PLUNGER ASSISTED GAS LIFT IN THE PERMIAN BASIN

Mike Swihart
PROLIFTCO (Production Lift Companies)

ABSTRACT

Over the last few years Gas Lift has become a popular artificial lift choice for producing unconventional wells in the Permian Basin. Gas Lift is a good choice for producing wells with high bottom-hole pressures (BHP) and high gas liquid ratios (GLR). Gas Lift is also a good choice for wells that produce solids or have deviated wellbores. Gas Lift however, like all artificial lift choices, has an optimum range which typically tends to be above five hundred barrels per day. When Gas Lift gets below five hundred barrels per day inefficiencies begin to surface with regards to the amount of fluid produced relative to the amount of gas injected. These inefficiencies can be addressed by running a hybrid system of gas lift and plunger lift to help maximize fluid production and minimize injection gas with the use of an interface tool known as a plunger that free cycles up and down the tubing and keeps gas from breaking thru fluid while flowing to surface. The system known as Plunger Assisted Gas Lift (PAGL) for continuous flow gas lift systems is becoming more popular and some operators have gone almost exclusively to this choice as Gas Lift wells begin to mature. This paper will highlight operators in the Permian Basin who have successfully integrated these systems into their long- term production plans and review before and after production numbers, costs, estimated annual savings and increases to net revenue. The mechanical aspects of the system will be reviewed as well as installation and best operating practices. Additionally, a preview of producing a well intermittently as it continues to decline by another hybrid system known as Gas Assisted Plunger Lift (GAPL) will be reviewed.

INTRODUCTION

There are unconventional wells coming on-line every month in the Permian Basin. Most of these wells will have high bottom-hole pressures and initially flow on their own. However, after the initial flow back phase, pressures and rates decline and wells will begin to liquid load. At this point some type of artificial lift choice needs to be considered. The Permian Basin has historically been an oil basin and the predominant artificial lift choice has been some type of pump. However, new unconventional horizontal wells currently being completed will generally have unconventionally high bottom-hole pressures and flow rates which are not easily pumped. Many operators have had difficulty identifying the best artificial lift choice at various phases of a well's production life. Many times these wells are put on electrical submersible, hydraulic, jet or rod pump only to discover that the higher bottom-hole pressures or gas volumes can compromise pump efficiency and hold back production. Gas lift has become a more appropriate lift choice under these conditions.

GAS LIFT

Unconventional wells in the Permian Basin will have high liquid production rates as well as high bottom-hole pressures when they first begin to liquid load. This makes them good candidates for Gas Lift. Gas Lift increases the gas liquid ratio by injecting additional gas down the casing into the tubing, which lightens the gradient of the flow stream causing the well to flow. Gas Lift is a good lift choice for wells producing from five hundred to five thousand barrels per day. Below five hundred barrels inefficiencies

begin to occur. Although not much at first, at around 300 barrels per day (BPD) it will be more apparent that the amount of injection gas used in relation to fluid produced is increasing. In this range it is a good idea to consider Plunger Assisted Gas Lift to help minimize the amount of gas required to get fluid to surface.

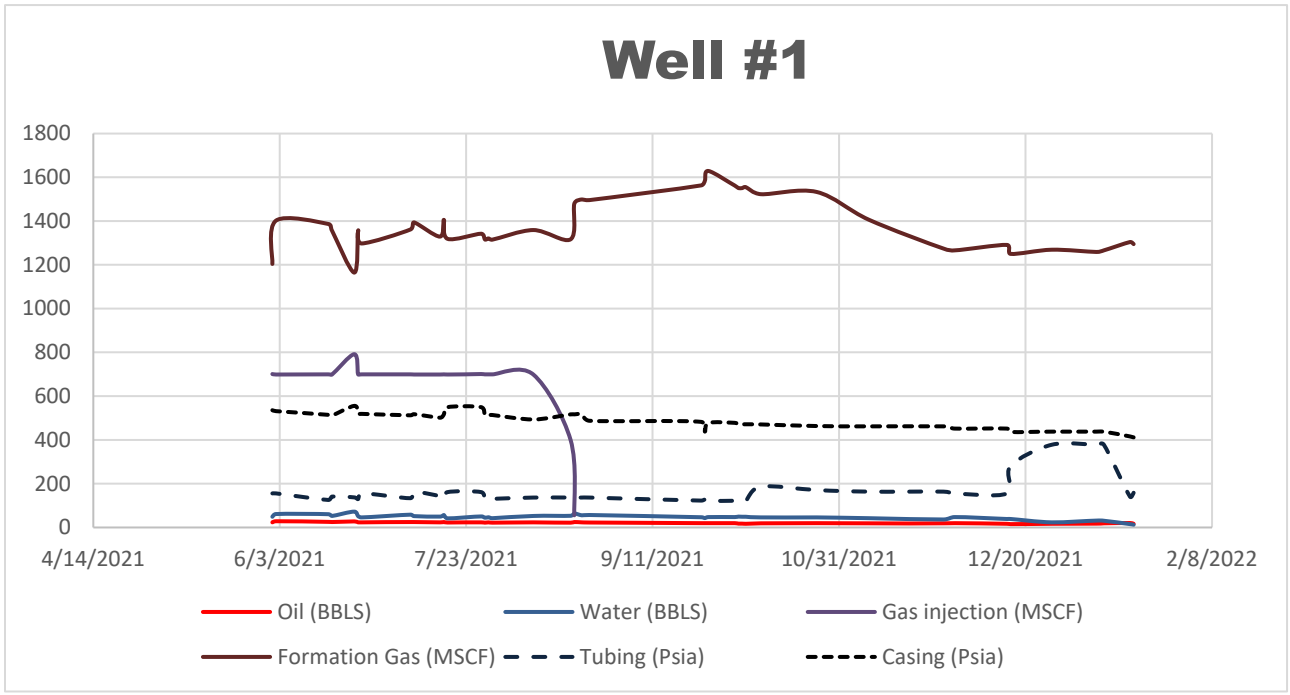
PLUNGER ASSISTED GAS LIFT (PAGL)

In production rates less than 500 BPD is where gas lift begins to be less efficient it is becoming more common to combine gas lift with plunger lift in a hybrid system referred to as Plunger Assisted Gas Lift (PAGL). With PAGL the well is still being produced by continuous gas lift injection. The plungers utilized for this operation are specifically designed with a large bypass to fall against flowing rates, thereby allowing for the continuous gas lift operation to continue simultaneously. When on bottom the plunger bypass is closed and now serves as an interfacing seal between the liquids above it and the injection gas below it. This interface serves to keep gas from bypassing the fluid. The down-hole spring assembly that the plunger stops on is strategically placed above the operating injection valve. It is important to have a proper gas lift design that will prevent multiple gas lift valves from opening and closing down hole know as multi-porting that would compromise the operation. There are two types of plungers used for this operation. These plungers are known as “Bypass Plungers” because they allow for gas and fluid to pass through them as they fall to bottom. One type has an internal valve incorporated within the plunger body that is used in the lower production rates. The other plunger used in higher production rates is a two-piece plunger that separates at surface. Each piece drops independently of the other and reconnects at the down-hole spring assembly to reseal. By trapping gas below the plunger and fluid above it the problem of gas bypassing fluid is minimized and the amount of injection gas can be reduced. As a well’s fluid production declines the amount of required injection gas can be reduced and sometimes completely shut off. At this point the well is being produced solely as a plunger lift system.

EXAMPLE WELLS

PAGL WELL DATA

	Well #1	Well #2	Well #3	Well #4
Install Date	21-Aug	21-Aug	21-Nov	21-Nov
Tubing Size	2-7/8"	2-7/8"	2-7/8"	2-7/8"
Packer Depth	8100'	8220'	8551'	8050'
Oil (BPD)	25	25	35	30
Water (BPD)	55	150	130	150
Gas (MCFD)	1300	1000	600	700
Inj Gas (MCFD)	700	500	1000	800


Well #1
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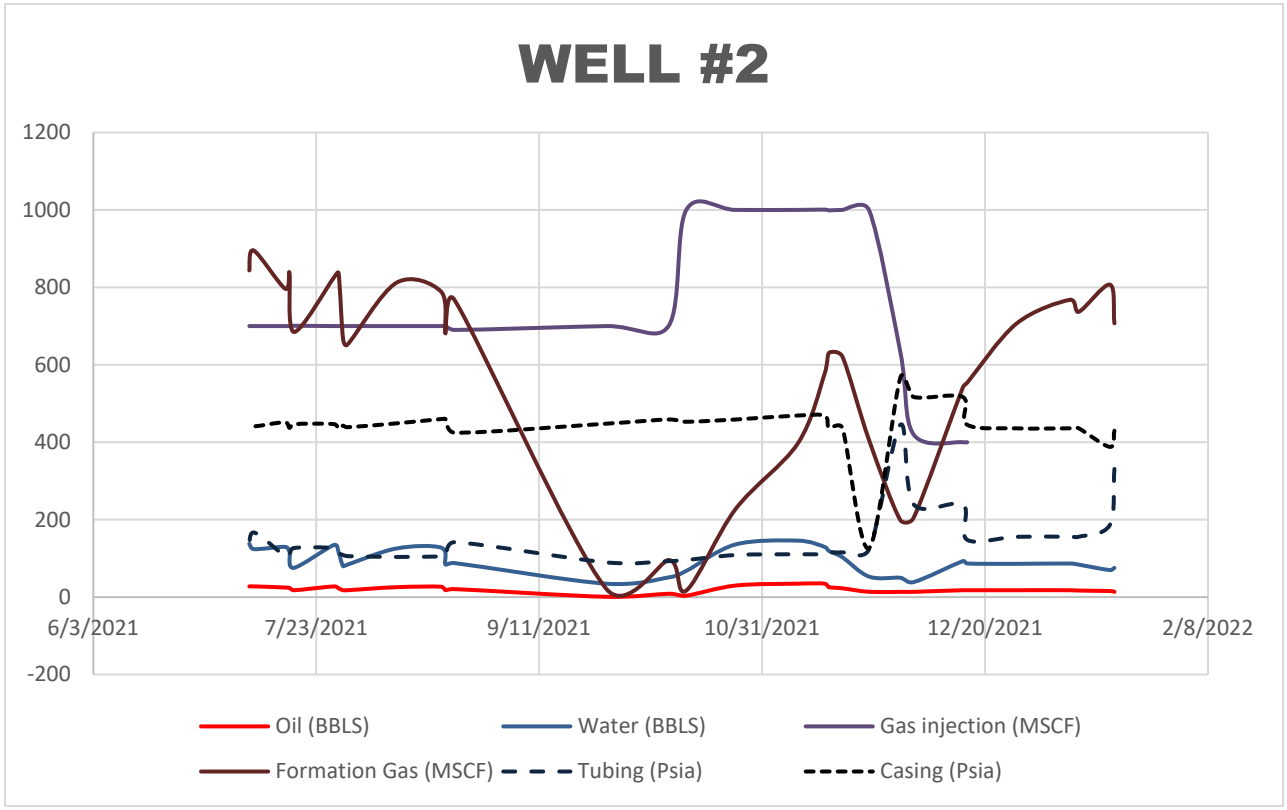
1600
1400
1200
1000
800
600
400
200
0
4/14/2021
6/3/2021
7/23/2021
9/11/2021
10/31/2021
12/20/2021
2/8/2022
Oil (BBLS)
Water (BBLS)
Gas injection (MSCF)
Formation Gas (MSCF)
Tubing (Psia)
Casing (Psia)


WELL #2
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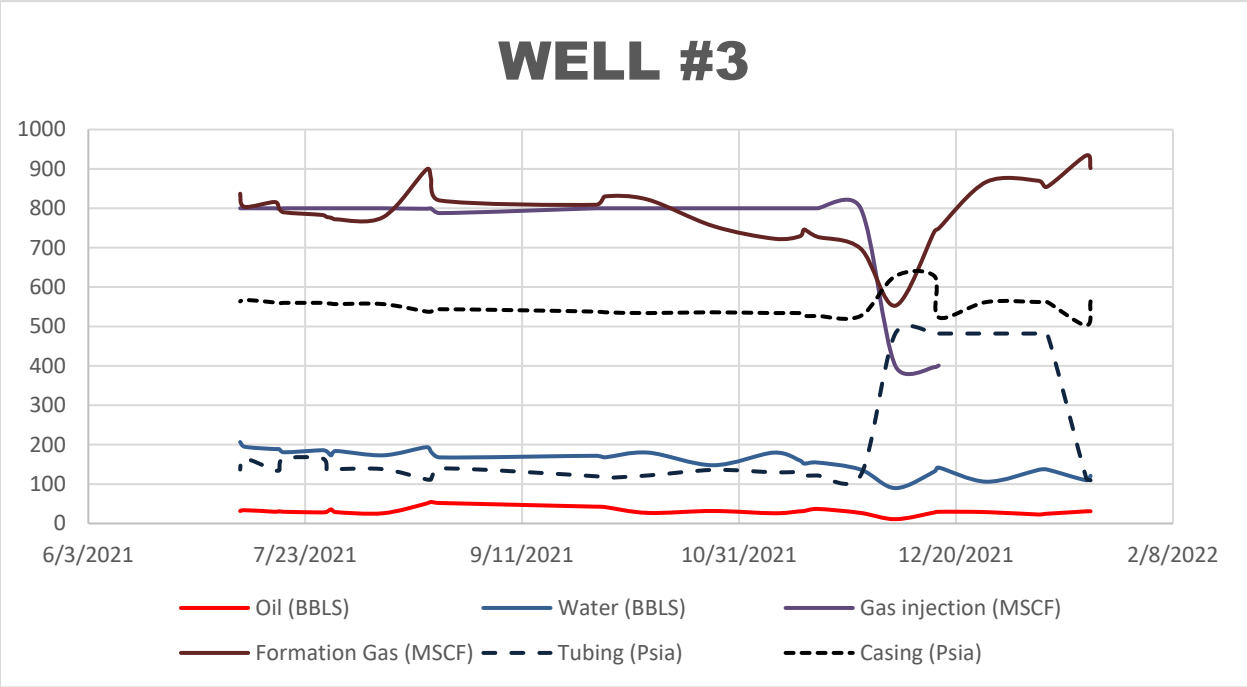
1000
800
600
400
200
0
-200
6/3/2021
7/23/2021
9/11/2021
10/31/2021
12/20/2021
2/8/2022
Oil (BBLS)
Water (BBLS)
Gas injection (MSCF)
Formation Gas (MSCF)
Tubing (Psia)
Casing (Psia)


WELL #3
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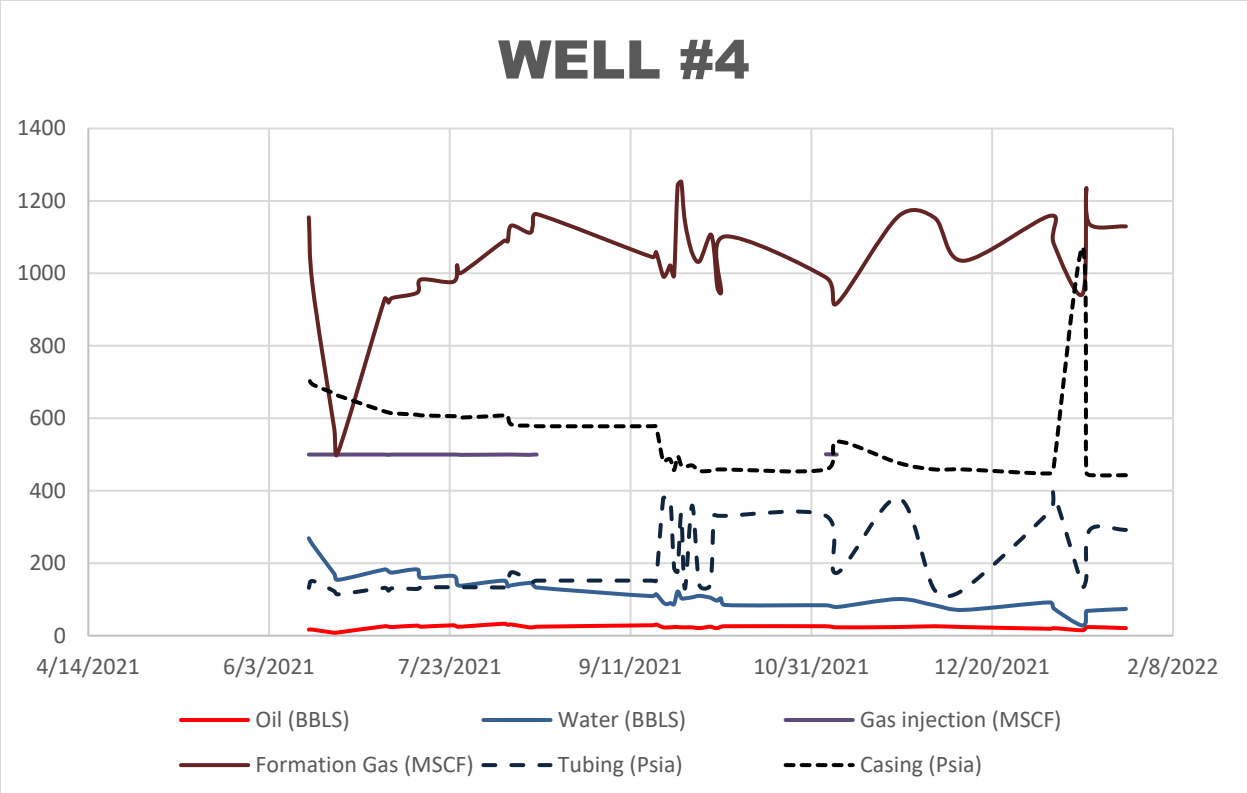
900
800
700
600
500
400
300
200
100
0
6/3/2021
7/23/2021
9/11/2021
10/31/2021
12/20/2021
2/8/2022
Oil (BBLS)
Water (BBLS)
Gas injection (MSCF)
Formation Gas (MSCF)
Tubing (Psia)
Casing (Psia)


WELL #4
1400
1200
1000
800
600
400
200
0
4/14/2021
6/3/2021
7/23/2021
9/11/2021
10/31/2021
12/20/2021
2/8/2022
Oil (BBLS)
Water (BBLS)
Gas injection (MSCF)
Formation Gas (MSCF)
Tubing (Psia)
Casing (Psia)

SUMMARY PLUNGER ASSISTED GAS LIFT

The four example wells had total fluid production from 80-180 BPD (Oil 25-35 BPD) and gas production of 600-1000 MCFD. Producing depths ranged from 8100-8550 feet. Injection gas ranged from 700-1000 MCFD. In each well injection gas was eventually completely shut off and the wells we able to produce themselves with no outside energy. They each had transitioned to plunger lifted wells and essentially maintained prior production. Estimated gas injection savings was 3MMCFD at $4.25/MCF/Month ($12,750/Month) or $153,000 per year. All injection gas was able to be diverted to newer gas lifted wells with no additional injection gas costs.

GAS ASSISTED PLUNGER LIFT (GAPL)

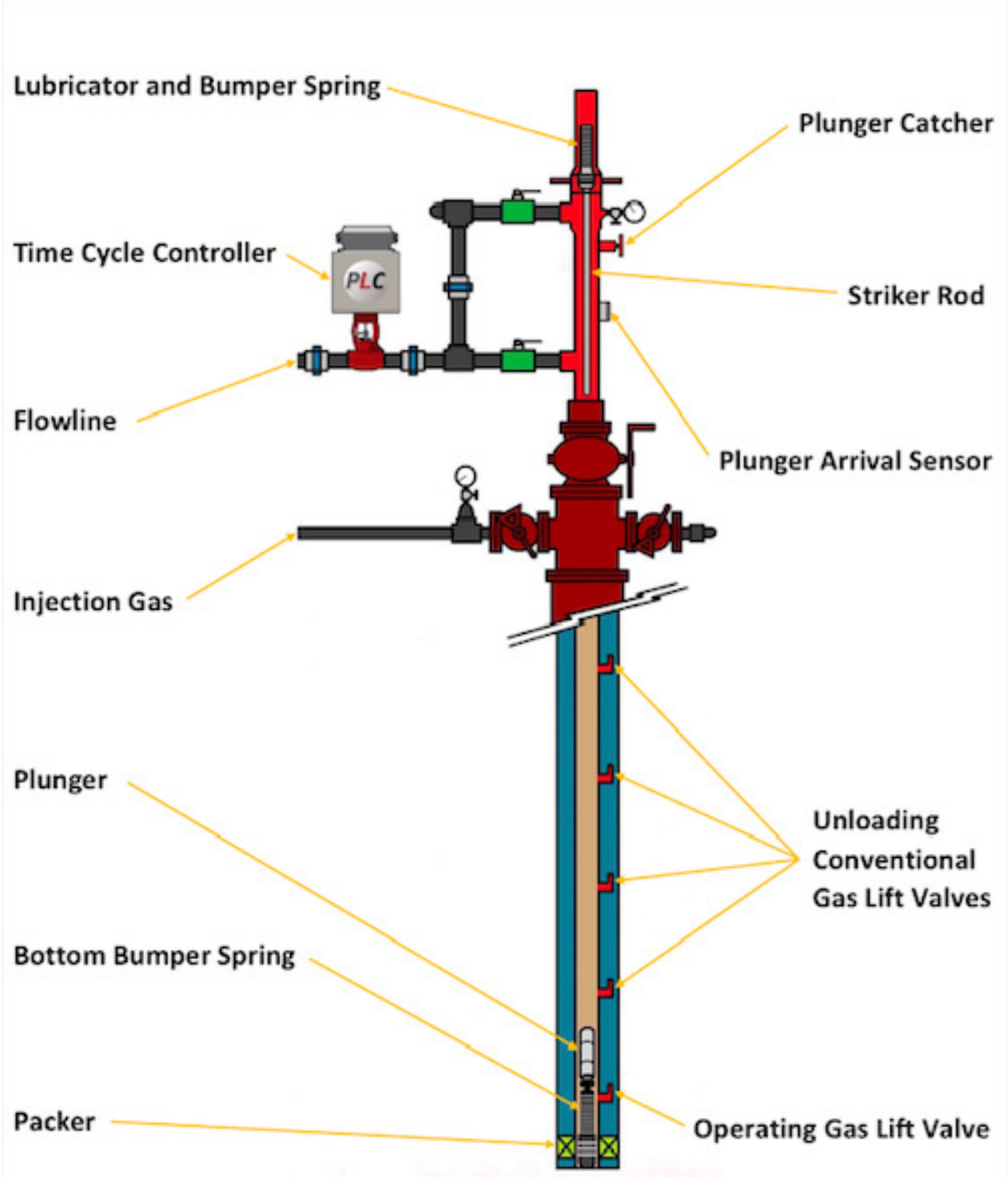
Later in the life of a well when gas and pressures further decline Gas Assisted Plunger Lift (GAPL) is an excellent option due to the existing gas lift infrastructure in the field and down hole. GAPL is an intermittent operation that involves reinjecting gas down the casing to drive the plunger to surface. The down-hole spring assembly will still need to be above the operating valve. A standing valve might need to be inserted in low Bottom Hole Pressure (BHP) wells in the seating nipple below the operating valve to prevent injection gas from going into the reservoir. Gas is again intermittently injected down the casing during each plunger cycle to assist the plunger to surface. Injection gas is limited to just enough to surface the plunger. This operation is essentially a low-cost pump option and may be utilized for the remaining life of the well.

CONCLUSION

Plunger Assisted Gas Lift has proven to be a viable artificial lift choice for improving the efficiencies in the lower ranges of continuous gas lift injection below five hundred barrels per day. Thru the addition of PAGL many unconventional wells in the Permian Basin have been able to shut off gas injection completely and simply produce these wells as plunger lifted wells resulting in significant savings in compression and injection gas expense. Some operators have continued to run a string of gas lift valves after reworking a well that is expected to run as a plunger lifted well as insurance and future GAPL options. The rationale being that a string of gas lift valves is cheap compared to having to pull the well. The system has additional advantages of not having to kill or pull the well to be installed or transition to plunger lift and subsequently to GAPL. These choices of artificial lift do not require the field to be electrified over the life of the well resulting in significant cost savings. Chemical treatments are also still optional during each phase of production without having to pull the well. Additional training for field personal will be needed to insure optimum production.

BYPASS PLUNGERS

In a **“Free Cycling”** well the plunger falls to bottom against the flowrate without shutting in the well. An internal bypass in the plunger allows gas and fluids to flow through. The plunger can have an internal valve or be two pieces. The plunger engages a shift rod at the surface to either shift the valve open or separate the ball and sleeve. The valve closes when it hits the spring assembly on bottom. The sleeve reconnects with the ball on bottom to reseal.



PLUNGER ASSISTED GAS LIFT (PAGL) INSTALLATION