

CAPILLARY INJECTION TUBING ANCHOR TECHNOLOGIES

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ABSTRACT

There are many oil and gas fields across the United States which have been producing for over 100 years or more. The barriers that exist to prevent such extended field life are many. Those issues include: rod and rod pump failures, damage to the tubing, paraffin/ scale deposition and corrosion. All of these can present challenges of how to deal with the problem and correct it, while maintaining economic viability of a field.

Tackling these issues has mostly been done using batch treatments with various preventative chemicals which over the years have proved to be expensive and not very effective as it cannot pinpoint the problem directly. More recently the use of capillary injection strings attached to the outside of the production tubing has helped to improve this situation by providing a means of injecting smaller volumes of chemical closer to the source of the problem. However, on rod pump wells the point of injection can only be made above the tubing anchor; thus failing to protect the pump and internals of the tubing string. A new design of tubing anchor is now becoming available which incorporates a pass through capability for a capillary injection string thus enabling chemical treatment capabilities for the pump as well as the rods and tubing.

In this paper the author will review the history of chemical treatment methods and describe the use of a new tubing anchor design that addresses the shortcomings of current chemical injection techniques.

INTRODUCTION

As oil and gas fields mature they develop problems that can make it difficult to maintain the economic operability of a field. These problems include:

- Corrosion – this can affect production tubing, positive displacement pumps and rods, and cause damage which can lead to expensive work overs.
- Scale – this can form in the tubing string and accessories leading to reduced flow passage and eventual damage requiring expensive intervention.
- Paraffin, Hydrate and salt deposits – again these can cause restrictions to flow and render down hole pumps and plunger lift systems inoperable.

These and other conditions require the injection of chemicals into the well to treat the condition and help to extend its' operating lifetime. Until recently this has been carried out using batch treatment of the appropriate chemicals. A batch treatment is described as Pumping comparatively large volumes of chemicals into a well followed by a "soaking" period and eventual production and clean-up of the fluids before production can continue. This is a very inefficient approach. It is expensive, causes lengthy production downtime and is not very effective as the accompanying improvement is short term at best.

Recently a new method has been implemented for such treatments using a new downhole injection design.

CAPILLARY INJECTION STRING

This approach uses a small diameter string, usually 1/4" or 3/8" diameter, strapped to the outside of the production tubing string which accesses the tubing at a chosen point in the well. Surface access to this conduit is supplied in much the same way as is commonly used in subsurface safety valve installations and low volumes of chemical can be pumped into the well on a continuous basis. This provides for a much more effective and economic way of treating the problems while maintaining continuous production. The capillary string can be used to inject corrosion inhibitors, paraffin and hydrate solvents, H₂S scavengers, CO₂ scavengers, foaming agents, water and even steam. Current methods of achieving this include the following components:

Chemical Injection Sub

This is run in the tubing string to the required injection point and provides a direct means of access to the tubing ID. Chemical Injection Valve (Figure 1.)

This is banded to the lowest injection point (customer's preference) and controls the flow of injection chemicals and acts as a check valve for the capillary string. Prior to installation the opening pressure of the valve is set by adjusting the tension of its' internal spring so that it remains in the closed position. In this way the valve prevents any possibility of backflow of well fluids into the capillary string.

Capillary String

This is installed as the production tubing is run, using a derrick mounted sheave (Figure 2.) and a deck mounted spooling unit (Figure 3.) This string is banded to the tubing using either Xeron 100 bands (Figure 4.) or stainless steel cannon clamps (Figure. 5), Band type is determined by well deviation.

Wellhead Exit (Figure 6.)

This normally consists of an extended neck tubing hanger and ported adapter flange as is commonly used in both onshore and offshore applications. Multiple injection ports can be accommodated if more than one injection line is required, and chemical is pumped into the well using a standard pneumatic injection pump.

Surface Injection Manifold (Figure 7.)

The surface manifold includes a 21 micron filter that insure that no contaminants are pumped downhole. The apparatus includes a pressure gauge to monitor (and record if necessary) the injection pressure and provide an indicator as to the integrity of the capillary string. The functionality of the injection valve and allows for an estimation of the bottom hole pressure. The manifold also includes an anti-syphon device to prevent any suction effect caused by the hydrostatic head of the fluid in the capillary string acting against bottom hole pressure. The manifold can be rated at 5K or 10Kpsi and is usually supplied in 316 stainless steel material.

This method has been used successfully for some time and is equally suitable for plunger lift installations. However, it has one major drawback in rod pump wells, its' inability to inject below any tubing device such as a tubing anchor. This is an important component in reducing pump and rod wear due to corrosion. Thus the need for this mechanical device which will enable chemical injection to be pinpointed at the bottom of a rod pump well.

Capillary Injection Tubing Anchor (Figure 8.)

This device enables a capillary string to pass through it so that chemical injection can be introduced to the bottom of the well. The by-pass consists of a 5/8" control section encased in the body of the anchor so that a 1/4" or 3/8" capillary string can pass through it to an injection sub and valve located anywhere below that it may be needed. It provides the following features:

- It ensures chemical injection into the well production before it enters the rod pump, thereby providing for protection of the pump and the complete rod and tubing strings.
- It provides for higher pump efficiency and reduced tubing and rod wear.
- It is most commonly used at depths below 5000ft. but can be considered in shallower high volume wells.
- It allows for gas flow into the annulus.
- It incorporates a J-latch setting mechanism to allow it to be set by a 1/4 turn of the tubing string at the tool followed by applied tension as required by the well geometry.

The installation is illustrated in Figure 9.

PRECAUTIONS

To ensure that this installation is fully functional at all times, some precautions must be taken:

- While running the capillary string installation it should be pressure tested every 1000ft. to ensure maintenance of integrity.
- If injection ceases for a period of more than 24 hours, the capillary string should be flushed with de-ionized water or methanol due to the fact that most chemicals dehydrate over a relatively short time and could plug the line rendering it inoperable.
- Extreme caution should be taken to ensure that slips set on the tubing during the running procedure do not impinge on the capillary string as this will crush it. If this should happen it can be repaired by cutting out the

damaged section and rejoining the string with a standard tubing union. The same would apply if the BOP had to be closed around the tubing in an emergency.

Practical Application

This tool has gone from a conceptual idea to real world installation in the last year. In September, 2013 the first installation of the modified tubing anchor was installed on the University 1801 #19 well in Andrews County, Texas. The field test of the tool was done to help the operator with a set of problems that were decreasing run life and increasing lifting cost. The field was under primary development with a history of new wells having very short run times due to corrosion. The wells were high liquid producers that typically carried fluid levels of 1000' or more for several months as the well pumped off.

Basic installation information for the trial well is as follows. 5.5" 15.5# J-55 casing run to 5012', Completed interval from 4577-4852, 2 7/8" Tubing string with a 76 rod string design. 2-1.5"X24' insert pump with desander set at 4490'. 640-365-168 Pumping unit. SL 143" SPM 8. The design was capable of making 500 BFPD. Typically the operator would run a 320-305-100 and run the pump on the middle hole for SL of 88". The design was capable of 350-400 BFPD. The operator was testing the larger pump to see how long it took to pump off the well.

The tubing string and capillary string were installed increasing normal operations by no more than 2 hours to band the cap string as the tubing was run. No issues were encountered while the new tubing anchor or cap string were run into the hole. The modified tubing anchor set on the first attempt with a 1/4 turn to the right then slack off with 11 points of compression. This was a significant improvement over normal tubing anchor operations which could take several attempts to get seated correctly. A modified well head was installed at the surface allowing for the pass-through of the cap string through the pumping rubber. Only 1 day was needed for installation of the BHA, Tubing, Capillary string, pumps and rods.

Economics of installation

Normal operations for a well in this field required continuous backside treatment with a weighted corrosion inhibitor that would be pumped at 5 gals/per day to get residuals at the surface at adequate concentrations to ensure proper treatment. This was costing \$25/gal or \$125/day. With the capillary string installation normal corrosion inhibitor was run at \$5/gal and only 1 gal/day needed to get equivalent residual to surface. Thus a savings of \$120/day in chemical spend alone was generated. The installation of the cap string and TAC were paid off in less than 90 days.

The greater impact will be in run time. The current failure rate for the wells in the field with adequate chemical treatment is .2. Currently the failure rate on the new drills is 2. Thus if we can simply improve the new drill failure rate to 1 or .5 they will have saved more than double the cost of the capillary installation in the first pull.

Results to date

The well has produced with no malfunction or issue since installation. The well did pump off faster than expected due to the increased pump size. This brought in to question should they continue to use the cap string and the answer was, yes. There is no more accurate way to make sure the chemistry you pay for is delivered where it is needed most than through this application.

The operator has been so impressed that more installations are being prepared. The operator is driving costs down further by using used capillary strings that have been retested. The overall cost of the installation will be reduced and tools gathering dust in a yard will find a new home.

CONCLUSION

Chemical injection techniques have improved and become more efficient over the years and now the use of an Injection Tubing Anchor will provide for optimal injection of chemicals in a rod pump well to ensure maximum protection for the whole completion. This will provide for a considerable improvement in run life, reduced failure rate, and improved well profit margins.

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Figure 1 -Chemical Injection Valve

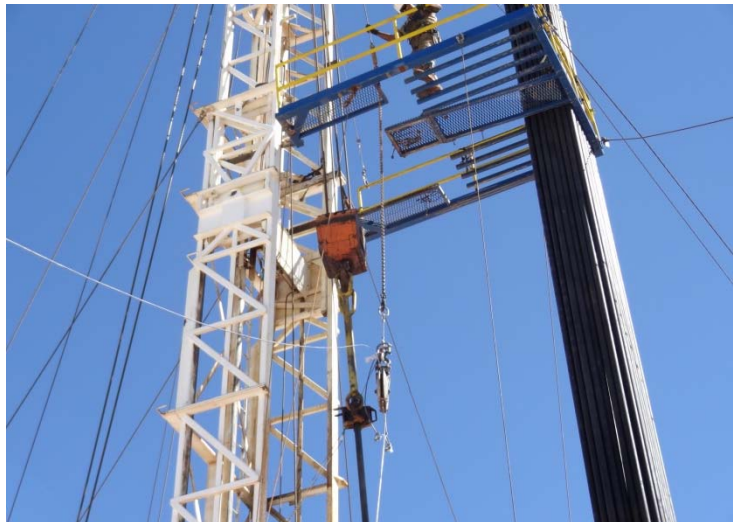


Figure 2 - Derrick Mounted Sheave



Figure 3 - Capillary Spooling Unit



Figure 4 - Zeron 100 band installation



Figure 5 - Cannon clamp band installation



Figure 6 - Wellhead Exit



Figure 7 - Surface Injection Manifold



Figure 8 - Capillary Injection Tubing Anchor

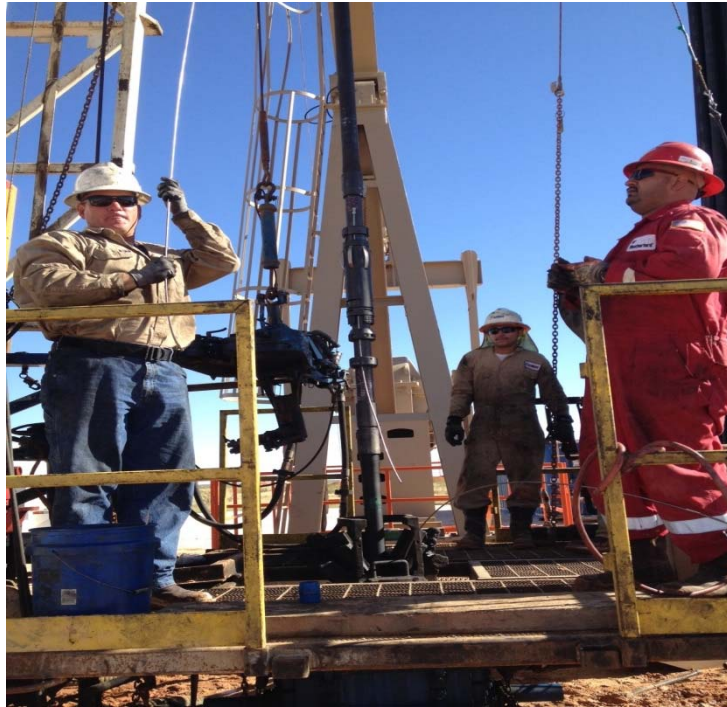


Figure 9 - Rod Pump installation with Capillary Injection Tubing Anchor