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Coiled Tubing Lift Improves Performance in Deliquification of a Gas well in SW Kansas

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Abstract

The use of coiled tubing in place of rods in artificial lift systems has proven to be an effective way to improve performance, reduce expenses, lower lost production, and facilitate a more efficient, well-treatment program. The proposed system can act as a velocity string (primarily in gas wells) and can replace the sucker rods used in actuating downhole rod pumps. Coiled Tubing (CT) can be used to convey chemicals used to treat corrosion and wash out sand accumulation, improving well reliability, and therefore economics.

This paper describes the history and track record of coiled tubing used as “hollow” rod string, illustrates installation procedures, and provides information on performance of a well used in a field trial. Provided are diagrams and schematics of the surface and downhole equipment, as well as photographs of the hardware used. Shown also are the well dynamometer cards generated. The system’s case history is presented.

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Introduction

Wells using sucker rod pumps (SRP) as their primary artificial lift method make up more than 60% of all oil wells globally. In the US, This artifical lift pumping method is used in more than 500,000 wells and has been in operation for more than 100 years and continues to be used today.

This form of artificial lift is not without risk. Mechanical issues can lead to costly fishing jobs or rod failures. In most cases, stress induced by constant change of loads caused by the pumping motion, together with lack of proper handling practices result in rod failures. Additionally, corrosion and mechanical wear due to well geometry and compressive forces contribute to the likelihood of rod failure. Such failure not only requires well servicing (resulting in added rig cost), but also results in downtime and lost production caused by wait times for service units. Depending on well location, such delays add up to weeks

Adding to the problem of rod failure is that sucker rods are connected to each other by couplings which have a larger diameter than that of rods. The couplings make contact with the inner wall of production tubing during the reciprocating cycle. This constant contact will result in tubing and/or rod failure, commonly known as "rod wear effect". The weakest point of a sucker rod string is at the rod coupling connection.

Another cause of downtime is pump failures, which in most cases are premature. A typical rod pumping configuration limits pump preventive maintenance, such as control of corrosion, sand and scale. These failures are unavoidable and add significantly to well maintenance cost and downtime.

History of CT Lift

In the last decade CT has been tested to replace sucker rods in rod pumping wells. This application targets wells from slim holes to regular oil wells. One of the objectives of this system is to facilitate Gas Well Deliquification (GWD). Numerous lab-scale tests have proved the reliability of CT as pumping string for this particular application.

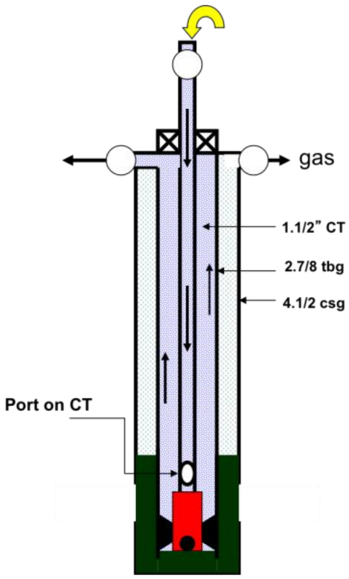
CT Lift pumping systems have proved successful to depths up to 7,000 ft. in Slim holes, mostly old gas wells cased with 2.7/8" tbg in need of dewatering. The range of applications in regular wells has been expanded throughout the years, but the most common application nowadays is to replace rods with CT in regular beam pumping wells. The advantages of doing so are (1) to facilitate preventive maintenance of pump and production string, CT and production tbg, and (2) to minimize mechanical failures of pumping string as well as premature failure of subsurface pump, and (3) to avoid downtime.

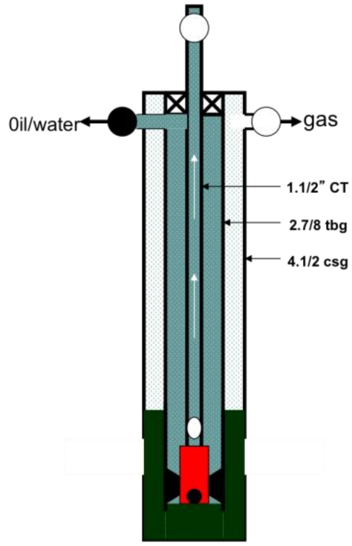
There are 3 primary applications for this technology:

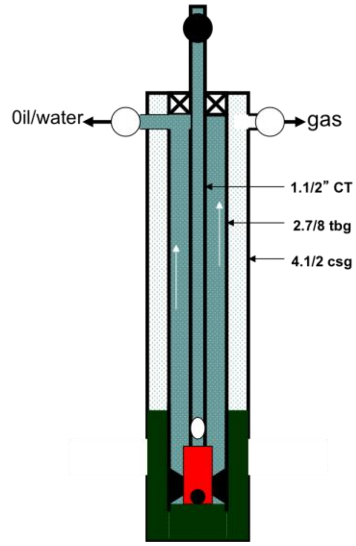
Fig. of Case 1: both the CT top valve and the annular valve are open. In this application the CT can be used as a conveyance mechanism for" flushing" the production tubing with fluid to clean sand or scale, and for chemical treatment.

Fig. of Case 2: shows the CT top valve open and the annular valve closed. These valve positions allow well fluids to flow through the smaller diameter CT, thus increasing fluid velocity that can facilitate sand removal.

Fig. of Case 3: illustrates a closed CT valve and an open annular valve which allows fluid to be be carried through the production tubing, just as it flows through a traditional sucker rod pumping. As can be seen, just opening and closing valves on the surface gives various options for either well treatment or fluid production.







Case 1 – Chemical Treatment **Case 2 – Production from CT** **Case 3 – Production from Tubing**

Background and Field Trial

Chevron operates approximately 12,000 rod-pumped wells, 5000 of which are in North America. Simply due to natural decline, or operation issues (sand, scale, corrosion), some wells, of course, will become inactive. The selected well for field trial is one such well, which has suffered from sand and scaling issues for a number of years which has resulted in unplanned shutdown production and ultimately, a lengthy period of inactivity. Workovers caused by each failure could not be economically justified from this well's low gas production rates.

A trial was proposed to replace sucker rods and pump with coiled tubing, with the primary objective of treating the well for its history of sand problems. During normal operations the well would operate as per Case 3; that is, with the CT valve closed allowing production through the production tubing. As part of the trial the well would be treated on a quarterly basis as per Case 1, injecting chemical treatment directly through the coiled tubing , all the way to the top of the pump and up through the production tubing.

In this trial, treating the well by circulating fluid down the CT had the following advantages:

- Washing sand or scale that gradually settled on top of the pump, especially in wells operating with POC
- Providing 100% corrosion inhibitor coverage of CT string as well as the ID of production tubing
- Washing paraffin with hot oil, displacing this oil downward through the CT and then upward through the product ion tubing.

In December, 2012. coiled tubing pumping string was installed in a Chevron well, located in Liberal, Kansas. This was a vertical well, drilled to a depth of approximately 3000 feet, with a 2.3/8" production tubing set inside a 7" casing.

The installation consisted of running 1.1/4" CT inside 2.3/8" production tbg, in the Gooch LD 1 well, according to the following procedure:

Day 1: The first CT run was 1.1/4" CT inside 2.3/8 tbg to wash the hole to 2,814 ft by circulating brine.
Day 1: The second CT run made use of same string of 1.1/4" CT with 1.1/4 " bore subsurface pump attached at the

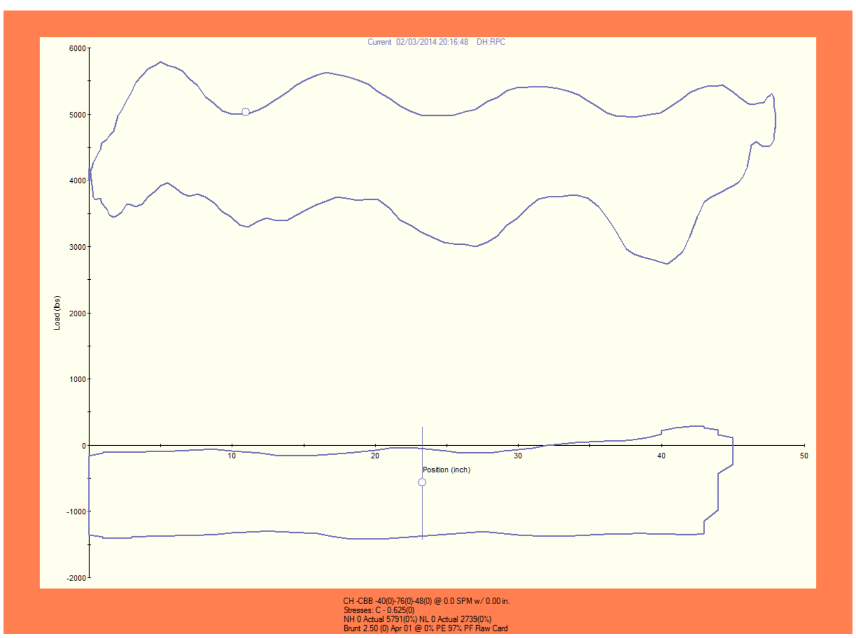
end of the string and set @ 2,786 ft

Once the pump was set on the seating nipple, pump was spaced and CT was cut. On top of the CT, a ball valve was installed and the well was put in production with the following parameters:

8.5 SPM
48” stroke length
POC pumps an average of 5 hours a day

Note: CT string has no polished rod. Top portion of CT acts as a polished rod and the string is held with polished rod clamp.

A well dynamometer card was recorded, allowing the operator to validate pumping performance.



Treatment and Results

As part of the installation, a quarterly treatment program was recommended. This program involved the pumping chemicals down the coiled tubing in order to clean any accumulated sand, as well as to treat the well for corrosion and scale. In order to accomplish this, the top valve CT was left open and a chemical line was attached to convey fluid down the CT.

Figure 1 – Chemical Injection Setup.

At the time of publication, two treatments had been performed.

The first treatment plan was to circulate 12 bls of fluid containing equal quantities of corrosion inhibitor, surfactant and a trace amount of biocide. Fluid samples were taken at samples in 2bbls intervals starting at 4bbls., while maintaining pumping pressure below 300 psi. Results are indicated below:

Figure 2 – Initial Treatment results. (Left 4bbls, Right 12 bbls)

A second treatment plan was carried out several months later, this time circulating 16bbls of treatment of the same composition as in the first trial.

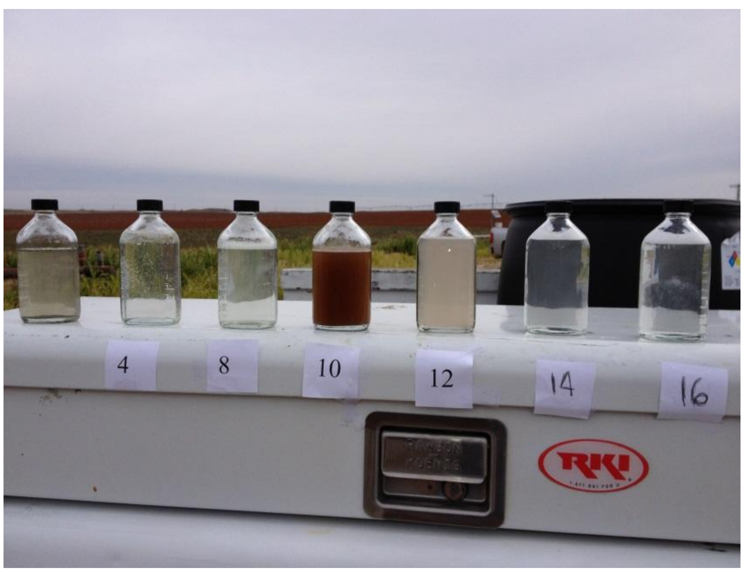
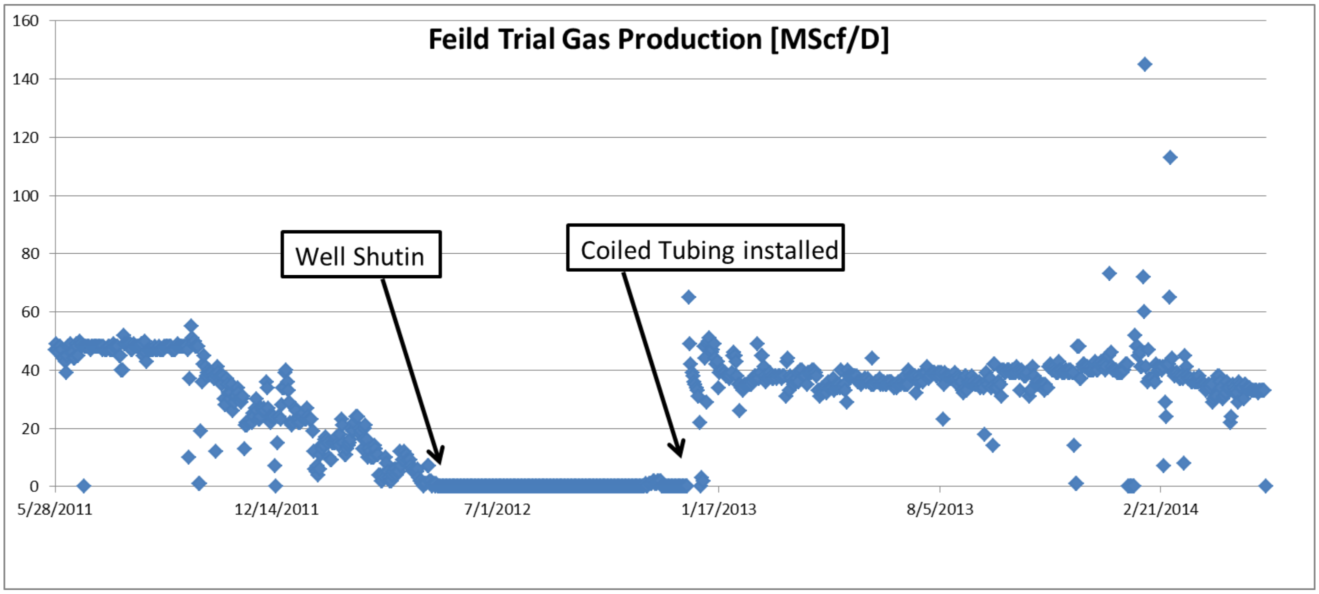


Figure 3 – Second Treatment results.

The fluid samples show that the CT chemical conveyance system is highly effective at treating the well, removing a significant amount of solids and other debris, resulting in a clean sample taken at the end of the trial. Samples were taken from the bleed valve of the well manifold, while the fluid was continually displaced back to the flow line.

This technology has been effective in allowing the well to produce continuously and efficiently as illustrated below. Previously, well failures on this well were experienced every 6 months due to rod, tubing, or pump failures. Using CT Lift, the well has been producing continuously without failure for the past 18 months.



Conclusions

CTLIFT technology has shown to be effective in reducing downtime of this well. By using coiled tubing, the operator was easily able to implement a regular preventative maintenance program. This has reduced the for need for expensive fishing jobs, pump changes and has prevented corrosion to the extent that the well was able to be brought back online after a lengthy shut-in period.

At the time of this paper's submission the trial well had been producing for eighteen months without any downhole incidents .

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