AN ARTIFICIAL LIFT STRATEGY FOR UNCONVENTIONAL WELLS IN THE PERMIAN BASIN

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ABSTRACT

There are a large number of 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 the well will begin to liquid load. At this point some type of artificial lift choice needs to be considered. This paper will lay out an artificial lift strategy for many of these wells that will transition from completion to depletion through various artificial lift options as a well's production and pressures decline. The production phases reviewed will be: Completion, Flowing, Intermitting, Gas Lift, Plunger Assisted Gas Lift, Plunger Lift, Multistage Plunger Lift and finally Gas Assisted Plunger Lift.

INTRODUCTION

The Permian Basin has historically been an oil basin and the predominant artificial lift choice has always 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 is becoming a more appropriate lift choice under these conditions, but operators are still not sure how to transition from gas lift to other artificial lift phases. This paper will lay out a strategy for transitioning through each phase of a well's decline to the final production phase.

COMPLETION--FLOWBACK

The completion phase is important when planning ahead for a well's production decline. Many operators have recognized this and will design and run a gas lift string in the well at initial completion. This a good strategy as long as the design parameters used, primarily pressure, temperature and rates are accurately predicted. The problem is that when the well is finally put on gas lift the design parameters quite often do not reflect current down-hole conditions and the system ends up being poorly designed and production suffers. Some operators have tried to address this by simply running valves every five hundred feet to bottom, a technique known as "Laddering". This causes other issues, primarily valve jumping or "Multi Porting". This is when the operating valve that gas is being injected through changes and multiple valves are opening and closing down hole This is further complicated in horizontal completions that head and surge fluid and gas due to peaks and valleys in the horizontal leg. Many times a well will need to be recompleted with a gas lift design that more accurately reflects current conditions to achieve desired production results and to accommodate future artificial lift choices. Additionally, when a well is put online, it is generally understood that flowing a well too hard may cause damage to a Frac Job and pull sand into the flow stream, wellbore or production string. Most operators will flow back at a choked rate to avoid this. As flowrates decline, production and pressures will begin to fluctuate due to liquid loading down hole. At this point intermitting the well may be a good temporary solution to maintain production.

INTERMITTING

Intermitting is a good option in the early stages of liquid loading, especially if the gas lift infrastructure is not in place and still being developed across the field. As well pressures and rates decline the heavier gradient fluids will begin to fall back and accumulate down hole. Initially a well will purge itself by heading and surging which is evidenced by fluctuating fluid and gas production and surface wellhead pressures. Field personnel can assist this flow process by temporarily shutting the well in for pressure buildup. When the well is reopened the additional pressure will purge fluids out of the well and reestablish flow rates. But this is only a temporary solution as well as labor intensive. An economical answer is to put the well on an "Intermitter" that can be programed to open and close on time or pressure. Complete installation costs for this option are around five thousand dollars and all equipment can be used later with future artificial lift options such as Plunger Assisted Gas Lift.

GAS LIFT

Many unconventional wells in the Permian Basin will still 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 more than five hundred barrels per day. Below this amount 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 all available fluid to surface.

PLUNGER ASSISTED GAS LIFT

In production rates less than 500 BPD where gas lift begins to be less efficient it is becoming more common to hybrid gas lift with plunger lift in an operation referred to as Plunger Assisted Gas Lift (PAGL). With PAGL the well is still being produced by continuous gas lift injection. The plunger utilized for this operation is 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 serves as an interface 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 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. The other 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.

PLUNGER LIFT

During the plunger lift phase of the well is being produced solely from the gas and pressure in the reservoir. Most wells will continue to run a bypass plunger while the production rates and pressures are high enough to require the plunger to be on bottom faster than a conventional plunger. Conventional plungers do not have a bypass and take more time to reach the down-hole spring assembly. When a well's recovery time exceeds the time it takes a conventional plunger to reach bottom, a bypass plunger is no longer needed. As pressures and rates continue to decline the sealing element of the plunger becomes more important. The better the seal of the plunger, the less gas and pressure required for the plunger to reach surface with each load of liquid. At some point the well's gas and pressure are no longer sufficient to surface a plunger and the tubing casing annulus may need to be opened for storage of

additional lift gas. This can be done by retrieving a side pocket valve off bottom, opening a sliding sleeve or punching holes in the tubing and setting a stop above them. As the well continues to decline the bottom-hole pressure or gas liquid ratio may again get too low to surface a plunger. At this point a production technique known as Multi-Stage Plunger Lift can be considered.

MULTI-STAGE PLUNGER LIFT

In this system a downhole staging tool is used to create multiple plunger lift systems in a well. The multistage tool allows liquid to be lifted and transferred from one stage to the next. The reduced travel distance for each stage requires less gas and pressure per cycle. The well will continue to be shut in between cycles for pressure recovery. This production technique may be used as long as there is still sufficient gas and pressure. At some point the bottom-hole pressure or gas liquid ratio may no longer support this option and a final phase of Gas Assisted Plunger Lift may be appropriate.

GAS ASSISTED PLUNGER LIFT

Gas Assisted Plunger Lift is an intermittent lift operation that may be an excellent option due to the existing gas lift infrastructure in the field and down hole. At this phase the multistage would need to be removed and the down-hole spring assembly will still need to be above the bottom operating valve. A standing valve will also need to be inserted in the seating nipple below the operating valve to prevent injection gas from going into the reservoir. Gas is again injected down the casing 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.

SUMMARY

Portions of this strategy, primarily the transitions from Gas Lift to Plunger Assisted Gas Lift t have been put into practice in some areas of the Permian Basin. What has not been determined is a comprehensive long term strategy to take wells from completion to depletion through these production phases as they decline. There are several overall cost savings utilizing this strategy. One primary advantage that would save millions of dollars is no need to electrify the field. Another area of tremendous cost savings is no need to kill or pull a well to transition between phases. Chemical treatment down the casing is also still an option through each phase. As a long term strategy, the operational and economic benefits are considerable. One of the obvious drawbacks in the Permian is the lack of knowledge and understanding of some of these options. Rod pump is the most widely accepted lift choice in the Permian and there would be a natural resistance to new or unfamiliar technologies. There would be a need for additional training at several levels.