Introduction

Progressive Cavity Pumps are the most commonly used method of artificial lift in south-east Queensland.

Up to 40% of progressive cavity pumps in the South-East Queensland can be down at any given time on account of torque due to formation solids causing excessive pump torque leading to eventual pump failure. A major CSG Operator in south east Queensland stated that they have 1800 CSG wells, and on average 720 wells are shut down due to solids issues. Wells that are down lead to lost production and costly work-overs to get the wells back producing. The time between work-overs and progressive pump efficiency need to improve to make these wells and projects economical.

The purpose of this paper is to showcase the improvement in progressive cavity pump efficiency with the recirculation of clean (solids free) fluid back down the well-bore.

One of the major challenges with progressive cavity pumps is the pump torqueing up due to formation solids. Once solids in the well-bore start to increase pump torque it may eventually result in the pump seizing up and pump failure. Once the pump stops, the water and solids that were being produced stop lifting, fall back down the tubing and settle on the pump. Due to the solids settling on the pump, the pump is often not able to re-start and the end result is lost production and the need for intervention with a flush-by unit or service rig. The operators use a flush-by unit to flush and wash the solids off the pump, or alternatively a service rig is required. In the event a service rig is used, the rig either unseats the rods and rotor, or is required to completely pull the rods and tubing to clear the solids blockage.

A solution has been engineering and trialled to improve pump efficiency whereby solid laden fluid, produced from the well, is put through a desander to remove solids and then the clean fluid is re-injected down the well. There are 3 ways in which water can be re-injected in the well: straight down the tubing and casing annulus, via hollow rods, or by using a dedicated capillary line. This recirculation system removes sands and solids from the well, dilutes solids concentration with clean fluid, and allows the progressive cavity pump to operate without torque issues.

This can all be done at a fraction of the cost of intervention with a flush-by unit or service rig. The well was going down every 2 months and the work-over costs were $125,000 or $2,083/day. The costs of the recirculation system are $400/day.

Overview

Although progressive cavity pump failures are currently an industry issue causing lost production and costly work-overs, there is a solution. The theory going into the trials was that the solids production into the well-bore should decrease as the water rates decrease for coal seam gas wells in south-east Queensland. Wells typically start with a very high water rate and low gas rate, over time the water rate declines and gas rate increases. When looking at the solids production from an 800m wellbore, the gas rates would need to be very high to be able to lift solids to surface, and therefore the water is typically what is carrying the solids. The problem is that operators must keep wells producing long enough to reach the point in a wells production life cycle when the water rates drop off and stop lifting solids. The thought process was to dilute solids concentrations downhole to improve pump performance, and with the increased fluid the speed of the pumps could increase, thus increasing upward velocities to further aid in solids lifting. The trial showed that when the PCP was turning at 150RPM the water was clean and free of solids. When water was re-injected into the well-bore and the pump was sped up from 150RPM to 300RPM the water sample immediately showed solids. With the increased pump speed it was calculated that the upward fluid velocity went from 0.384ft/sec to 1.305ft/sec, which was now sufficient to lift solids form the well-bore. From the trials in the Surat Basin the use of clean water for re-circulation minimized pump torque leading to pump failure. The clean water recirculation allows wells to keep operating long enough to get to a free flow state, thus producing gas without the aid of a pump.

The Process

1. Solid laden water is lifted to surface from the down hole progressive cavity pump

2. The solids are removed from the surface Desander

3. Clean (solids free) water comes out of Desander

4. Clean water is re-injected back down the well-bore

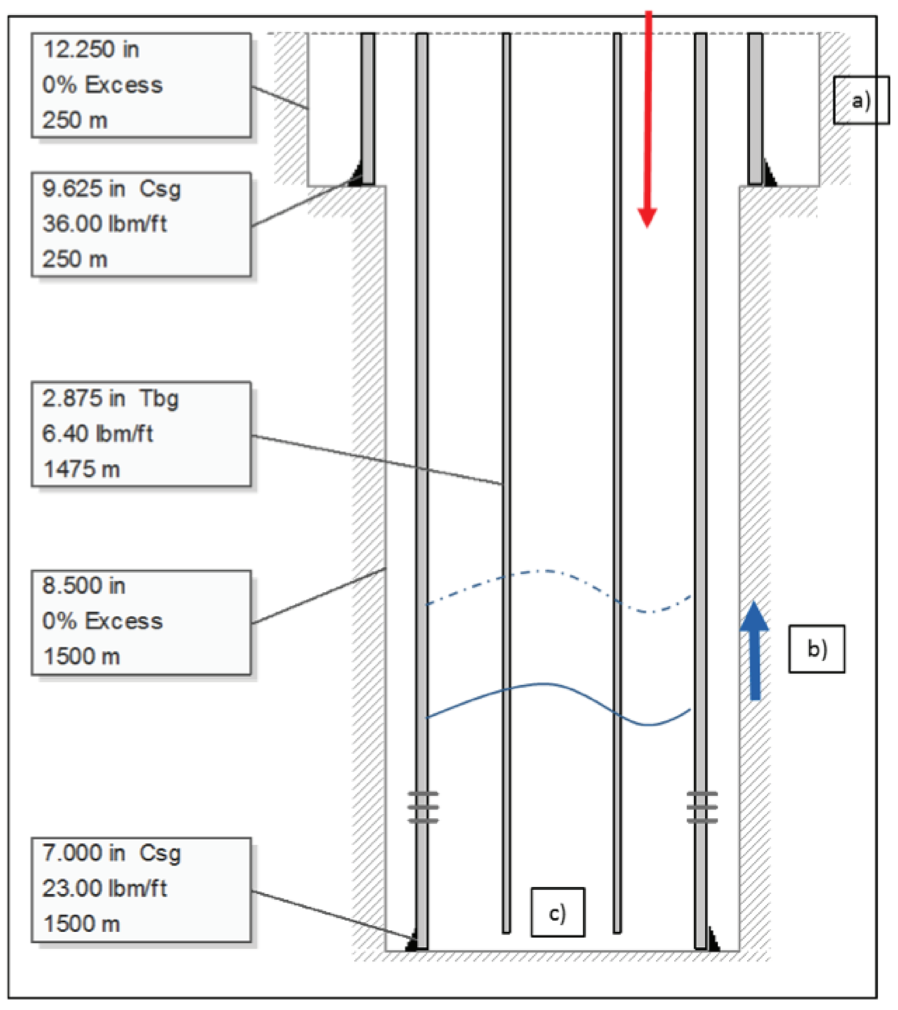
5. Water that isn't required for re-injection goes to the separator

   a) Clean water is re-injected down the well-bore

   b) The clean fluid dilutes the concentration of solids down-hole, the fluid level increases

   c) With the increase in fluid level the speed of the progressive cavity pump can safely be sped up without risk of pumping off. The increase pump speed increases the tubing velocity and effectively lifts the solids from the well-bore. The dilution of the solids concentration with the clean water lowers the pump torque and improves pump run life and efficiency.

Discussion & Results



Increased concentration of solids in the water cause issues for progressive cavity pumps resulting in them torqueing up as solids pass through the rotor and stator lobes. Although progressive cavity pumps are designed to handle some solids production the formations in south-east Queensland are producing such large amounts of solids that the pumps are struggling and torqueing up.

In 2015 a nine month trial was conducted to recirculate clean, solids free, water back down the annulus of a CSG well that was plagued with solids production and resulting in pump failure. The well averaged six failures per annum, in other words the well required intervention by a flush-by rig, or a service rig every two months as it had stopped pumping. The cause for the down-hole pump to fail and stop pumping was due to high torque caused by solids being produced from the down-hole formation. The trial was to take the solids laden water from the well-bore, remove the solids from this water and re-inject the produced water back down the annulus of the well. The theory was re-injecting solids-free water would dilute the concentration of solids downhole. The well was producing 200 BPD of solids laden water. The trial consisted of re-injecting 200 BPD of clean water, so the combined total water being produced was increased from the original 200 barrels to 400 BPD.

The introduction of 200 barrels of clean fluid effectively diluted the solids concentration by approximately 50%. The well originally had 50kgs of solids being produced in 200 barrels the solids ratio was 0.25kg solids per barrel of water. With the injection of clean fluid the well was producing a new ratio of 0.125kg per 1 barrel of water. The re-injection of clean water helped the well in several ways; firstly it diluted the solids concentration, and also with the increase in water into the system the progressive cavity pump needed to be sped up to now lift 400 barrels versus 200 barrels per day. Speeding the pump up helped the torque issues as the pump was able to increase the velocities in the well and help lift more solids out of the well, it was clearing its throat. The well went from needing well intervention every two months, and after recirculation of clean fluid for nine months the well went to gas free flow, a positive and cost effective solution for the operator.

Lessons learned include;

- Verification of solids issues in CSG wells in the Surat Basin
- Quantification of produced solids

Summary & Conclusion

The conclusion of the trial is that re-injection of clean water dilutes solids concentrations, helps progressive cavity pumps lift solids out of the well, lowers pump torque, resulting in increased run life. The main conclusion was that the theory that over time as gas rates increase and water rates decrease the solids production rates would decrease as well. After nine months the well went from needing a work-over every two months to gas free flow, unassisted by the pump. That well has produced enough water during nine months that the water rates have dropped off and gas is freely flowing to surface without the aid of any artificial lift.

The annulus re-injection has some limitations. What the trail found that by dumping the clean water back down the annulus only 47% of the re-injected fluid reach the downhole pump. With the annulus injection the clean water has to flow against the gas being produced up the annulus, so the other 53% of the water injected simply misted and was lifted out of the well by the annulus gas.

From the trial there are several methods for improvement to this system. The way to improve the amount of clean water to reach the pump is to have a conduit to place the water at the pump, this would eliminate the "misting effect" on the annulus side. The future scope and next step is to use hollow rods or a dedicated capillary string to place clean water at the pump.

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