CAPILLARY INJECTION TECHNOLOGIES

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ABSTRACT

There are many oil and gas fields across the United States which have been producing for some 100 years or more. The barriers that exist to prevent such extended field lifetime are many, including such issues as rod and rod pump failures, damage to the tubing, paraffin or scale deposition and corrosion. All of these can present Operators with the challenge of how to deal with the problem and correct it, so as to enhance and continue production on an economically viable basis.

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, thereby failing to protect the pump itself. 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 this new tubing anchor to address the shortcomings of current chemical injection techniques.

INTRODUCTION

As oil and gas fields mature so many associated problems can occur which make it difficult to maintain the economic operability of the well completions and production methods. 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 such conditions as foaming require the injection of chemicals into the well to treat the condition and help to extend its' operating lifetime before intervention is needed. Until recently this has been carried out using batch treatment of the appropriate chemicals – pumping comparatively large volumes into the 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, 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:

CAPILLARY INJECTION STRING

This approach uses a small diameter string, usually ¼' 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, which makes 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, H_2S scavengers, CO_2 scavengers, foaming agents, water and even steam. Current methods of achieving this include the following components:

Gas Lift Mandrel

This is run in the tubing string to the required injection point and provides a means of access to the tubing ID and serves as a protection for a:

Chemical Injection Valve (Figure 1)

This is mounted in the gas lift mandrel and controls the flow of injection chemicals into the tubing 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 normally closed position. In this way the valve prevents any possibility of backflow of well fluids into the capillary string, but can be opened by surface pressure applied to the:

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 monel bands (Figure 4.) or stainless steel cannon clamps (Figure. 5), depending on the well deviation. At surface this string is terminated at a:

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, by way of a:

Surface Injection Manifold (Figure 7.)

This is designed to provide filtration to 25 microns for the chemical being injected to ensure that solids and contaminants are prevented from getting into the capillary string. The manifold 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 allow 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 due to its' inability to inject below any tubing device such as a tubing anchor, which is an important component in reducing pump and rod wear. To address this situation a new device is now becoming available which will enable chemical injection to be pinpointed at the bottom of the well, it is a:

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 ¼" 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 ¼ 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.

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 the life of the well, greatly increase the time between work overs and improve the overall economics of the operation.

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