SUCCESS IN OVERCOMING GAS LOCKING PROBLEMS UPDATE OF TWO YEARS OF FIELD APPLICATIONS FOR THE HARBISON-FISCHER DOWN-HOLE SUCKER ROD VARIABLE SLIPPAGE PUMP® (VSP®)

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ABSTRACT AND SCOPE

The Variable Slippage Pump® for gas locking conditions has completed two years of field applications. Gas locking was eliminated in all applications and many installations showed further benefits of reduced sucker rod stress, elimination of "tagging the pump," less rod and tubing wear and increased fluid and gas production.

INTRODUCTION AND BACKGROUND

For any sucker rod pump with a metal plunger, slippage of fluid from the high pressure side of the plunger to the low pressure side, on the upstroke, is a necessary inefficiency in order to provide lubrication for the metal plunger as well as to provide clearance for sand or other particulates. A long-standing rule of thumb is that approximately 2% of the produced fluid should slip past the plunger in order to provide adequate lubrication. Particulate size is the other determining factor in choosing clearance between a plunger and barrel. The clearance should be large enough to pass most of the sizes of particulates without causing excessive slippage.

A slippage formula was presented at the 2000 Southwestern Petroleum Short Course (SWPSC) titled, "Fluid Slippage in Down-hole Sucker Rod Pumps."(1) 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 lengthened their pump run times.

The Variable Slippage Pump® uses the concept of slippage to balance the high pressure above and the low pressure below the plunger prior to the plunger starting downward on its compression stroke. This allows the traveling valve to open without the plunger compressing the fluid/gas mixture in the compression chamber, thus reducing the compression effect on the lower sucker rods and overcoming gas locking, fluid pound and gas pound.

THEORY

The H-F Variable Slippage Pump®, (VSP®): The VSP® pump uses the principle of increased slippage near the top of the upstroke to allow pressure to equalize above and below the traveling valve before the traveling valve starts its downstroke. Thus the traveling valve does not need to build up pressure in the compression chamber to open on the downstroke. The pressure is already high enough to open the traveling valve at the start of the downstroke.

The VSP® uses a gradually tapered upper barrel. With this configuration a standard RH lower barrel is used for the primary barrel and the tapered VSP® upper barrel is attached on the top. In this manner the operator can choose the length of the lower barrel to fit production conditions and use the upper VSP® barrel as needed to fine tune the well production characteristics.

The length of the lower, normal barrel is shorter than usual and only needs to allow for the downhole stroke and twelve inches (12") for spacing. The length of the VSP® barrel is nine feet (9'). The length of the upper extension above the VSP® barrel accounts for the plunger length, fittings length, sucker rod stretch and normal spacing allowance, less the VSP® barrel length of nine feet (9'). See figure A.

A consideration was that the slippage bypass would be unacceptable to operators. However, initial calculations showed that a slight taper would allow enough fluid to bypass the plunger and equalize the pressure without causing unreasonable slippage.

Also, it was noted that the slippage amount was variable. By spacing the plunger higher or lower an operator could increase or decrease the slippage, or by pumping in the lower barrel below the tapered barrel eliminate the additional slippage entirely. Field usage has shown that the additional slippage is normally not a problem since the desired production is significantly below the pump capacity and the well is able to be pumped off due to elimination of gas locking.

FIELD APPLICATIONS

Over 100 field applications were studied. These wells suffered from gas locking and fluid pumped off conditions that were observed as tagging the pump, fluid pound, and/or gas pound, and were manifested as broken sucker rods, failed pump hold-down bodies, cracked valve rods, worn tubing and sucker rods, and other broken pump parts.

In all applications of the Variable Slippage Pump® gas locking was cured and tagging of the pump was eliminated. This led to reduced breakage of sucker rod pump components as well as reduced wear and breakage of other sucker rod pumping system parts.

Figures 1 through 6, located at the end of this paper, show the grouped data for these wells.

SUMMARY

Several items were learned during the evaluation of this field data:

Production Increases: Some of these wells were not pumped off by previous standard or special pump installations. By avoiding gas locking with the VSP® pump, these wells were pumped off and fluid and gas production increased.

Reduced Pulling Frequency: Many of the wells were previously pulled frequently due to sucker rod and tubing wear that resulted in tubing leaks and broken sucker rods. This new pump eliminated the need for tagging the pump, and eliminated fluid pound resulting in longer pump runs.

REFERENCES

(1) “Fluid Slippage in Down-Hole Rod-Drawn Oil Well Pumps,” by John Patterson, ARCO, Jim Curfew ARCO Permian, Mike Brock ARCO Permian, Dennis Braaten, ARCO Permian, Jeff Dittman, ARCO, Benny Williams, Harbison-Fischer, Southwest Petroleum Short Course, 2000, pp 117-148.

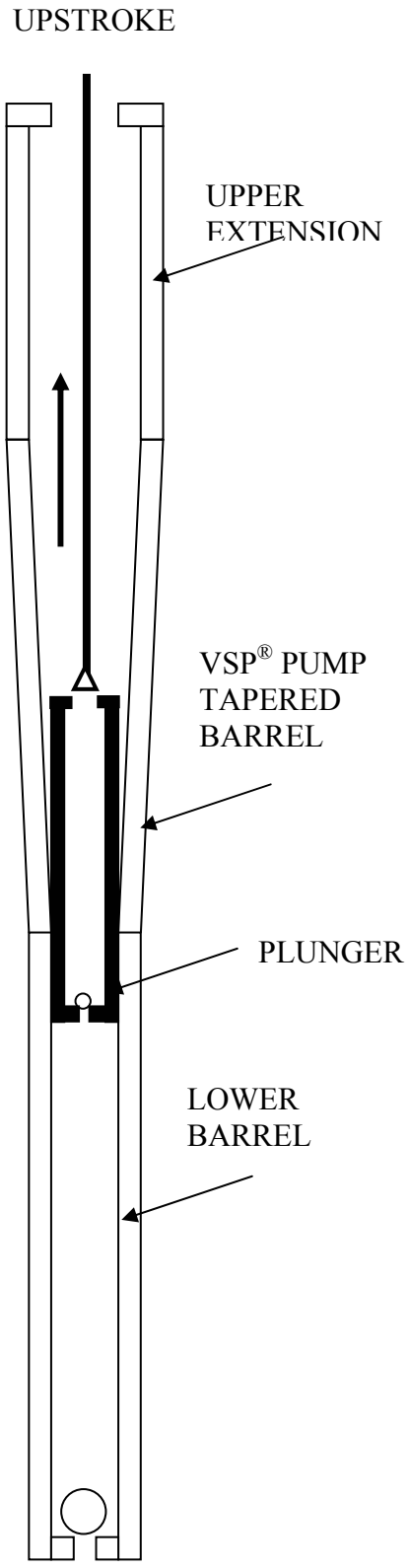

UPSTROKE
UPPER
EXTENSION
VSP® PUMP
TAPERED
BARREL
PLUNGER
LOWER
BARREL

Figure A

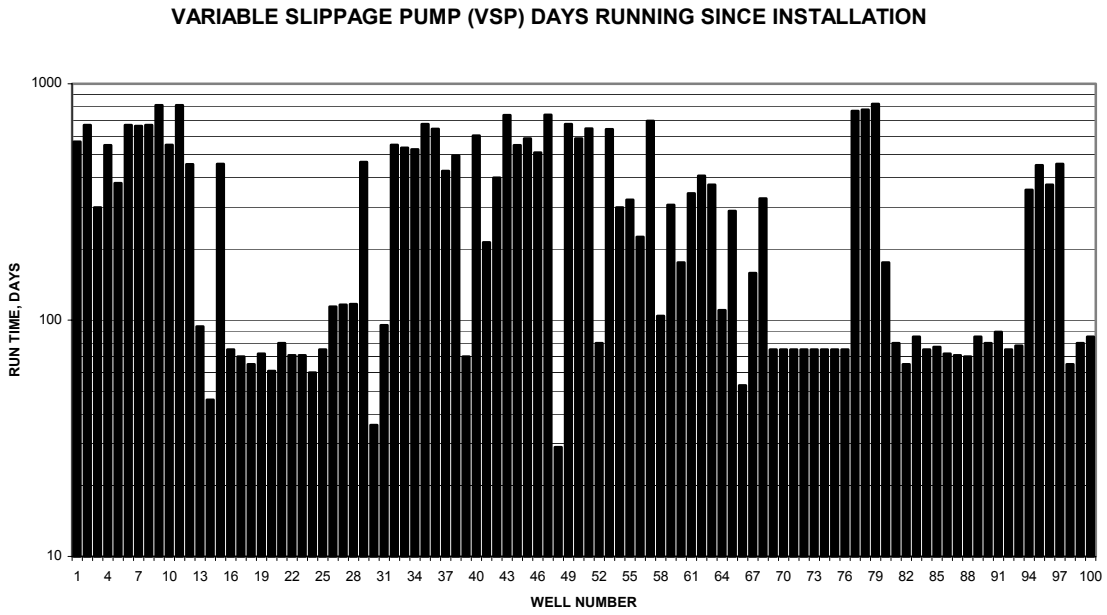


Figure 1

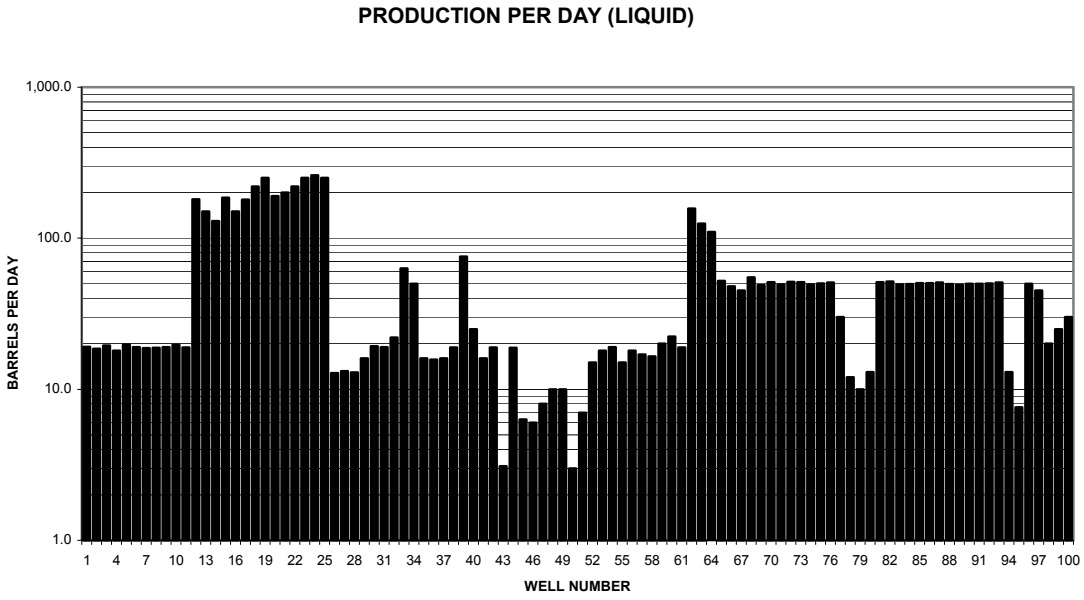


Figure 2

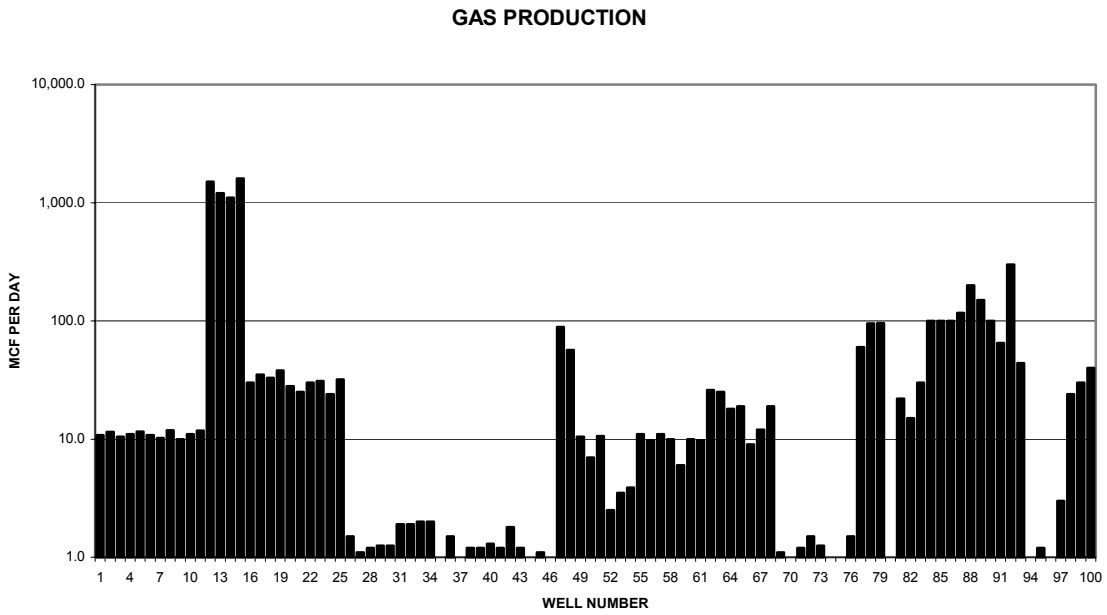


Figure 3

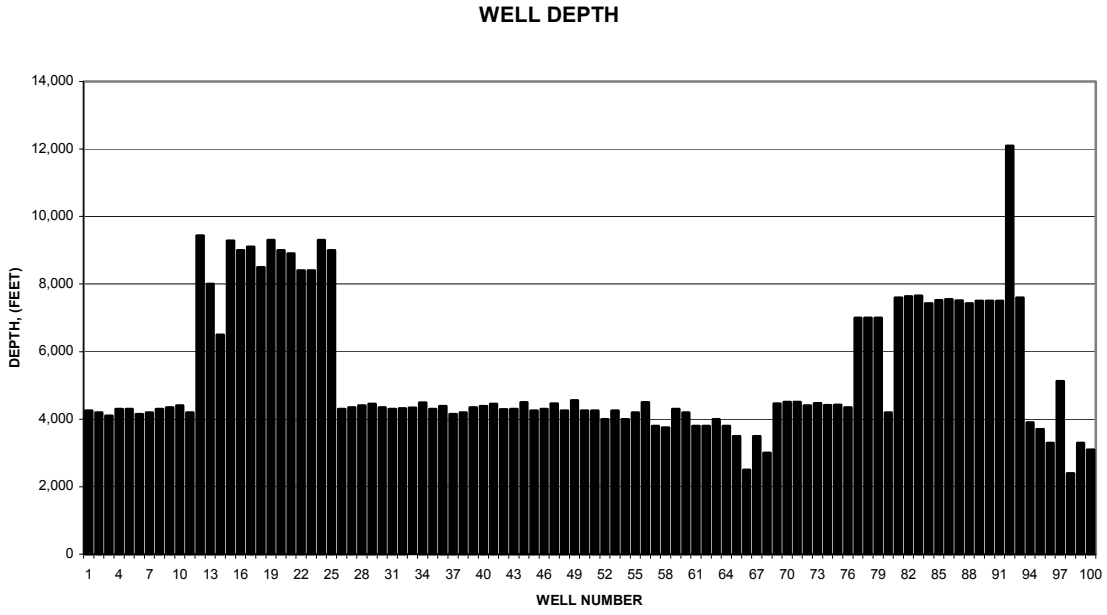


Figure 4

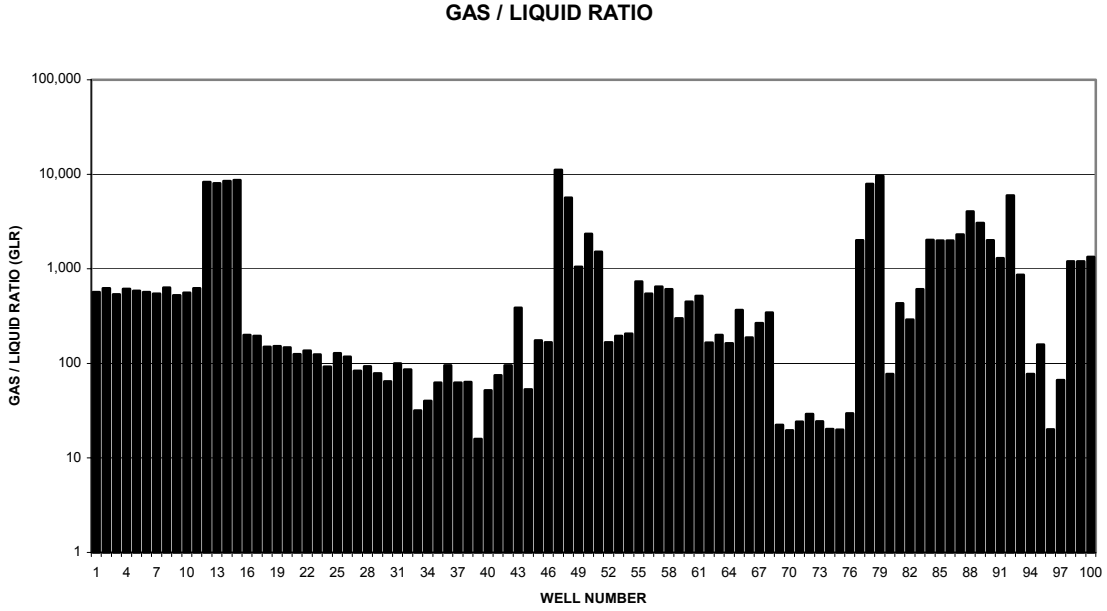
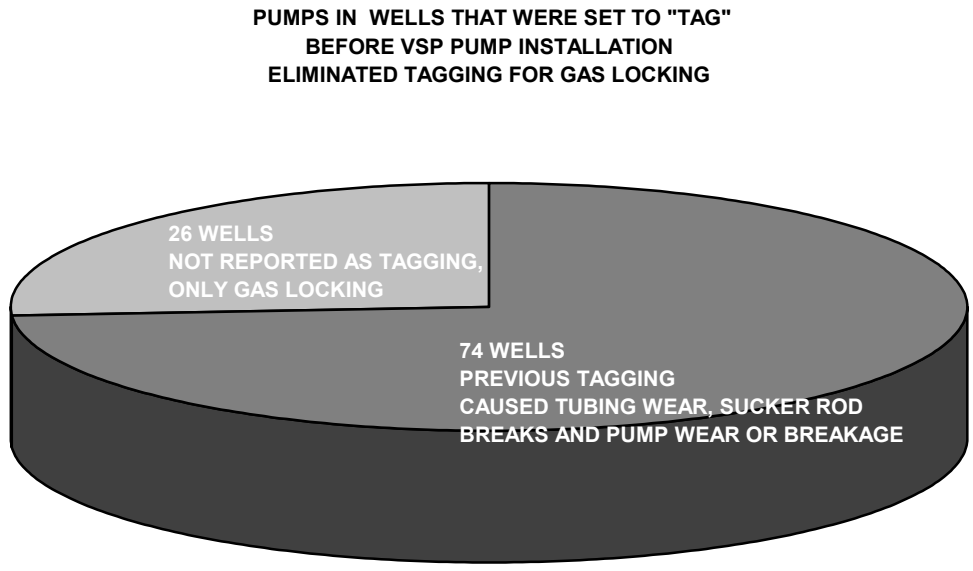


Figure 5



NOTE: "TAGGING" OF THE PUMP HAPPENS ON THE DOWNSTROKE WHEN THE PUMP IS SET TOO LOW SUCH THAT THE MECHANICAL PARTS OF THE PUMP HIT, CAUSING A SHOCK TO THE SYSTEM.

Figure 6