PREVENTING TUBING FAILURES AND LIQUID LOADING IN HORIZONTAL WELLS

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INTRODUCTION

Many production companies in the Haynesville Shale formation have experienced production tubing problems like corrosion and scaling. They also expect to see liquid loading problems due to the water left after fracturing. Most of the frac jobs in the Haynesville Shale use at least 40,000 bbls of water per stage. The Haynesville Shale is typically 10,000 feet below the surface and about 200 feet thick. The reservoir has a bottom hole pressure of approximately 9000 psi and a bottom hole temperature in the range of 250° – 325° F. The problem is not only the corrosion, scale, or the potential for liquid loading but also an effective means of delivering the chemical mixture, used to prevent these problems, to the point of most effectiveness, the heel of a horizontal well and the end of the production tubing.

PROBLEMS

Corrosion

One of the main causes of production tubing failure is corrosion, which creates holes in the tubing. These holes in the production tubing will greatly affect the tubing's ability to transport gas and water efficiently. There are three key ingredients for corrosion to occur: an electrolyte, a driving, force, and a complete electrical circuit. For most wells in the oilfield, the electrolyte is the water containing ions that can transmit current. These ions are usually dissolved gasses and salts found in the form of chlorides, bicarbonates, sulfates, sodium, calcium, magnesium, and barium. The driving force can be simply the metal which is storing energy and trying to return to a lower energy state or a concentration difference of ion or gasses at varying locations on the same piece of metal. The electrical circuit is completed by the metal in the production tubing itself. Corrosion isn't the only issue leading to tubing failure; the problem of scaling must also be addressed.

Scale

The other main cause of production tubing failure is scale which leads to a restriction in the production flow. Many of the shale formations are initially dry. When water is introduced, it can begin to cause scaling problems. These problems occur when a reservoir's equilibrium, established long ago with the formation, is thrown out of balance by the introduction of water during a frac job. When water from fracturing is introduced, it is at a great pressure and temperature downhole. This pressure and temperature allows the water to be saturated with salts. When these waters, saturated with salts, enter the well bore they experience a pressure and temperature drop. This temperature drop can cause dissolved gasses to come out of solution and change the pH. A pressure, temperature, or pH change will make conditions favorable for precipitants to fall out of solution. These precipitants build up on the walls of production tubing causing blockage that impedes the flow of production. The obstacles caused by the introduction of water into shale formations are not limited to production tubing failures but also include liquid loading.

Liquid Loading

Another problem facing many operators in the Haynesville Shale are the effects of liquid loading. This occurs when the well bore pressure of a well is increased by the hydrostatic column of fluid. This fluid can build up in the horizontal portion of these wells and affect the production dramatically. This water is often pumped into the formation by hydraulic fracturing. For these wells to be economically feasible, the fracturing is necessary, but many times only a small percentage, maybe 3%, of this fracture water is recovered initially. The other water is left in the formation to flow back with the gas. Over time this water will begin to put pressure on the formation and restrict the well's flowing pressure and ultimately the total assets that can be recovered from this well. The solution to these production problems is simply applying the correct chemical mixture that will prevent corrosion, scale, and liquid loading.

SOLUTION

Treatment Options

The placement of this chemical mixture is also of great importance. Historically the only way to treat the problems that lead to tubing failure has been to use batch treatment or gas lift atomized chemical. If a well is batch treated, the well has to be shut in. Then the chemical must be given time to fall and it may not fall to the desired location. More chemical will have to be applied to get the same desired effect, because much of the chemical will be flowed to surface before reacting or contacting the area it is meant to protect. More chemical cost and less effectiveness are not the direction to go. The production tubing will be suffering from not being treated properly and the well production will be shut in while the chemical falls. Another possible option is treating gas lift gas with an atomized chemical mixture. This option, while cheaper than the batch treatment, will still waste chemical by coating the exterior of the production tubing as well as the interior. This option is also not usually considered until the well reaches closer to the end of the decline curve. The proper option for the Haynesville Shale was to install a capillary string of the proper alloy. This allows better placement of chemical, as well as, ensuring the entire production tubing is treated.

Capillary Alloy Selection

It is very important when selecting a capillary string that the proper alloy is selected. Just like production tubing, capillary strings are prone to corrosion. There are three alloys that are often used in the oilfield for capillary strings: 2205, 825, and 625. Each alloy of tubing can withstand varying levels of corrosiveness. The level of corrosiveness and the correct alloy for a given well is determined from a few key well parameters like pH, chlorides, percentage of H_2S and CO_2, shut in surface pressure, flowing tubing pressure, and bottom hole temperature. When these parameters are known, it is fairly simple to choose the correct alloy for a given well by using a partial pressure calculator. With the normal parameters of the Haynesville Shale being quite corrosive, the 625 alloy is usually required. The correct alloy capillary string is only part of the solution

Chemical Selection

The other part of a proper capillary program is the correct chemical mixture. The mixture should be a combination of chemicals to prevent each of the addressed problems. The corrosion inhibitor prevents the completion of the electrical circuit by creating a film on the production tubing. This film prevents the transfer of ions and keeps the tubing from corroding. The scale inhibitor keeps the precipitates from falling out of solution until they can be dealt with at the surface more easily. The part of the chemical that helps alleviate liquid loading is a foamer. It works by lowering the surface tension of the water and entrapping the produced gas in small fluid bubbles, forming foam. This foam is much lighter than the original fluid column and can be lifted to the surface where it will break into gas and water.

CONCLUSION

Many of the Haynesville Shale well parameters are often too high for other treatments to be considered an option. A capillary string matched with the proper chemical mixture can solve the problems stated above by continuously treating the production tubing with a corrosion prevention film, by keeping many scaling tendencies in solution, and by not having flow impedance due to liquid loading. Currently, there have been more than 20 wells installed with capillary strings in the Haynesville Shale. The production companies have not seen any corrosion or scale tendencies since these installs were performed. They are also planning to begin adding foamer to their chemical mixtures as the wells begin to mature. They want to catch the wells when they still have enough velocity to lift the fluid so that they are not caught off guard by the wells beginning to liquid load. By doing this, they will be able to extend the life of their well further into the decline curve before they will have to use another form of artificial lift.

References

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ACKNOWLEDGEMENTS

Mike Mills, JW Operating