is open and injecting a large bubble
of gas into tubing, and under fluid column. Gas
velocities are high enough to carry fluid column to
surface. Standing Valve still closed.

Casing Pressure Cycle



Casing pressure drops to the pilot valve
PSC, the tubing is void of fluid, and
standing valve is open. The instantaneous
FBHP is gas gradient + wellhead pressure

Casing Pressure Build to
Valve PSO, currently the
valve is closed and fluid is
feeding into the tubing,
standing valve is open
until hydrostatic pressure
from the liquid inflow
equalizes with the BHP

Huff 32 SL 08H - Summary

- A Total of 33 Cycles Per Day
- Averaged production of 40 bfpd
- 1.22-1.25 bbls per cycle w/ 1-3% fluid loss
- Calculated fluid column above the pilot valve during each cycle is ~216 ft.
- Reservoir Pressure 355 psi
- Average Wellhead Pressure of 90 psig
- Standing Valve Depth = 10,750' MD – 10,676' TVD (50 Degrees)
- Injection Cycle of 14 MCF

Closed:

- Total Pressure @ standing valve = 350 psi

Open:

- Instantaneous Flowing Pressure @ standing valve = 117 psi

Lessons Learned

- Utilize Plunger Lift System to improve lift efficiency
- Include unloading gas lift valves to prevent swab runs during compressor down time
- Install orifice valve after work-over to clean well up before installing pilot valve and plunger system.
- Set packer and pilot valve as deep as feasible possible
- Tested applications in Eagleford, Permian Basin, and Granite Wash

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