DOWNHOLE GAS SEPARATORS
FIELD CASE STUDIES AND RESULTS

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ABSTRACT

The Wolfberry offers additional production opportunities as well as many operational downhole challenges. This paper will cover a field study of"gas interference" challenges and the problems of "free gas" at the pump. Gas interference creates costly expenditures for operators of Wolfberry and other oil wells with similar wellbore conditions. Poor volumetric pump efficiency, gas pound, gas locking potential, higher energy lifting costs and uncontrollable well operations are some of the conditions to be addressed with some of the downhole gas separator's (DHGS) available today.

INTRODUCTION

The objective of this project was to observe the performance of several of the DHGS available in the Permian Asset Area in Wolfberry wells and remains a work in progress. Gas interference has been a huge problem with rod pumping oil wells and now with the challenges of the Wolfberry and other formation combination this problem is requiring massive amount of attention. The amount of measured gas does not seem to have a direct relationship to the amount of gas interference encounter by a downhole pump on any given well in the Permian area. That is to say an oil well with a gas volume of 50 mcf per day may not encounter any more or less gas interference than an oil well with 10 mcf per day values. Higher pump intake pressures and fluid viscosity seem to effect down hole pump efficiency greatly more than other downhole pump conditions. The purpose of this project was to evaluate the improvement of gas diversion pass the pump intake with less gas interference in the pump, control well operations, production volumes and reduction of failures by using a packer type downhole gas separator.

Much has been said and written as to the downhole pump spacing tolerance issue to compensate for and or aid in the consumption of associated gas. Through years of dynamometer card observations the pump plunger does not usually travel in the identical barrel area in every stroke. Usually downhole pump spacing can vary greatly, several inches, as the well is pumped down or has fallen behind with a fluid buildup. Thus meaning a lease operator must keep a constant vigil on the plunger travel area location and ensure the well does not begin to tagging and beating on the clutches of the top of pump and physically maintaining proper pump spacing at surface. This action will assist in maintaining the best compression ratio inside the pump barrel for better gas consumption. The API downhole pumps used for this project appear to be very capable of consuming large amounts of gas with proper pump plunger spacing.

TYPICAL TUBING DETAIL

The most popular downhole separator used for wells in the Permian operations is the Modified Gas Separator set above the perforations initially and then possibly relocated at a later time as shown in Figure 1. This type of separator benefits the operator with solids control and reduced CAPEX due to the availability of materials in the field. However a higher than desired fluid level and gas interference usually results in this type of system.

PROBLEMS W/ GAS INTERFERENCE

- Poor volumetric pump efficiency
- Gas pounding
    - Rod buckling and wear
    - Tubing leaks
    - Split barrels and cages

- Gas lock – seldom and not likely
- Higher energy consumption/barrel of fluid lifted
- Well not controllable
- Decrease in equipment life due to continuous runtime

GAS INTERFERENCE CONSEQUENCES

Some of the consequences dealing with gas interference are:

- More pump cycles per barrel of fluid lifted
- Higher energy consumption
- Increase cyclic loads on rods and pumps
- Increase wear on tubing, rods and pumps
- More frequent workover i.e. downhole equipment repairs
- Less than optimal draw down cannot produce well to capacity
- Poor chemical distribution

PROPOSED PROJECT SOLUTIONS

- Lower Pump Below Perforations (Natural Gas Separator)
    - – Solids issues (shortens pump life)
    - – Higher CAPEX
        - More tubing and rods
        - Possibly larger pumping unit and motor
        - Well servicing costs
- ▪ Change artificial lift method
    - – Usually not an option
- ▪ Reduce gas entering the pump
    - – Packer type gas separator
    - – Utilized 3 different DHGS (Figures 2,3,4)

DOWNHOLE GAS SEPARTORS

- Allow for increased retention time
- Gas bubble rise at about 0.4 ft/sec (max)
- Downward fluid velocity *<0.4ft/sec

$$\textbf{Fluid Velocity} = \frac{0.0119\,(\text{Rate})}{ID_L^2 - OD_S^2}$$

Where:

Rate = Gross pump displacement, BPD

ID2 = Inside diameter of large tube in inches

OD2 = Outside diameter of small tube in inches

Fluid Velocity = ft/sec (Figure 5)

*Viscosity of fluids effect

DHGS – Specs

- Single Unit Design Installation
- Emulsion Diffuser
- Longer tool length = more storage
  - 20' or 40' tools available
- Maximize Separation Area
  - Available in 2-3/8" & 2-7/8".
  - When production allows use 2-3/8"
  - Packer Addressed Rotational PKR concerns

PERFORMANCE METRICS

- Improves Pump and Overall System Efficiency
- Maximizes Production and Lowers Fluid Level
- Reduces Subsurface Failure Rates
  - Case Studies Included: Figure 6,7
  - Small statistical pool (13 Wells)
  - Most well's <1 yr old
  - POC installed

PUMP EFFICIENCY SUMMARY

- Increase in pump fillage
- Prolonged full DHPC
- Faster pump down of fluid level (Figure 7)

PRODUCTION IMPACT

- Total production increase in over 50% of wells
- Oil production 75% of wells
- Water cut decreased
- GLR increased on most wells (Figures 8,9,10,11)

CONCLUSIONS

All the project wells were selected based on gas interference and failure problems. Failure rate of tubing leaks, pump changes and rod parts as per Figures 8,9,10 and 11 showed a decrease. The DHGS successfully met expectations advertised and an overall increase in GLR, pump fillage, production were also recorded. No gas lock conditions were encountered during the test. The author will make a recommendation to continue the project observation and to include a test with a variable strokes per minute (SPM) setup to verify the capacities of the DHGS systems.

REFERENCES

1. Spirit Energy Global Solutions http://www.spiritenergysolutions.com/spirit-gas-separator

2. Echometer Gas Separator http://echometer.com

3. Don-Nan Gas Separator http://www.don-nan.net/gas_separator.php

ACKNOWLEDGEMENTS

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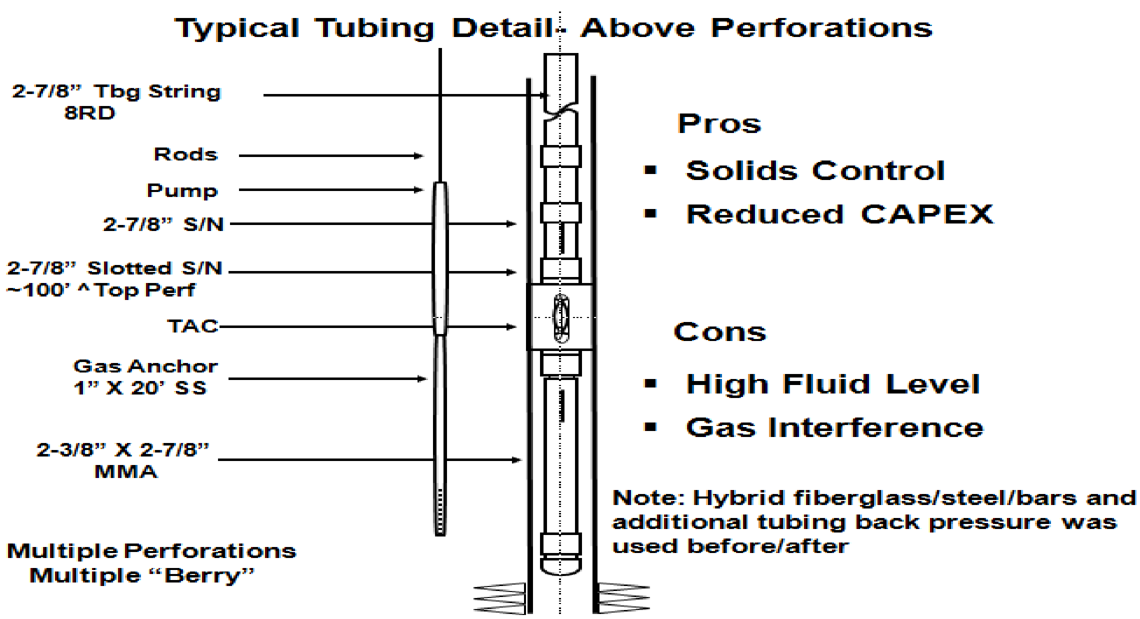

Figure 1

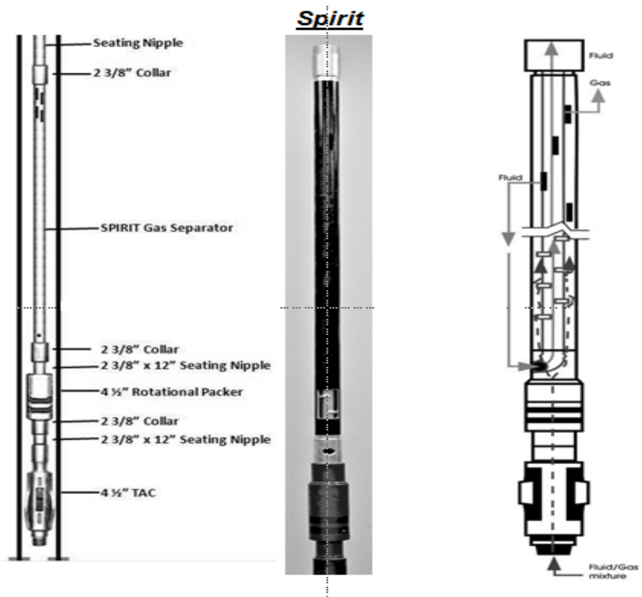

Figure 2

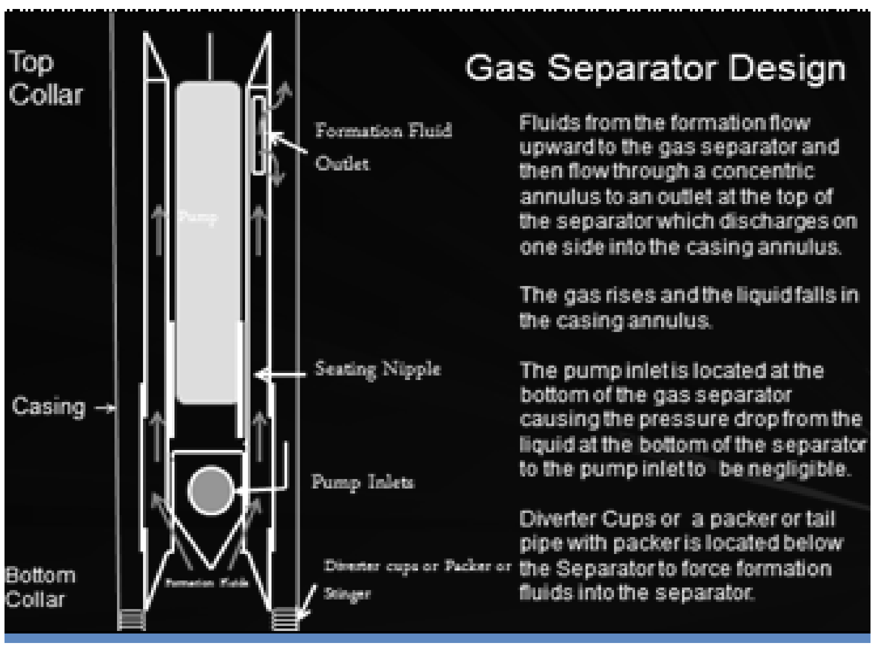

Figure 3 - Echometer

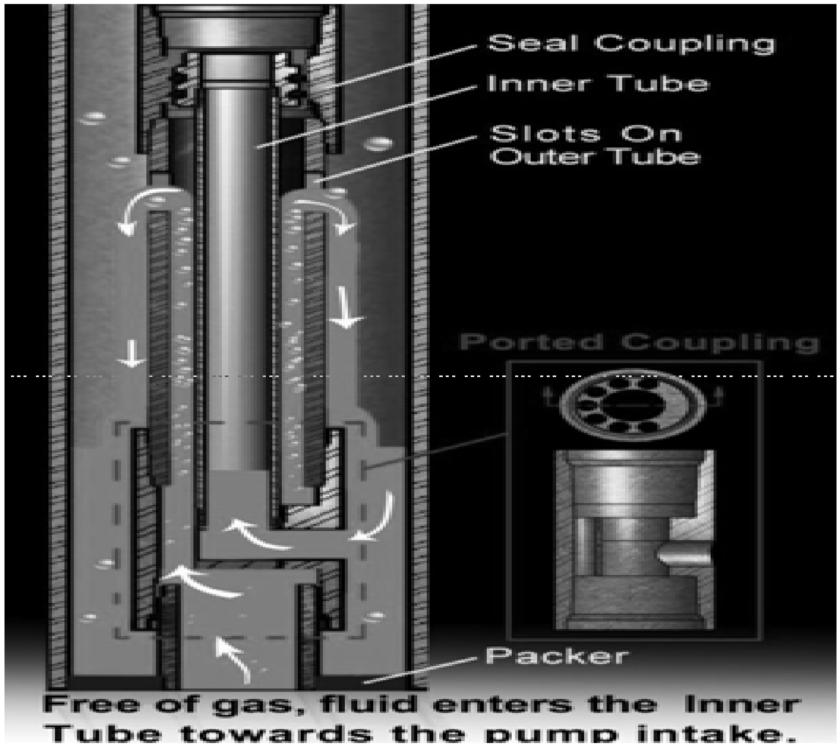

Figure 4 - Don-Nan

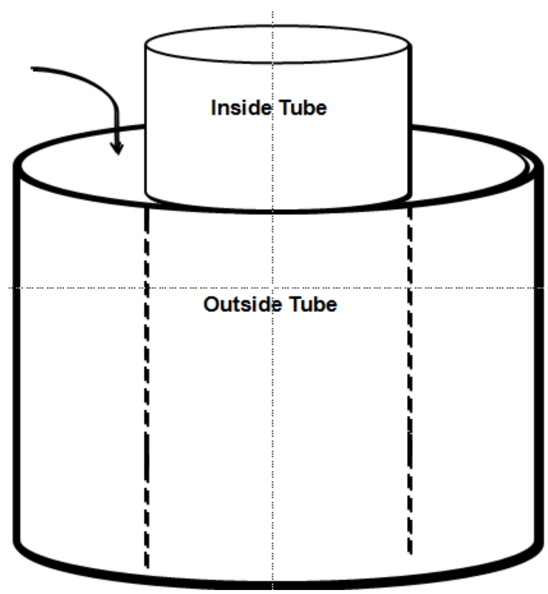

Figure 5 - Increase Cross Sectional Area of Sump

MMA **DHGS**

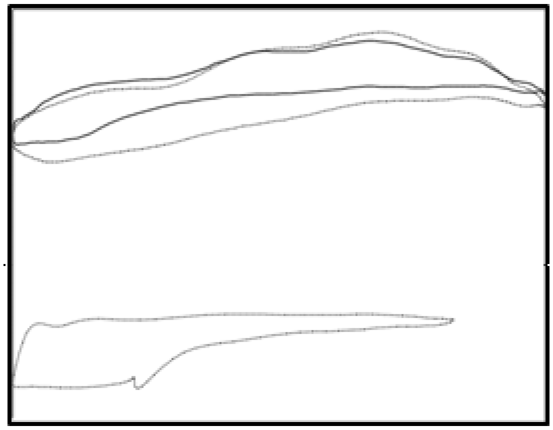

Figure 6

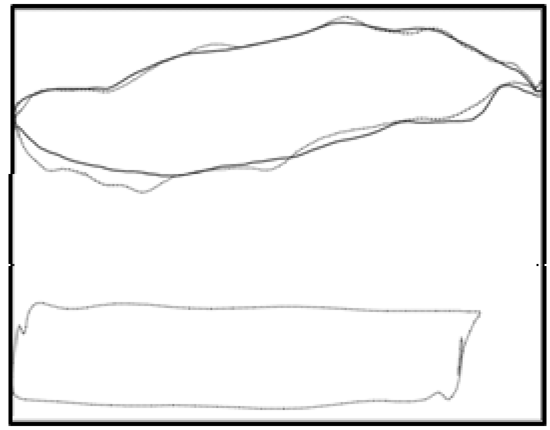

Figure 7

Pump Efficiency – Case 1

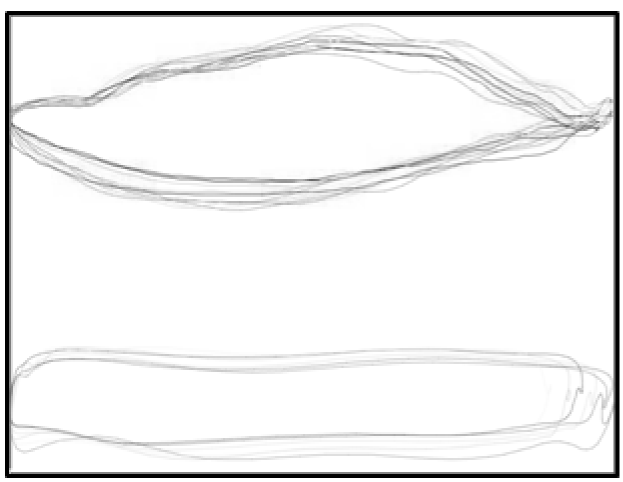

Figure 8

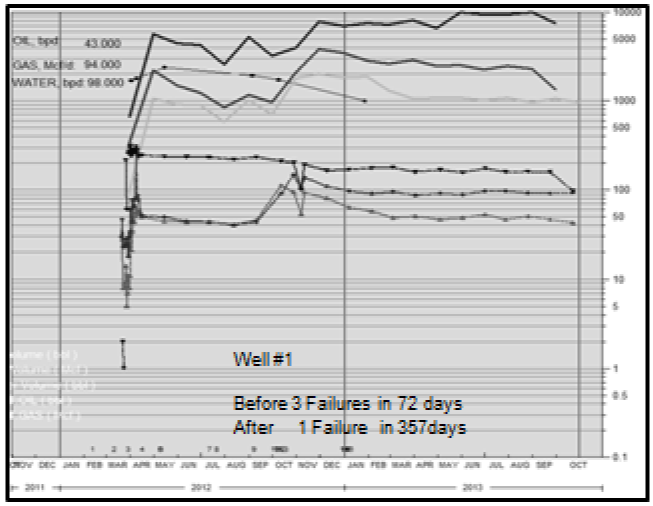

Figure 9

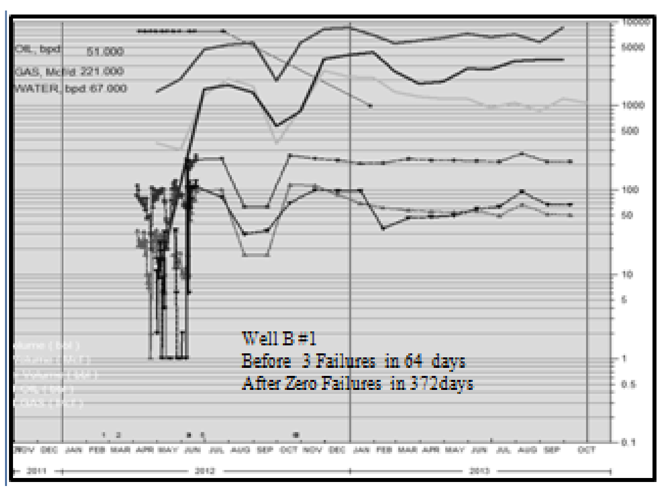

Figure 10

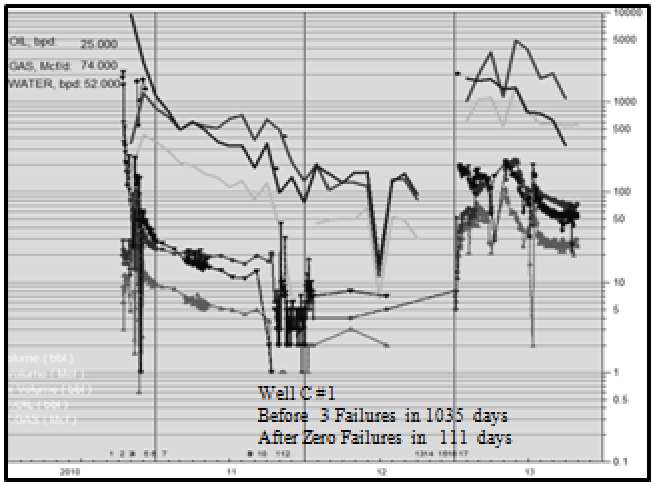

Figure 11

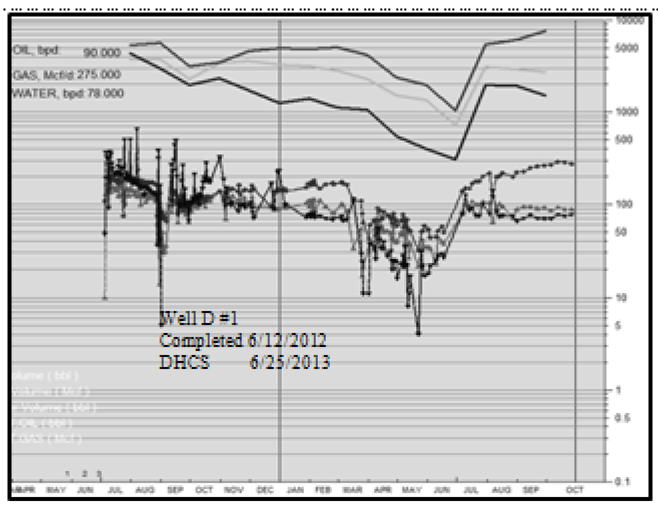

Figure 12