# KEEPING ESPS PRIMED IN HIGH VOLUME GAS WELLS

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ABSTRACT

Wells used for gas production can present many problems for ESP systems. Extended duration gas slugs can cause pumps to lose prime and cycle on and off.

This paper deals with one lease holder's attempts to produce gas with an ESP system in place. New Dominion has wells with gas slugs lasting one to three minutes and longer. Working with a manufacturer, a solution was developed that (when properly sized) can balance the well and allow production of gas without constant system shutdowns.

This paper examines two case histories involving inverted shrouds as long as 450'. While producing as little as 900BWPD, output rose to 600MCFD of gas before leveling off at 400MCFD.

This information will be beneficial to anyone wishing to use ESPs who is having problems with gas slugs in vertical or horizontal applications.

## INTRODUCTION

How much gas is too much? There is too much gas present when it prohibits the use of conventional methods (Gas Separators and Tapered Pumps) normally used to prevent gas locking of an ESP. The term shroud is most commonly associated with motor cooling. While this may be the case for most applications, there is another use of shrouds that is beneficial to gas production. If the shroud is inverted, sealed directly below the pump intake and extended upward, its length can be adjusted for gas slug duration. This allows the pump to run, emptying the shroud of its fluid while the gas slug works its way past the shroud. Once the slug passes, the shroud will refill and be ready for the next gas slug. In addition to an increase in production, ESP equipment should benefit from the reduced number of starts and stops.

## EQUIPMENT DESCRIPTION

The use of inverted shrouds as a gas handling method is not new to the industry. Operators are currently experiencing renewed interest due to the rising cost of gas. The ability to lower fluid levels in order to produce gas can be significantly enhanced by the use of inverted shrouds. The major components are described here and can be seen in Figure 1 at the back of this paper.

**Pump/Shroud Seal** – This provides a method of sealing the area between the pump base and the shroud, so that production fluid is forced to pass upward over the pump, then turn and flow down the inside the shroud to the pump entrance. The total ESP system must be able to pass through the shroud. The motor and seal section (protector) extend below the shroud and are exposed to the well fluid allowing for proper cooling.

**Shroud Hanger** – The hanger is installed on a short, non-upset pup joint sandwiched between two casing collars. The body of the hanger has an external lip which rests against the top end of the casing inside the casing collar. It is held in place by a short casing pup joint threaded into the top of the casing collar. The only weight carried by the hanger is that of the inverted shroud.

**Assembly** – The shroud is assembled into the well first and clamped at the well head. The ESP system is assembled normally except for the shroud seal attached to the pump base. Pup joints are used for spacing to assure proper location of the shroud seal. After the hanger is installed the entire system is ready to be lowered into the well.

## CASE STUDIES

The two case studies covered in this paper involve wells located in Lincoln County, Oklahoma just east of Oklahoma City. These recently completed wells had been unable to produce because the extended length of the gas slugs caused the ESP systems to continually cycle without reaching the stable drawdown required for gas flow. The data presented here begins at the time of installation of the inverted shroud systems.

Case 1 – Chitsey #1-H

| | | | |
|---|---|---|---|
| **Equipment:** | Motor | 4 ½" O.D. | 93H.P. |
| | Pump | 4" O.D. | 215 Stage Taper Pump |
| | Shroud | 5 ½" O.D. | 250 feet long |

| | | |
|---|---|---|
| **Well Location:** | Bottom of Motor | 4589' @ 77.9 degrees |
| | Bottom of Shroud | 4556.2' |
| | Top of Shroud | 4309' @ 74.3 degrees |

This example used 2 3/8" production tubing inside the shroud to increase the amount of area between the tubing outside diameter and the shroud inside diameter; 2 7/8" tubing was used from the area above the shroud to the surface.

The Chitsey #1-H Daily Production graph Figure 3 illustrates that both gas and fluid production begins to level out after three months of operation. The downward spikes seen on the graph are caused primarily by field kills, power failures, flow line problems, drive changes, gas vent tie-in and blown fuses. Minor downward spikes can be attributed to small amounts of cycling. During December this well produced an average of 400BFPD and an average of 88MCFD of gas. This well did not produce before the installation of the inverted shroud because the ESP system would cycle on and off approximately every five minutes as a result of the gas slugs.

The inverted shroud will function even at an extreme angle. Figure 4 shows the system at its installed angle. This installation angle only renders the top six to ten feet of the shroud ineffective in the pump prime area. The radius of the bend has been exaggerated to fit the figure.

Case 2 – Bledsoe #1-H

| | | | |
|---|---|---|---|
| **Equipment:** | Motor | 4 ½" O.D. | 216H.P. |
| | Pump | 4" O.D. | 275 Stage Taper Pump |
| | Shroud | 5 ½" O.D. | 450 feet long |

| | | |
|---|---|---|
| **Well Location:** | Bottom of Motor | 5239' @ 80.1 degrees |
| | Bottom of Shroud | 5202' |
| | Top of Shroud | 4754' @ 81 degrees |

This example used 2 3/8" production tubing inside the shroud to increase the area between the tubing outside diameter and the shroud inside diameter; 2 7/8" tubing was used from the area above the shroud to the surface.

This well developed very large gas slugs. As the equipment listing above shows, a 450 foot long shroud was deployed. The lease holder had been unable to produce this field with ESPs before the use of inverted shrouds.

The Bledsoe #1-H Daily Production graph Figure 6 looks very similar to the Chitsey #1-H well. (With exception of additional gas volume.) Because of the amount of gas, this well took over four months to stabilize. The average production during the month of December was 437BFPD and 389MCFD of gas. Once again, the only time the system was inoperable was during to surface equipment repairs and tie-ins.

The Bledsoe unit was also installed very close to horizontal Figure 7. It was placed in the well at 80˚ off of vertical. The data shows that as fluid level is lowered, the trapped gas is allowed to travel up and out of the well, allowing the slugs that cause cycling to be reduced in size.

## CONCLUSIONS

The case studies show that ESPs with inverted shrouds provide a viable method for removing fluids in gas producing wells. Neither of these wells could be produced on ESPs minus the inverted shrouds without serious gas locking and equipment cycling.

The benefits of inverted shroud are easy to define:

- Innovative design is cost effective and simple

- Less downtime reduces workover costs
- Relatively steady gas flow compared to large slugs
- Faster pay-back on equipment investment

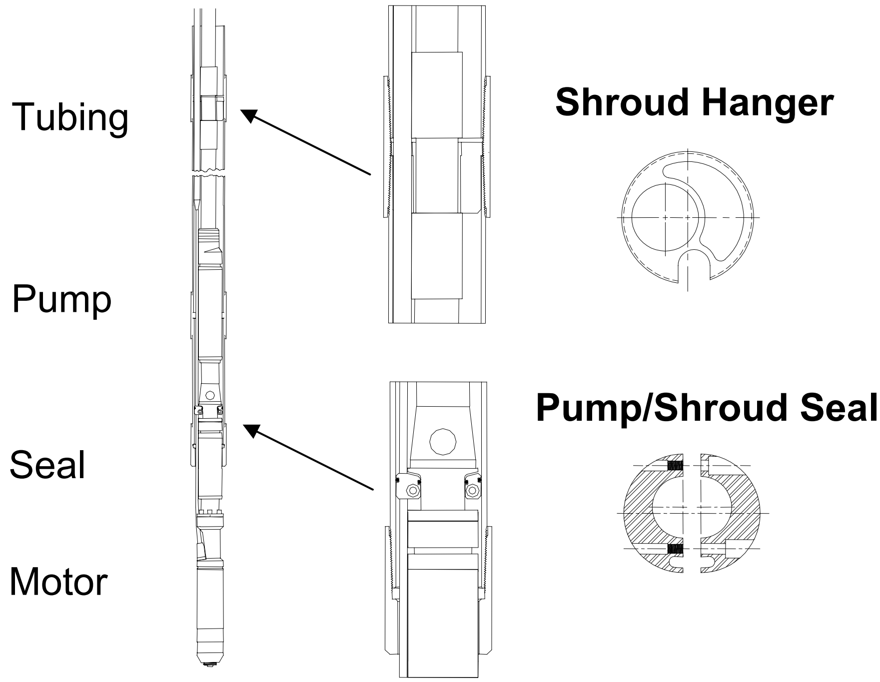


Figure 1

| QUANTITY | FROM | TO |
|---|---|---|
| # OF WELLS | --- | 1 |
| AVG. BFPD WATER | --- | 400 |
| AVG. MCFD GAS | --- | 83 |
| SIBHP, PSI | --- | N/A |
| PUMP INTAKE PSI | --- | 141 |
| API, SP.GR. | --- | 1.05 |
| TBG, O.D.(IN) & WT. | --- | 2 7/8” 6.5# |
| CSG, O.D.(IN) & WT. | --- | 7” 23# |
| TVD, FEET | --- | 4051.55 |
| MD, FEET | --- | 7485 |
| SCALE (LIGHT, ETC) | --- | N/A |
| SAND | --- | N/A |
| H2S | --- | 5-10 PPM |
| CO2 | --- | N/A |
| EMULSION (yes or no) | --- | NO |
| ONSHORE/OFFSHORE | --- | ONSHORE |

Figure 2- Data: Chitsey #1-H Field Conditions

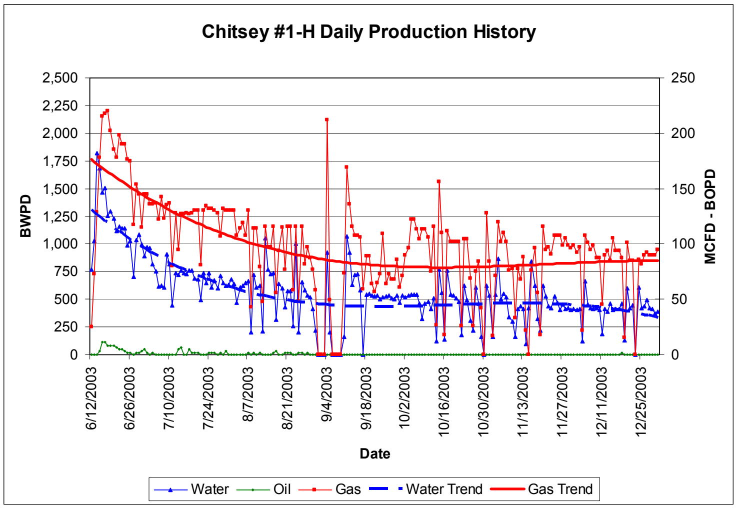


Figure 3

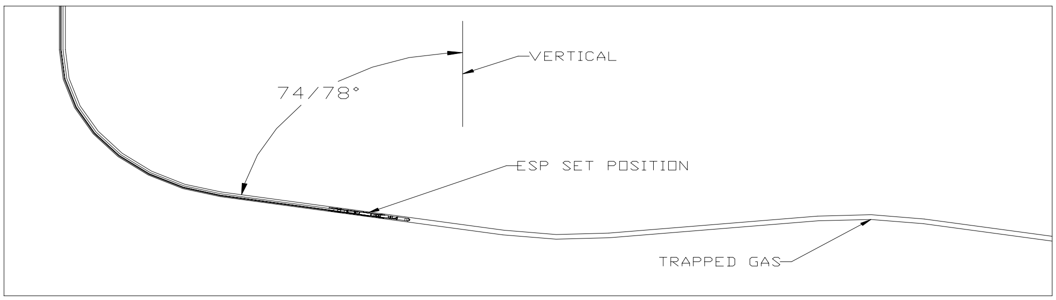


Figure 4

| QUANTITY | FROM | TO |
|---|---|---|
| # OF WELLS | --- | 1 |
| AVG. BFPD WATER | --- | 497 |
| AVG. MCFD GAS | --- | 389 |
| SIBHP, PSI | --- | N/A |
| PUMP INTAKE PSI | --- | 310 |
| API, SP.GR. | --- | 1.05 |
| TBG, O.D.(IN) & WT. | --- | 2 7/8” 6.5# |
| CSG, O.D.(IN) & WT. | --- | 7” 23# |
| TVD, FEET | --- | 4161.14 |
| MD, FEET | --- | 9441 |
| SCALE (LIGHT, ETC) | --- | N/A |
| SAND | --- | N/A |
| H2S | --- | 5-10 PPM |
| CO2 | --- | N/A |
| EMULSION (yes or no) | --- | NO |
| ONSHORE/OFFSHORE | --- | ONSHORE |

Figure 5- Data: Bledsoe #1-H Field Conditions

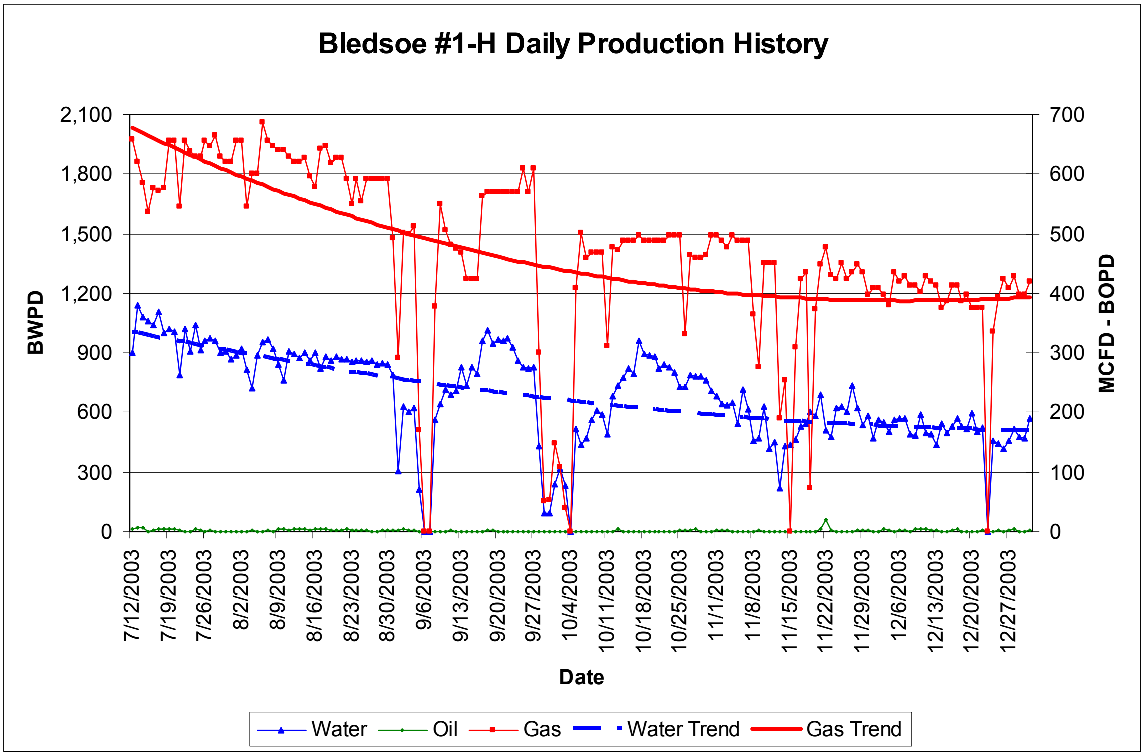


Figure 6

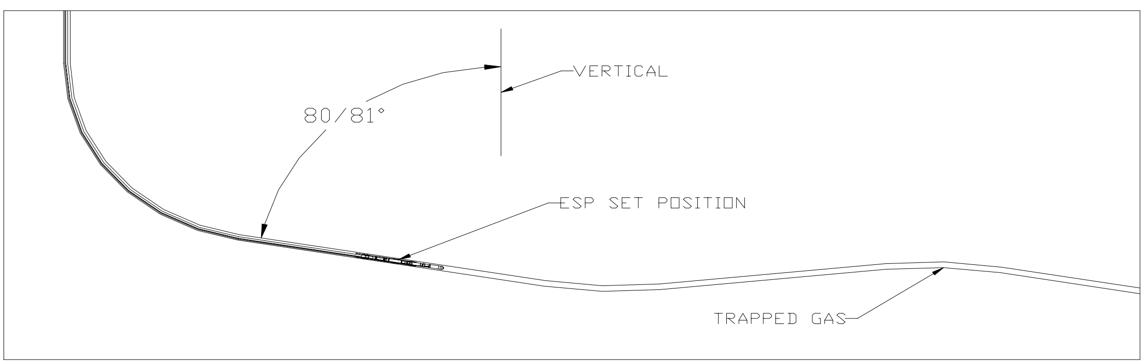


Figure 7