VSP® AN UPDATE FROM 2001

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ABSTRACT AND SCOPE

A tried and true method of reducing gas interference in rod pumps is to set the pump in a position below all the perforations. The liquid and gas separate with the liquid dropping down to the pump intake and the gas rising in the casing-tubing annulus. This is not possible in today's horizontally completed wells where the preferred pump placement is in the vertical section. In 2001 Benny Williams with Harbison Fischer presented a paper regarding the then new Harbison-Fischer Variable Slippage Pump® (VSP®) patent #6,273,690 . In the last 24 months there has been an increase of interest of the VSP®. Many of these pumps have gone into these horizontally completed wells. The timing is good to update the paper with the large number of new wells being completed horizontally.

INTRODUCTION AND BACKGROUND

This discussion will only discuss the VSP® design not gas separators, or other products that may be beneficial with gas related issues. A conventional rod pump is dependent on pressure to open the valves and flow to close them. Rod pumps that are free of gas, and have adequate fluid level do not have an issue opening and closing their valves. One exception to this is when solids are introduced into the valves. When gas is introduced into the compression chamber the traveling valve does not open properly. The reason is that the pressure above the traveling valve remains higher than in the compression chamber. Depending on the amount of gas and fluid in the compression chamber the valve may not open until the very end of the down stroke. Some of the undesired results are very poor pump efficiency, rod compression, and rod on tubing wear.

PUMP SLIPPAGE

During the rod pumps normal operation some of the fluid that is being lifted to the surface will slip by the plunger barrel interface by design. A certain amount of slippage is desired to properly lubricate and allow room for particulates to pass the plunger barrel interface. The "fit" can be different on each pump and is normally calculated on a well by well basis. A slippage formula was presented at the 2000 Southwestern Petroleum Short Course (SWPSC) titled, "Fluid Slippage in Down-hole Sucker Rod Pumps." This formula updated decades-old formulas with a formula based on theoretical study, lab testing and field testing. In comparison to the older formulas this new formula showed that many operators were choosing their plunger to barrel clearances too tight, thus not providing enough plunger lubrication or clearance for particulates. As a result, during the next few years many operators increased their plunger to barrel clearances and improving their pump run times. In pumps having gas interference this slippage will back fill the compression chamber. After several strokes there will be enough fluid in the compression chamber to open the traveling valve for one stroke. During the other strokes the pump pounds gas or fluid damaging the entire pumping system. Extremely loose fit pumps can reduce the gas interference but may increase the slippage to an undesirable rate.

VARIABLE SLIPPAGE PUMP® SOLUTION

When an operator is experiencing gas interference a common practice is to lower the rods until the pump is tagging. The idea is that the shock will clear any gas and or solids in the pump. The only positive to tagging a pump is you reach the highest compression ratio possible in that particular pump. A paper was presented in the 2009 Southwest Petroleum Short Course Basic Rod Pump Design and The Effects of Tagging. In that paper tagging is defined as the weight of the rods resting on the pump. The paper goes on to describe the damage that occurs when this practice is used. The Variable Slippage Pump® overcomes the gas interference problem by equalizing the pressure above and below the traveling valve near the top of the stroke. This allows the traveling valve to open sooner when the plunger starts compressing the fluid/gas mixture in the compression chamber. The plunger will then easily fall through the

fluid/gas mixture minimizing any rod compression. This also lets trapped gas to flow through the plunger traveling valve assembly eliminating gas interference in the pump. There is no longer a need to tag your pump.

VARIABLE SLIPPAGE PUMP® DESIGN

The pump design for the VSP® is the same as a standard API RH pump except for adding a specialized barrel between the standard RH barrel and the standard RH extension. (FIGURE A) To achieve the pressure equalization at the top of the downhole stroke we use predictive programs to customize each pump for its pumping parameters. This is achieved by matching the lower barrel length to the downhole stroke. In the 2000 paper it was also recommended to design the pump with the best compression characteristics possible as you would any pump in a gassy situation. You should also follow best practices for wells that are corrosive and or have high temperature.

VARIABLE SLIPPAGE PUMP® LIMITATIONS

Soon after the introduction of this pump we determined that it would not be successful in wells that required fiberglass rods. To my knowledge we did not design any for wells with fiberglass rods for approximately 10 years after the first attempts. In 2011 a producer challenged this idea saying that there would not be any reason that they should not work in wells with fiber glass rods. Their wells were carrying a high fluid level but the POC would shut them down due to gas interference. In the beginning we saw a lot of success lowering their fluid level and oil production was much improved. The increased revenue was very desirable for them so over a period of 6 months they installed Variable Slippage Pumps® in 18 wells. Once the fluid levels begin to drop we started experiencing issues with pump spacing. This led to problems in tagging the pump or the plunger would be so far into the taper and was inefficient. The decision was made to abandon the project soon after that. We are still hopeful to come up with a design that will work with fiberglass rods but at this time we do not recommend it.

VARIABLE SLIPPAGE PUMP® WINS

The problem with POC's shutting wells down due to gas interference is eliminated with the VSP®. The improved oil and gas production is only one benefit of the pump. By stopping gas pound rod buckling is reduced and the rod on tubing wear is reduced. It is widely known that rod wear causes tubing leaks and pulling tubing is very expensive. Another aspect of having any failure is more man hours equal the possibility of an accident. This is often over looked when costs are considered or a decision is made to tag a well. Another issue with gas pound and rod on tubing wear is the fact that your chemical film will be wiped off when the rod makes contact with the tubing. All the costs associated with you chemical program are useless if the film is not there. The VSP® will increase production, reduce rod on tubing wear and take the gas pound out of the entire pumping system.

VARIABLE SLIPPAGE PUMP® CUSTOMER RESPONSES

With the increase in wells where the pump will see gas due its location in the well the VSP® is a good choice. Users of this pump have given feedback on wells where they have installed the VSP®. One customer that has the pump in 46 gassy wells commented they had very good success with them to date with just a few minor issues. They also added that once the pump is properly spaced, they can effectively produce gassy fluids better with the variable slippage aspect of the pump. They have not yet suffered a catastrophic pump failure with the design. They have pulled a few but only minor repairs were needed and we were able to get the pumps back and the well producing quickly. In the cases where the pumps were pulled, it was not due to a pump failure. They also added this comment regarding the pump. "I would recommend the pump to other producers who are having similar issues to ours regarding the production of gassy fluids. It comes at an expense, but it saves in the long run."

Another operator that has over 50 of these pumps in wells commented that they were seeing less plungers stuck in barrels on the VSP®. They had originally used the pump for gassy horizontal completions but are seeing this benefit and are continuing to run them in many of the other wells for this additional benefit.

Another customer that has about 8 of these pumps running in their wells commented that this is definitely the pump to run in gassy wells. One of their high gas producers currently has a 30 plus month run time. They believe the biggest benefit is that the POC is not shutting down due to gas.

One Field Production Engineer commented: "VSPs have become a standard in our Permian Operations on both conventional gassy wells and new horizontal development. This pump has greatly reduced our failure rate when used in a gassy well. Often, we will use a pump off controller or variable speed drive with a VSP. This combination of technology is a standard moving forward with our horizontal development. I can confidently say the VSP is the most crucial addition to our standard rod pump system with respect to optimizing our Operations. Without this technology, our most prolific wells would suffer."

SUMMARY

Many wells can benefit from a Variable Slippage Pump® whether the well is shutting down or experiencing rod on tubing wear due to gas. With careful consideration to the downhole stroke the Variable Slippage Pump® can be customized to fit any well problem associated with gas. Using standard rod pump components and the Variable Slippage Barrel you can solve your gas interference issues once and for all.

REFERENCES

1. SUMMARY OF TESTING OF VARIABLE SLIPPAGE PUMP SUCKER ROD PUMPS® (VSP®) FOR GAS LOCKING CONDITIONS IN DOWN-HOLE
   Benny J. Williams Harbison-Fischer

2. PROGRESS REPORT #3 ON "FLUID SLIPPAGE IN DOWN-HOLE ROD-DRAWN OIL WELL PUMPS"

   John Patterson, ARCO Jim Curfew, ARCO Permian
   Mike Brock, ARCO Permian
   Dennis Braaten, ARCO Permian
   Jeff Dittman, ARCO
   Benny Williams, Harbison-Fischer

3. BASIC ROD PUMP DESIGN AND THE EFFECTS OF TAGGING

   Larry Hambek, Robert Hillger & Albert Garza, Pioneer Natural Resources
   Charlie Burdette & Rodney Sands, Harbison Fischer
   Johnny Bunsen, Tommy White Supply

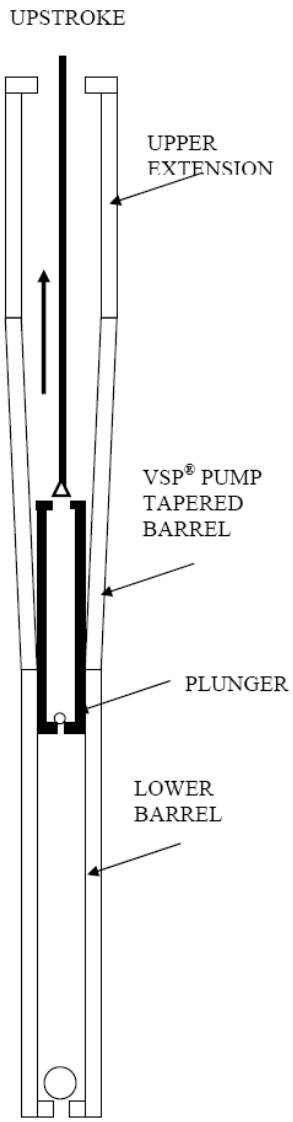
UPSTROKE
UPPER
EXTENSION
VSP® PUMP
TAPERED
BARREL
PLUNGER
LOWER
BARREL

FIGURE A