OPERATOR DECISION-MAKING PROCESS ON WHICH PLUNGERS TO USE IN PLUNGER LIFT WELLS

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ABSTRACT

With heightened technological advances in the area of late well life development and further production possibilities, there has been an increase in attention to plunger lift and the decision-making process that backs the selection of plungers in these plunger lift wells. It has been noted by companies, like ConocoPhillips, that 'with more than 200 plunger lift systems in the San Juan basin, the plunger operator is the single most important factor in keeping a plunger lift system operating efficiently. If an operator knows certain principles of plunger operation and gas well mechanics, they can effectively maintain and troubleshoot the system… If an operator does not understand these principles, a system will lose efficiency due to poor maintenance… and they may be frustrated when the system does not work well.' (Hingerl et al., 2020) This quote from literature reviews is an enlightening outlook on why the topic of how an operator chooses a plunger for PL wells is so important; Without knowing the principles of plunger operation or gas well mechanics both efficiency and production will be lost. Many variables go into the selection method of plungers. There are steps and methods that can aid in the classifying and understanding the lifecycle plunger lift wells to best optimize the wells. The first method is linked to understanding what kind of wells we have and what sort of plunger fits best; for example, a conventional or bypass plunger would be best equipped to handle a well that produces from pressure or gas volume rates. Continued surveillance of these wells and monitoring of the plungers used is crucial and even beneficial to a system consistently progressing in its life cycle.

INTRODUCTION AND BACKGROUND

Plunger lift wells and their systems have a crucial role in optimizing production and bringing about more efficiency in gas lift wells. Selecting the best plungers is paramount to a smooth operation and to increase the longevity of the well throughout its lifecycle.

Wells have multiple stages and securing the well in the most optimal environment by increasing the endurance in a selected stage using the right plungers and equipment is most beneficial to the operator. The efficiency of a plunger lift system heavily depends on the design and quality of the plungers used. Well-designed plungers ensure proper sealing and efficient removal of liquids from the wellbore during the upstroke. This efficiency directly translates into increased production rates and reduced downtime. When it comes to fluid management plungers are instrumental in effectively managing fluids in the wellbore. They aid in the lifting of liquids such as water, condensate, and other contaminants to the surface; aiming to prevent liquid loading and maintain optimal gas flow rates is crucial, therefore properly selecting plungers allows for the handling of varying fluid compositions and flow rates, this therefore ensures consistent performance under different operating conditions in a given well. In said wellbores, plungers can operate in harsh downhole environments that are characterized by high temperatures, pressures, and even abrasive conditions. Corrosive elements and fluids need specified steps and methods to help in their treatments and prevention. Selecting durable plungers made from high-quality materials (composite materials or coated metals) that are made to last on given conditions downhole and in the travel back to the surface ensures longevity and minimizes the need for frequent replacements or even maintenance interventions. This, in turn, reduces operational costs and enhances the overall reliability of the plunger. It is important in the selection of plungers, that the consideration of the specific well characteristics, including depths, diameters, and production dynamics be taken into account. Using properly sized and compatible plungers ensures optimal fit and functionality within the wellbore. Compatibility also extends to the wellbore configuration, such as deviations, doglegs, or obstructions, where specialized plungers may be required for efficient operation. The choice of plungers can significantly impact the overall performance of the plunger lift system. Factors such as plunger design, weight, and surface coatings influence key performance metrics such as cycle time, gas lift efficiency, and fluid removal rates. Selecting plungers based on the well's requirements allows field personnel and operators to maximize production potential and minimize any constraints in operations. Although cost analysis is crucial, being able to have an effective run in the long term that needs minimal upkeep or constant supervision, and maintenance proves to be a cost-effective method. Plungers selected with all these variables in mind tend to offer better performances, reduced downtimes, and reliability over the well's lifespan. These methods aim to mitigate risks associated with safety measures for the environment and personnel, unwanted gas migration, liquid loading in the well, and even equipment failures or damage.

Overall, being able to select an optimal plunger for a PL well is key to having the best outcomes in production and rates in a well in its later life. It ensures efficiency while considering the economic viability of these gas lift wells. It is key to consider factors in these wells and plungers such as their safety, cost, compatibility, and efficient results as well as the durability of the plungers in the wells to sustain the best performance possible.

To introduce a plunger in GL wells it is first required to know if we have a PAGL or GAPL focused well. The overall basics of both these designs is to use gas injection to create better flow or "optimize" our well. The methods focus on decreasing flowing BHP to get a higher quality for the inflow of the well and avoid liquid loading which inevitably happens as the life cycle of a well progresses. Figure 1 depicts our wells life.

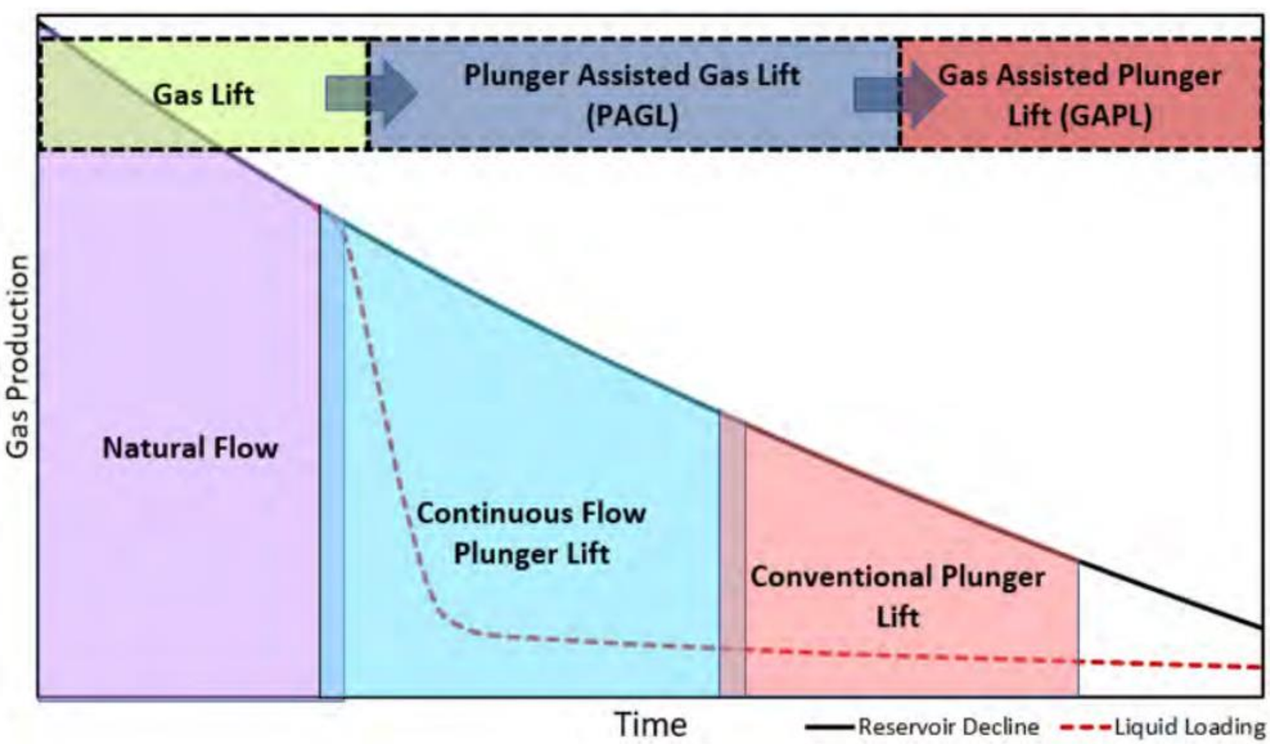

Figure 1 – Graphical representation of plunger lift types and GL (Ozan et al., 2020)

Without knowing the proper type of plunger to use in a well, you stand to lose out on production and better flow rates. "Plunger assisted gas lift is a continuous and… is implemented on higher gas and fluid producers."(Burns, 2018) For example, in wells in the DBE that have a higher GOR. The injected gas can help to raise the critical velocity that lets the fluid and plunger reach the top of our wells. "GAPL is an intermittent injection and… It is implemented on lower gas and fluid producers." (Sayman, 2020) For example, this method is used more in Midland, TX, and the Permian basin region. It is also known more so as the conventional method of plunger lift. In this scenario, "Gas is only injected during certain phases of the plunger cycle to supplement the wellbore inflow and successfully lift fluid and plunger to surface." (Burns, 2018)

Producing Method	GLR
Plunger Lift	>10
PAGL/GAPL/PBGL	~3-10
Gaslift	<3

Figure 2 – Methods of plunger lift

Overall, it is vital for an engineer to know, not just what kind of plunger to use, but first determine the method of plunger lift to use so the well can be appropriately optimized as seen in Figure 2, and "increase production, reduce operating cost and more effectively utilize horsepower (in scenarios)." (Burns, 2018)

THE PROBLEM

"The velocity at which the plunger travels up the tubing also affects the plunger efficiency. The very low velocity of the plunger increases gas slippage and subsequently leads to inefficient operation. Whereas high plunger velocities tend to push the plunger through the [scattered] liquids." This is something operators need to take into consideration when selecting a plunger in PL wells. Many studies have been performed to theorize the best plunger lift model or system after a plunger is selected for use. Because experiments that are "undertaken for different fluid[s], reservoir, and well properties and characteristics." must always be considered for each plunger use. (Rajvanshi et al., 2023)

Overall, this issue is very prevalent in the industry and there are many instances and uses for the determination of plungers in PL wells.

RELEVANCE AND REAL-LIFE USE OF THE SOLUTIONS

A few of the best methods and rules of thumb for selecting plungers come less from the plunger and more from what kind of well and fluid we have. Seal and velocity are major factors in providing lift. Limiting slippage and just the right amount of turbulence to allow movement but not liquid fallback is key and makes a plunger almost as unique as any well it is in. A balance in the velocities that a plunger travels with is also necessary: High velocities can increase back pressure or exert unnecessary energy in the well (or waste pressure). Too low speeds can cause slippage.

Therefore, your "Target velocities allow just enough slippage to provide a good seal" (Phillips et al., 1998) and this is the key to selecting an optimal plunger for your PL well.

BACKGROUND AND STEPS IN THE DECISION-MAKING PROCESS

The overall basics of PL designs are to use gas injection to create better flow or "optimize" (Burns, 2018) our well so that it is closest to near-flowing conditions.

The first step is to translate data from a wellbore diagram, production histories, and deviation summaries to determine if a well is focused on flowing and producing best from pressure or gas volume. We determine this by reading a Downhole Critical Rate Requirement. (minimum 70% gas [formation gas/formation gas + injected gas]). A Downhole Critical Rate Requirement and the method to determine it stems from the research of Dr. Guo, an LSU engineer. It is now an industry-standard method in which data is inputted, such as gas SG, pressures, well temps., production, and fluid data as well as calculated parameters like KE, average temperatures, and cross-sectional areas. A gas production rate is output; and to qualify for a bypass plunger, 70% of that gas production rate needs to be met utilizing either formation gas or a mix of formation gas and injected gas. Further evaluations can be made using this method as well.

Being able to select and utilize your plunger is key. After the evaluation of our selected data from a well we determine if a bypass plunger or conventional plunger is best needed.

A high-flowing or Bypass plunger best suits a well-flowing just above the critical rate; these plungers are designed to fall quickly against the flow and allow for high production rates due to sweeping and no unwanted pressure buildup and downtime. These plungers rely more on your gas volume (rather than building up pressure). Because of this reduction in flowing BHP, production rates benefit. Fall velocities are key.

Lower volume wells (60> BPD; 200 MCF>) tend to have less gas volumes to work with and are therefore more pressure dependent. This results in longer shut-in time (once a plunger reaches to bottom, it can build up pressure to then drive accumulated fluids and itself up during an on-time cycle) In these scenarios Conventional plungers work best and can provide unloading benefits.

With problems related to flow rates in conventional PLs => utilize plungers in either Type 1 (highest fall speed) or Type V (lowest fall speed) as depicted in Figure 3 below. (Phillips et al., 1998)

It is also important to note that fluids, volume, and rates in wells change periodically. There are methods to adapt and optimize your wells consistently with changes in gathered data. Further advancements in the industry with software and technology can streamline this process.

Other factors that impact the decision-making process for selecting plungers include tubing sizes, well inclinations, friction, and the presence of solids such as paraffin and scale, as well as corrosive materials and fluids in the well.

EFFECTS OF TUBING SIZES ON PLUNGER SELECTION

The size of the tubing in plunger lift wells plays a critical role in the selection of plungers. It affects various aspects of plunger performance and operation, influencing factors such as efficiency, fluid management, and overall well productivity. Tubing size directly influences the fit and compatibility of plungers within the wellbore. Proper sizing is essential to ensure plungers can move freely and effectively within the tubing without encountering obstructions or causing damage. Choosing plungers that align with the tubing size promotes optimal fit and functionality, reducing the likelihood of operational challenges.

The dimensions of the tubing play a significant role in determining the amount of fluid lifted during each plunger cycle. Larger tubing diameters can accommodate greater fluid volumes, facilitating more efficient fluid extraction from the wellbore. When choosing plungers, it is essential to factor in the tubing size to ensure they can adequately manage the expected fluid volumes and uphold optimal gas flow rates. Additionally, tubing size impacts the pressure drop along the wellbore during plunger operation. Smaller tubing diameters lead to increased frictional losses and pressure drop, which can impact plunger performance and efficiency. Therefore, appropriately sized plungers should be selected to address pressure drop concerns and maintain sufficient gas lift efficiency across the tubing length. Moreover, the tubing size influences the duration of the plunger’s traversing from the bottom to the top of the wellbore during each cycle. Larger tubing diameters typically result in longer cycles due to extended travel distances.

Selecting plungers with suitable characteristics, such as weight and design, helps optimize cycle times based on the specific tubing size and well conditions. The tubing size also affects the efficacy of gas-liquid separation within the wellbore. Smaller tubing diameters may encounter difficulties with gas-liquid separation, leading to challenges such as gas slippage and liquid fallback. Proper plunger selection, coupled with well-designed surface equipment like gas-liquid separators, aids in mitigating these issues and sustaining efficient fluid management. Additionally, tubing size influences the operational restrictions and limitations of the plunger lift system. For instance, smaller tubing diameters may constrain the use of certain plunger types or necessitate modifications to accommodate specialized equipment. Therefore, comprehending the tubing size and its implications is vital for selecting plungers capable of operating effectively within the specified constraints.

In summary, tubing size significantly impacts plunger selection in plunger lift wells by influencing factors such as fit, fluid handling, pressure drop, cycle time, gas-liquid separation, and operational constraints. Considering tubing size appropriately ensures the selection of plungers that can optimize production, improve efficiency, and sustain dependable operation throughout the well's lifespan.

WELLBORE INCLINATIONS EFFECTS ON PLUNGER SELECTION

The angle at which the wellbore deviates from vertical, known as wellbore inclination, plays a crucial role in determining the selection of plungers in plunger lift wells. In deviated or horizontal wells, plungers must traverse a longer distance from the bottom to the top of the wellbore during each cycle than in vertical wells. This extended travel distance can impact cycle times and overall efficiency. Therefore, it is imperative to choose plungers with suitable characteristics, including weight and design, to optimize cycle times based on the specific wellbore inclination and conditions.

Higher wellbore inclinations can introduce gravitational forces that affect the stability of plungers as they move through the wellbore. Inclined or horizontal sections of the well may cause plungers to experience instability, bouncing, or deviation from the intended path. To ensure smooth and reliable operation in deviated wellbores, selecting plungers equipped with features such as centralizers or stabilizing fins becomes essential.

Furthermore, wellbore inclination can influence the fluid’s behavior and distribution during plunger operation. Gravitational forces in deviated wells may lead to uneven fluid distribution or accumulation in certain tubing sections. Plunger selection should account for these fluid dynamics to effectively manage fluid movement and mitigate issues like liquid fallback or gas slippage.

Pressure drop along the wellbore during plunger operation is also affected by wellbore inclination. Variations in pressure drop may occur along different tubing sections due to changes in elevation and fluid behavior in deviated wells. Plungers must be chosen to accommodate these variations and maintain optimal gas lift efficiency throughout the entire wellbore.

Additionally, wellbore inclination introduces operational complexities and considerations for plunger lift systems. Installation, retrieval, and maintenance of plungers may pose greater challenges in deviated or horizontal wells compared to vertical wells. Specialized equipment or techniques may be necessary to ensure efficient plunger operation in deviated wellbores.

In summary, wellbore inclination significantly impacts the selection of plungers in plunger lift wells by influencing factors such as plunger travel distance, stability, fluid management, pressure drop, and operational considerations. Proper consideration of wellbore inclination is essential to select plungers that can operate effectively within the specific conditions of deviated or horizontal wellbores, thereby optimizing production and efficiency while minimizing operational challenges.

EFFECTS OF SELECTING A PLUNGER IN A PL WELL WITH FOREIGN MATERIALS OR FLUIDS PRESENT

The presence of solids or substances such as paraffin, scale, and corrosive elements or fluids can notably impact the plunger selection process within a plunger lift system. Over time, solids like paraffin and scale may accumulate within the wellbore, resulting in blockages and constraints within the tubing. Hence, when choosing a plunger, it is crucial to assess its capability to maneuver through potential buildup regions without encountering obstruction. Plungers equipped with features such as scrapers or brushes may be favored to diminish or eradicate solid accumulation during operation.

Corrosive elements or fluids in the well environment can expedite the equipment deterioration, including in plungers. Therefore, selecting plungers crafted corrosion-resistant materials is imperative to ensure their durability and reliability amidst corrosive conditions. Materials like stainless steel or corrosion-resistant alloys are commonly utilized to mitigate the adverse effects of corrosion.

Certain fluids within the wellbore may elicit adverse reactions with specific plunger materials, leading to their degradation or malfunction. Hence, when selecting a plunger, it is essential to consider its compatibility with the fluids present in the well to forestall any chemical reactions or damage. Opting for plungers constructed from materials compatible with a broad spectrum of fluids or those tailored explicitly to the well's fluid composition is vital to ensure optimal performance and longevity.

Plungers play a pivotal role in expelling liquids and solids from the wellbore during each cycle. Plungers endowed with effective sealing mechanisms and solid-handling capabilities are indispensable for efficiently eliminating solids like paraffin or scale from the tubing. Specialized plungers featuring attributes such as ample bypass areas or self-cleaning mechanisms may be selected to augment solids removal efficiency and mitigate clogging issues.

The existence of solids or corrosive elements in the well may escalate the maintenance demands of the plunger lift system. Plungers may necessitate more frequent inspections, cleanings, or replacements to address issues stemming from solids accumulation or corrosion. Therefore, when selecting a plunger, careful consideration should be given to its maintenance requisites and the availability of resources for ongoing upkeep.

In summary, the presence of solids or substances such as paraffin or scale, along with corrosive elements or fluids, substantially influences the plunger selection process in a plunger lift system. Plungers must be chosen based on their ability to navigate through potential buildup regions, corrosion resistance, compatibility with well fluids, efficiency in solids removal, and maintenance requirements to ensure dependable operation and optimize production efficiency. (Listiak et al., 2006)

DESCRIPTION OF FURTHER VARIABLES EFFECTING PLUNGER SELECTION

Friction holds a pivotal role in the plunger selection process for a plunger lift well. It arises as the plunger traverses through the tubing, manifesting several consequences on the overall performance of the plunger lift system. The interaction between the plunger and the tubing walls induces a deceleration in the plunger's movement, thus prolonging the cycle time—the duration of the plunger's ascent from the wellbore's bottom to its top during each cycle. Extended cycle times can diminish the system's efficiency by reducing the frequency of production cycles.

Moreover, friction engenders resistance against the plunger's motion, necessitating additional energy to overcome. This augmented energy consumption may exert an impact on the operational expenses of the plunger lift system, notably in wells experiencing substantial frictional losses. The frictional losses distributed along the tubing length precipitate a decline in pressure, signifying a reduction in the gas pressure as it traverses through the tubing. Elevated levels of friction can exacerbate pressure drop, impinging upon gas lift efficiency and the plunger's efficacy in lifting fluids to the surface.

Furthermore, the friction between the plunger and the tubing walls can instigate wear and tear on both components. Excessive friction has the potential to inflict damage upon the plunger, the tubing, or both, thereby diminishing their operational longevity and elevating maintenance requisites. Hence, a thorough consideration of friction's ramifications is imperative when selecting plungers for a plunger lift well. Plungers equipped with attributes tailored to mitigate friction, such as sleek surfaces, low-friction coatings, or streamlined designs, may be favored to curtail energy consumption, cycle times, and pressure drop while optimizing the system's efficiency and durability. Additionally, factors encompassing tubing material, surface texture, and wellbore conditions should be factored in to proficiently manage friction and enhance the plunger lift system's performance.

FURTHER DISCUSSIONS AND CONCLUSIONS

Two types of automated plunger lifts that operators can choose from are:

1. Travelling Smart Plunger
2. Downhole Smart Plunger

Both are designed to enhance well performance and follow ability and have gauges to record temperatures and pressures downhole. These plungers save downtime when it comes to running those pressure and temperature-logging devices. They are also equipped with retrievable technology. However, these plungers would especially cater to “intermittent flow regimes”, rather than PAGL wells. (Gray, 2009)

Based on a study and paper by Ajay Singh, “classification and regression tree (CART) analysis can be used to identify the root cause” given available data on production monitoring for a traditional PL. CART conducts an optimization analysis based on cause and effects based on field data. In the study, CART was used to perform regression tree analysis on field data with Gas-producing wells using PL. Using this system operational issues and production diagnostics found variables that “build-up time, production time, falling time, and well completion data would improve” based on different conditions, like having specific plungers used in PL wells. This once more highlights the importance of operators selecting proper plungers.

CFPs, or continuous flow plungers vary slightly in that they are best used in PAGL wells.

Another method of operators selecting plungers is through service companies, and being educated on the types of plungers used in conventional plunger lifts as would be seen in Figure 3. It is shown that “type I has the highest fall speed, and type V has the lowest fall speed.” Utilized in their respective scenarios will be the best plunger to use in specified PL wells and corresponding with revenue made. (Zhong, 2021)

Figure 3 – Different types of plungers (Liberty Lift Plunger Selection and Optimization, 2024)

And although it may be seen as “The plunger that is predicted to generate the most profits is considered the most optimal plunger.” It is clear that, “there are other considerations that need to be considered when selecting a plunger type.” Certain plungers cannot be run in wells with paraffin issues or sand production, etc. In Figure 3 we see our Type 1 and Type I-III plungers being the dart, ball and sleeve, and center rod plungers respectively. Type IV-V are our padded, solid, and brush plungers in that order. This model also parallels the lifecycle of a well (flowing -> GL -> Type 1 plungers -> Type 5 plungers).

A few of the best methods and rules of thumb for selecting plungers come from the seal and velocity a plunger can provide in its lift. Bypass versus conventional plungers have turbulent versus mechanical sealing tendencies respectively. These plunger types also have a lot of overlap (multiple bypasses/multiple conventional) depending on well data (gas rates differ in wells), fluid data, and production data; we can see this in Figure 4 by the rates by type of plunger used, all with a consistent average tubing pressure.

Conventional Plungers:	2 3/8" Fall Rate	Through Fluid	Min/Max Gas	Min/Max Fluid	2 7/8" Fall Rate	Through Fluid	Min/Max Gas	Min/Max Fluid
Dual Pad	150-250 ft/min	50 ft/min	10-300	1-50	200-350 ft/min	65 ft/min	10-300	1-50
Brush	150-180 ft/min	35 ft/min	10-300	1-50	175-250 ft/min	45 ft/min	10-300	1-50
Spiral or Bar Stock	300-400 ft/min	150 ft/min	10-300	1-50	350-500 ft/min	200 ft/min	10-300	1-50
Spitball (Ported Check Ball) 11mm	500-650 ft/min	200 ft/min	175-350	1-50	600-750 ft/min	225 ft/min	175-350	1-50
Bypass Plungers:								
Center Rod-Padded 6 Port	750-1000 ft/min	125	200-550	1-60	950-1200 ft/min	150	200-600	60-80
Center Rod-6 Port	1300-1600 ft/min	175	400-800	5-80	1500-1800ft/min	200	600-1000	10-100
Friction Dart-2 Slot	750-1100 ft/min	150	200-500	10-30	800-1100 ft/min	175	200-600	10-30
Friction Dart-3 Slot	1150-1350 ft/min	180	300-700	20-50	1000-1200 ft/min	200	350-800	20-50
Friction Dart-4 Slot	1350-1600 ft/min	200	500-850	40-80	1300-1800 ft/min	225	500-900	50-100
Friction Dart-5 Slot	1500-2000 ft/min	225	600-1000	100-150	1650-2200 ft/min	250	600-1200	100-200
2 Piece Padded 9"	850-1100 ft/min	200	200-450	5-25	950-1300 ft/min	250	200-500	5-25
2 Piece 6"	1100-1350 ft/min	250	200-500	10-50	1250-1500 ft/min	280	300-600	10-50
2 Piece 9"	1350-1650 ft/min	280	400-1000	20-100	1500-1750 ft/min	320	500-1250	20-200
2 Piece 12"	1650-1950 ft/min	325	600-1200	50-150	1750-2050 ft/min	350	800-1500	100-250
2 Piece 15"	1950-2150 ft/min	400	800-1400	125-200	2050-2400 ft/min	450	1250-2000	150-350
2 Piece 18"	2150-2500 ft/min	450	800-1600	150-300	2400-2800 ft/min	550	1500-2200	200-500

Figure 4 – Plunger Fall Rate vs. 100 psi Average Tubing Pressure (Liberty Lift Plunger Selection and Optimization, 2024)

Limiting slippage and just the right amount of turbulence to allow movement but not liquid fallback is key and makes a plunger almost as unique as any well it is in. A balance in the velocities that a plunger travels with is also necessary; high velocities can increase back pressure or exert unnecessary energy in the well (or waste pressure) and too low speeds can cause slippage. “Target velocities allow just enough slippage to provide a good seal” and this is the key to selecting an optimal plunger for PL well. Figure 5 shows this illustrated.

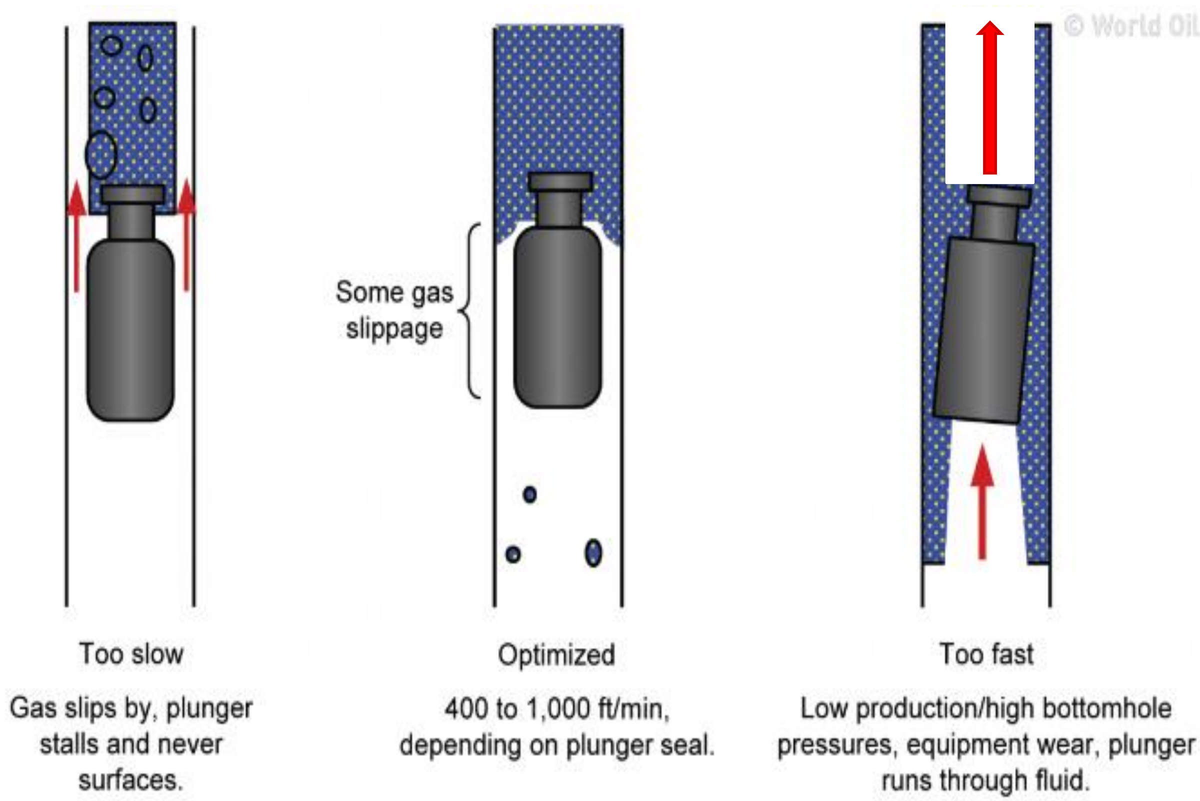

Figure 5 –The importance of plunger seal and velocity

RELEVANCE AND SIGNIFICANCE IN THE INDUSTRY

There is a surge in plunger-related technology coming out as “an alarming boom [in] liquid loading becomes an ever-increasing impediment to hydrocarbon recovery in depleting wells.” Because of this, operators must be able to select appropriate plungers for their PL wells to, “lead [with] improved well productivity with minimal increased operating expense.” (Gray, 2009)

As previously stated, with new and improved methods for utilizing plungers in PL wells in shale formations and other formations in high GLR areas, it is essential to have proper plungers in place for these new methods to be able to help with better optimizations eventually. For example, as Matthew Kravits states, different methods of plunger lifts, such as the “Testing for 90° Potential,” allow for the production of any leftover or remaining fluids in a horizontal lateral and thus more production.

To add more to the topic of relevance and significance of this topic- cloud-based PL optimization software has begun being more apparent in the industry, Hingerl states in his paper that algorithms and AI have been developed so that, “The operator's organization can access this data in a web-based user interface designed for streamlined plunger lift surveillance, diagnostics, and optimization.” His paper goes on to discuss three specific improvements to traditional plunger lift optimizations, “improved physics modeling for horizontal wells, automated anomaly detection for improved well stability, and automated setpoint management using both physics and artificial intelligence.” (Hingerl, et al., 2020) All of these highlight how plunger surveillance and optimization are on the rise and can improve entire production fields. (Disclaimer: the topic of optimization in my paper is based on literature reviews, and industry papers as well as feedback from industry professionals. It was used as relevant material and topics in support of my conclusions, recommendations, and discussion on the significance of my topic).

Nomenclature

GL = gas lift
PAGL = plunger-assisted gas lift
PL = plunger lift
GAPL = gas-assisted plunger lift
CFP = continuous flow plunger
DBE = Delaware Basin East
BHP = bottom hole pressure
BPD = barrels per day
MCF = one thousand cubic feet
CART = classification and regression tree
SG = specific gravity
KE = kinetic energy

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Acknowledgments

Thank you to the Liberty Lift Team, Clint Garett, Terry Stone, and Herman Garza for their insight, advice, industry and technical knowledge, and recommendations on my Student Undergraduate Poster contest submission for the Southwestern Petroleum Short course. Their support and patience throughout this project and with my paper was a fundamental process.