# CASE STUDY
# GAS INTERFERENCE: MANAGE OR MITIGATE

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## ABSTRACT

Murphy currently operates more than 600 wells in the Eagle Ford Shale. Currently 500 wells are on sucker rod pumps (SRP). The first Murphy SRP was installed during 2012. The challenges to SRP operations in the Eagle Ford include paraffin, corrosion, solids, deviated wellbores, slug flow, and foamy gassy fluid.

The presence of foamy gassy fluid in the Eagle Ford led to a study of the effectiveness of downhole separators. The results of the downhole gas separator trial will be presented. The case study found that gas interference can be effectively managed with a variable speed drive (VSD) controller for the pumping unit.

## INTRODUCTION

Murphy Oil Corporation chose sucker rod pumps (SRP) to produce the unconventional Eagle Ford Shale located in South Texas. The SRP system is one of the methods of artificial lift that can produce the well as the reservoir pressure declines and the production rate decreases. SRP are a well-known technology. It is reliable, versatile, and has reasonable OPEX.

The challenges of producing the Eagle Ford wells include paraffin, corrosion, solids, deviated wellbores, slug flow and foamy gassy fluid. The challenge of producing foamy gassy fluids in the Eagle Ford with SRP led to the case study. The study shows the results of the downhole gas separator trial. The study also demonstrates the ability to effectively manage gas interference with a variable speed drive installed on the pumping unit.

## GAS INTERFERENCE MITIGATION

Gas interference is defined in the oilfield glossary as “A phenomenon that occurs when gas enters the subsurface sucker rod pump. After the down stroke begins, the compressed gas reaches the pressure needed to open the traveling valve before the traveling valve reaches liquid. The traveling valve open slowly, without the drastic load change experienced in fluid pound. It does not cause premature equipment failure, but can indicate poor pump efficiency. A bottomhole separator or a gas anchor can correct gas interference.”

In unconventional horizontal wells, the SRP is installed above the perforations in the vertical portion of the well. This location is at or near the kick off point of the horizontal well. A downhole gas separator is installed in the tubing string below the pump seating nipple. The free gas flows up the casing. A robust downhole pump design is necessary to assist in the production of foamy, gassy fluids.

The purpose of the downhole separator is to separate the gas from the fluid so only liquid enters the downhole sucker rod pump. Numerous papers have been written that detail the calculations necessary for a gas separator to operate properly. The calculations consider the downward velocity of the fluid in the separator. The fluid production range expected from the well is part of the calculation. Gas flow velocities over ten feet per second create a mist and cause difficulty separating the gas and fluid.

Downhole separators do not separate gas in solution. They only separate the free gas at the pump intake. Gas flow up the casing tubing annulus can be subject to turbulent flow. Hold up flow and velocity changes of the free gas can affect the performance of the downhole gas separator.

Gas interference is expected in downhole pumps in unconventional horizontal wells. The pump intake is typically installed above the perforations. The fluid in the Eagle Ford is foamy and the gas stays entrained in the oil. The size of the horizontal portion of the well contributes to slug flow. The pump intake pressure is below the bubble point. These factors all contribute to gas interference in a SRP.

## CASE STUDY – TRIAL OF DOWNHOLE SEPARATORS

Five different models of downhole gas separators were installed in Murphy's wells in the Eagle Ford. Multiple wells were included in the trial. More than one of each model of separator was part of the trial. The separators were installed below the SRP intake and above the kick-off point. The separators were installed following the recommendations of the vendor. Design guidance was received from each vendor prior to installation.

Type A is a long gas separator with diffused ports and a long preinstalled dip tube. Type B is a combination gas and solids separator that uses cyclonic motion and internal baffling for separation. Type C is a collar size (same OD as the tubing collar) separator with the dip tube preinstalled and large fluid entry ports. Type D is a packer style separator with a complex flow path where low pressures and turbulence are thought to aid in breaking out gas. Type E has a helix gas anchor which induces centrifugal force for the creation of a slow vortex and gas coalescing zone. (Fig. 1)

The performance of each separator was evaluated individually. The evaluation included a review of the dynamometer cards from each well. Dynamometer cards were collected for each model of separator. In every instance the well controller captured dynamometer cards representative of full pumps and gas interference. The levels of gas interference in each well changed in the well in successive strokes. (Fig. 2)

The trial showed gas interference is present in the SRP wells regardless of the model of downhole separator.

## CASE STUDY - MANAGING GAS INTERFERENCE

Murphy's experience shows the downhole gas separator is not able to successfully mitigating gas interference. The case study continued by attempting to manage the gas interference. The variable speed drive (VSD) is an important component in managing gas interference. A VSD controls the speed of the pumping unit and is part of the controller connected to the pumping unit.

The key to managing gas interference is to properly configure the VSD. This involves a working knowledge of the VSD model installed on the SRP wells. The settings and operations of the VSD are not always intuitive. Murphy has two different models of VSDs installed in the Eagle Ford.

The proper configuration of the VSD includes setting the pump fill from 85 to 90 % depending on the well. The VSD then either speeds up or slows down the pumping unit based on the pump fill target. The VSD is desensitized to speed changes. The speed changes are gradual and smooth. The minimum and maximum speed range is set from 1.5 to 7 SPM. A full pump or pump fill above the set point indicates fluid is present in the well. The VSD then increases the pumping unit speed. The pumping unit slows down when the pump fill falls below the set point.

The gas interference study identified two different types of wells. Type 1 is a well that has moderate gas interference. The pumping speed (SPM) is easy to control around a pump fill target. (Fig. 3) The SPM of the pumping unit graphed with pump fill versus time shows the pumping unit gradually slows down as the pump fill declines. (Fig. 4)

The same data graphed with 10 minute data shows constant change in the pump fill and SPM. The pump fill ranges from 52 % to 100 %. The average pump fill for this example well is 80 %. The average pump speed is 4.5 SPM. The speed of the pumping unit changes in response to changes in the pump fill. (Fig. 5). This type of operation is expected in the Eagle Ford. The response of the unit speed to the pump fill maximizes the production.

The other type of well identified in the study is the Type 2 well. This well is more difficult to control the pump speed to the pump fill target. Severe gas interference is seen in this type of well during some strokes. The speed range is often limited in this type of well. Limiting the speed range caps the top speed of the pumping unit. The limited speed range gives the well time to recover from gas interference. The pumping unit is not able to speed up higher than the preset cap even if the pump fill is above the target of 85 %.

The SPM of the pumping unit graphed with pump fill versus time shows the pumping unit speed is low. The pump fill average never reaches the pump fill target. (Fig. 6) The 10 minute data for this well shows the pump fill does go above the target pump fill. The pumping unit speed increases with the pump fill just like the Type 1 well. The average pump fill for this well is 75 %. The average speed is 2.8 SPM.

## CASE STUDY – LESSONS LEARNED

Gas interference is expected and normal in the Eagle Ford. Production variations are expected and normal in unconventional horizontal wells. Gas interference can be managed with the use of a properly configured VSD.

Gas interference was not eliminated by the installation of a particular model of downhole gas separator. Gas interference was seen with all five models of downhole separators. The most economical and basic downhole gas separator is sufficient. A robust downhole pump designed for gas interference is beneficial in Eagle Ford operations.

Murphy’s 500 sucker rod pumped wells operate 24 hours a day at the most efficient speed to maximize production.

## REFERENCES

Lynn Rowlan and James McCoy: “Gas Locked Pumps are not Gas Locked”, ALRDC 9th Annual Sucker Rod Pumping Workshop, Oklahoma City, Oklahoma (2013)

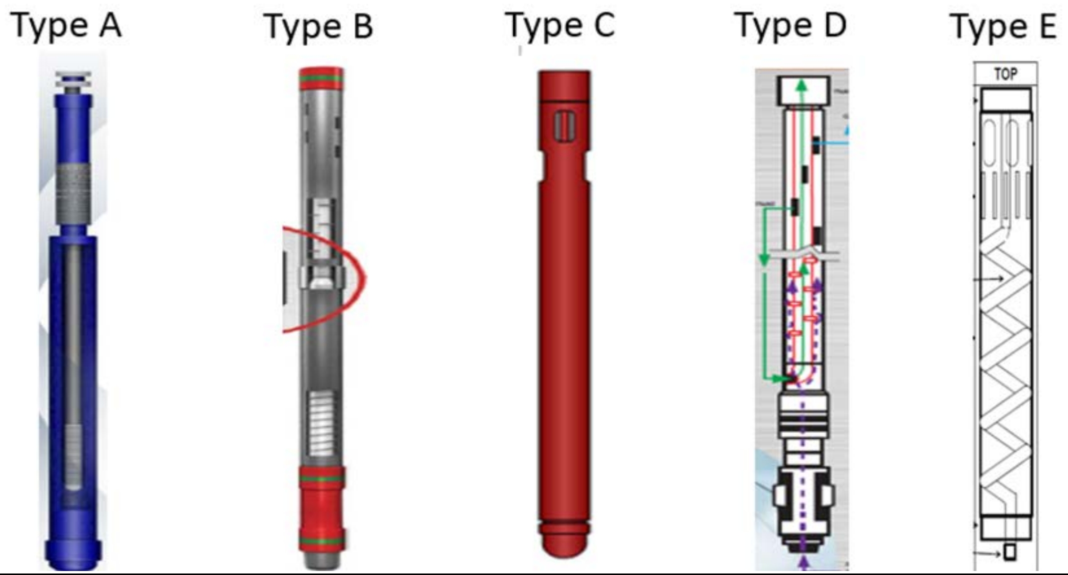


Figure 1 – Models of downhole gas separators trialed (Not to scale)

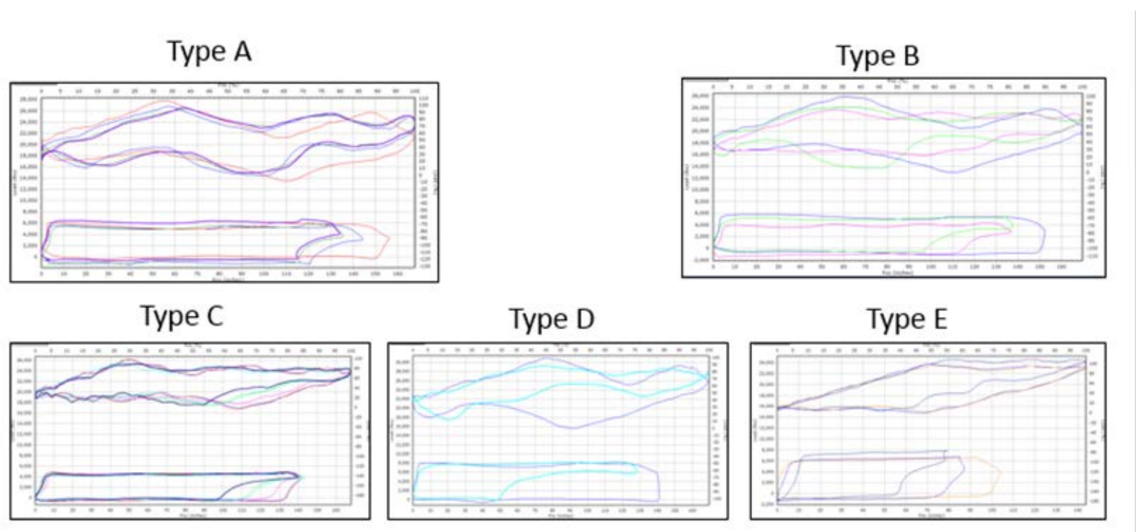


Figure 2 – Dynamometer cards for each downhole separator model

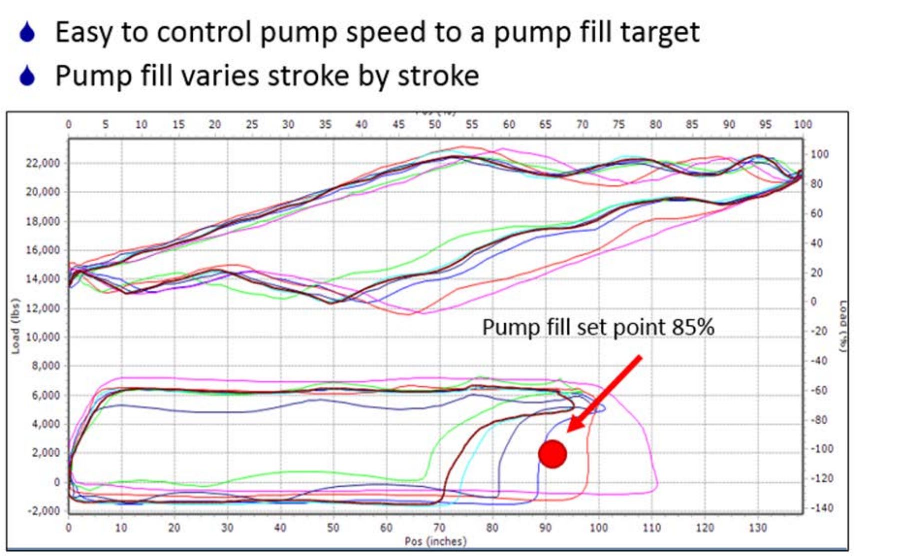


Figure 3 – Type 1 well dynamometer cards

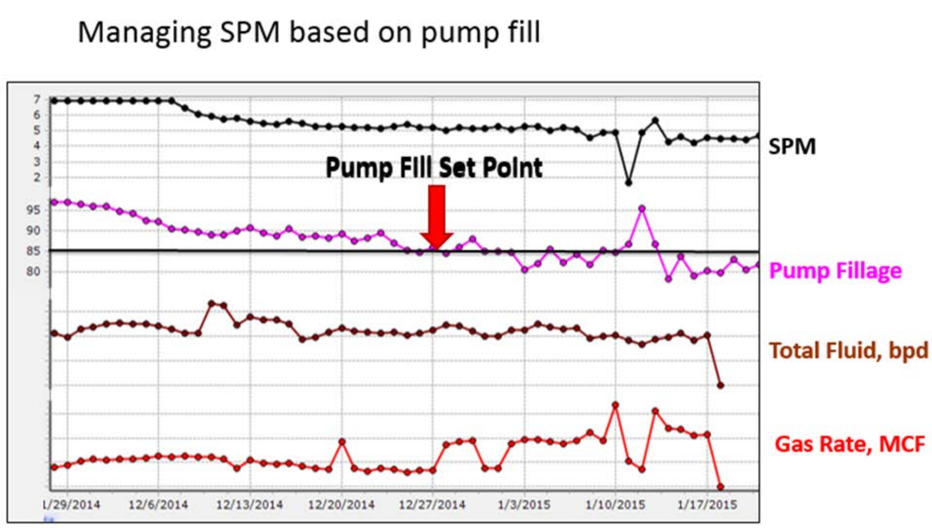


Figure 4 – Type 1 well SPM changes as pump fill changes

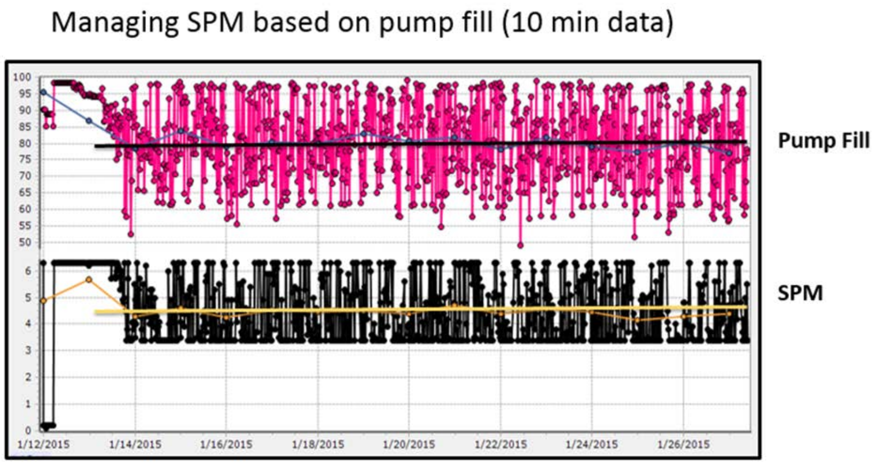


Figure 5 – Type 1 well 10 min data

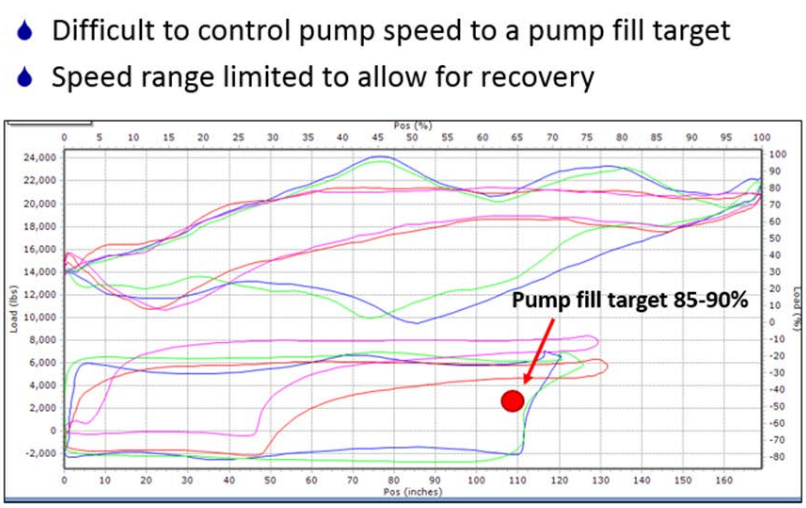


Figure 6 – Type 2 well dynamometer cards

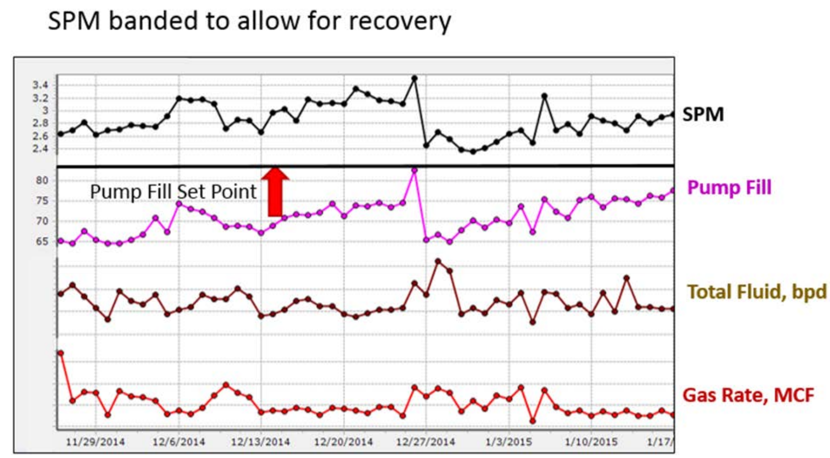


Figure 7 – Type 2 well SPM change as pump fill changes

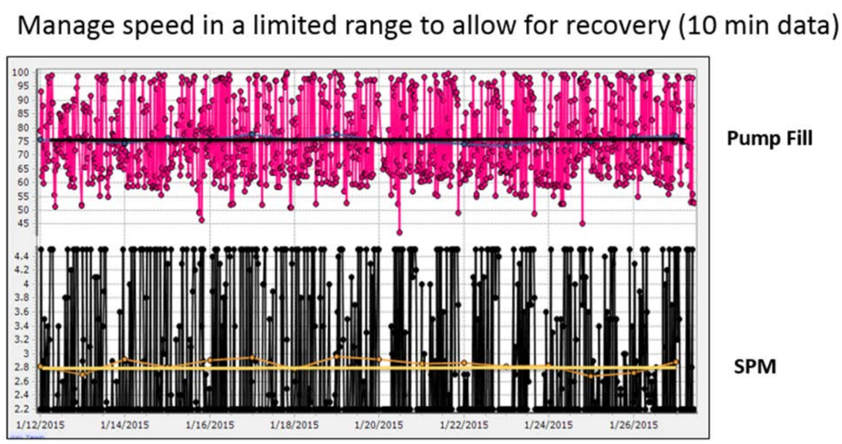


Figure 8 – Type 2 well 10 min data