SLOW-RELEASE DOWNHOLE CHEMICAL TREATMENT IN ROD PUMP, ESP AND GAS LIFT, INCLUDING A NON-PULLING TUBING METHOD OF INSTALLATION

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ABSTRACT

The effect of traditional chemical treatments at the pump intake can be minimum due to the fluid level, high GLR, production packers, among other reasons. Using a slow-release polymer matrix is an effective chemical treatment that was installed in several wells in the Delaware basin with Conoco Phillips. The chemicals were encapsulated in the matrix ensuring maximum absorption and then slow dispersion, and the tool was run under the intake of rod pumps, and gas lift. In rod pumps, the installations were carried out by pulling the production tubing while in the Gas Lifts, the chemical tool were installed via slickline without pulling the BHA. In the gas lifts and in rod pump, the chemical tool can be replaced whenever the concentration levels reach the minimum effective concentration without pulling the tubing. To track the dispersion rate, the wells were sampled monthly to measure the concentration of scale and corrosion inhibitor and the amount of THPS downhole. The whole tracking history of the wells will offer valuable information about the chemical concentrations expected using downhole chemical treatment compared with the concentrations obtained while using surface treatments and the longevity of the treatment at the production rates and depths installed.

INTRODUCTION

Delaware Basin located in far west Texas New Mexico is the deepest of Permian subbasins with the thickest deposits of rock. The Wolfcamp and Bone spring are mainly the shale plays of Delaware and are developed since the early 20th century with vertical wells, however, in the last two decades, the focus has changed looking for greater production through horizontal wells with greater production zones. The wells installed with the new technology were drilled and completed in Lea County in the Delaware basin (Figure 1). The production profile of the wells produced in this area is characterized by a high initial fluid production with high water cut, low GLR, and high sand production because of the flow back of the frac sand. The conditions change rapidly because of the well depletion using Gas Lift in the initial completion.

Chemical problems occur in almost every stage of production. Several methods have been presented to offer solutions to these problems and deliver chemical inhibitors into the produced fluids from oil wells. Nevertheless, some of these applications are not the best solution or represent a challenge for the oil industry due to the high cost and uncertainty in the efficiency of the application.

The most common chemical issues in these fields are related to scale precipitation and corrosion, iron sulfide, calcium carbonate, calcium sulfate, and the iron carbonate have been found, also zinc sulfide, barium sulfate, and strontium sulfate among others; regarding the corrosion problem, this is mainly caused by the high concentration of H2S.

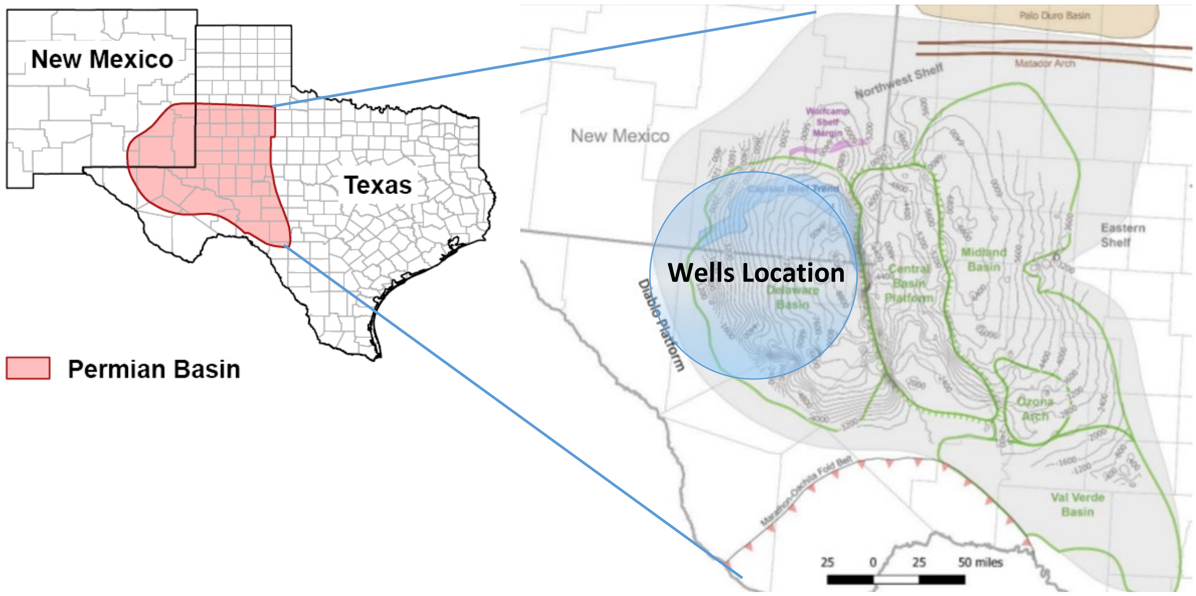

Figure 1 Wells Location (U.S. Energy Information Administration based on drilling Info)

To mitigate scale and corrosion problems, a chemical treatment was injected down to the pump intake for effective inhibition, however, this procedure has not had good results due to the high pressure at the bottom of the well, it flumps and holds the chemicals at the top of the fluid column. Also, the challenges faced with cap string related to the high costs and complexity of maintenance make it more difficult to decrease corrosion and scale issues. This paper Introduces a new technology that guarantees an optimal downhole treatment at the entry point that usually, the common surface chemical applications cannot reach.

MICROENCAPSULATION

Over the years many industries such as pharmaceutic, food, cosmetic among others have developed many processes that allow to create a membrane that stop (stops) a substance to be released until is necessary for some specific function. These processes have varied and are based on scientific principles that deal with polymerization, surface energetic and reaction kinetics. The microencapsulation process contains physical and chemical considerations, for example, there are three forms of physical encapsulation, a slurry, a wet cake, and dry powder. The slurry form is a suspension of microcapsules in water containing preservatives. The wet cake is a slurry that has been filtered to approximately 50% to 70% capsule solids, with the remainder weight being water containing preservatives. The dry powder form of microcapsules contains less than 5 wt% moisture. This Form is typically provided only for capsules that are about 500 microns or less in size and is also dependent upon the type of capsule required membrane-type used to prepare the coating. Figure 2 shows the Microencapsulation Techniques, each technique depends on the nature of the fluid that would be encapsulated, the physicochemical properties, compatibility, and the application.

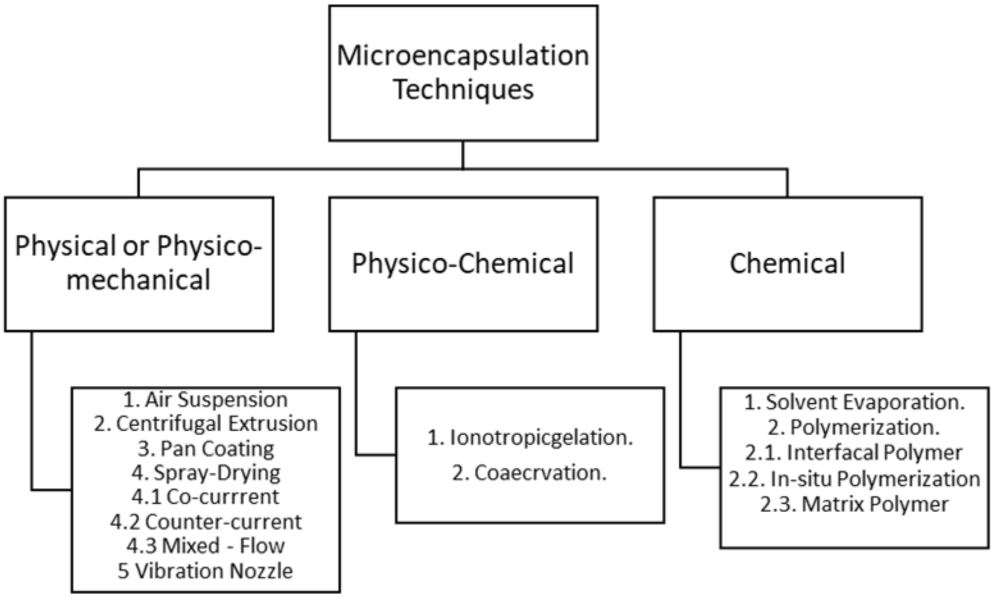

Figure 2 Microencapsulation techniques

Another important factor is how the fluid inside the microcapsule would be released. In this case there is a variety of mechanical rupture mechanism where the most common are; (1) melting the shell material, internal rupture of the shell material activated by temperature; a certain increase of temperature will trigger the reaction within the system, (2) Biological degradation of the shell material involving the consumption of the capsule by microbial action and (3) solubility of shell material; the shell material will tend to change from insoluble to soluble due to changes in the pH and this would produce the release of the substance inside of the shell.

The concept of encapsulation has been considered and practiced by a wide range of industries over many years. The pharmaceutical industry has pioneered this field by developing large gelatin capsules to provide a distinct dosage. The microencapsulating technology aims to protect and avoid deterioration of a special material due to high volatility and interaction with other components. In order to do that; the solid, liquid or gas that would be encapsulated, needs a matrix or membrane coating it but, also it has to be an agent or force that will release by breaking, melting, dissolving or crushing the thin wall that is covering it, so the fluid can act whenever is necessary which is the case of the New Technology applied to downhole treatments for oil wells. The chemical treatment needs to be dispersed at the bottom of the well so all the chemistry flows from the bottom to the top acting in the whole system.

A New Downhole Chemical Treatment has been developed for an optimal solution for chemical problems occurring downhole. This new technology includes chemical microencapsulation, a concept that has been around for many years, and that represents advantages such as control of the release rate of chemicals, easy installation, and protection of the encapsulated active agent against degradation.

MICROENCAPSULATION TECHNOLOGY APPLIED IN CHEMICAL TREATMENT

From the great number of Microencapsulated Techniques, polymerization is the process used to create the shell matrix that will cover the chemical treatment. There are a variety of polymerization processes (Figure 3) including Interfacial polymerization, In-situ polymerization, and matrix polymerization.

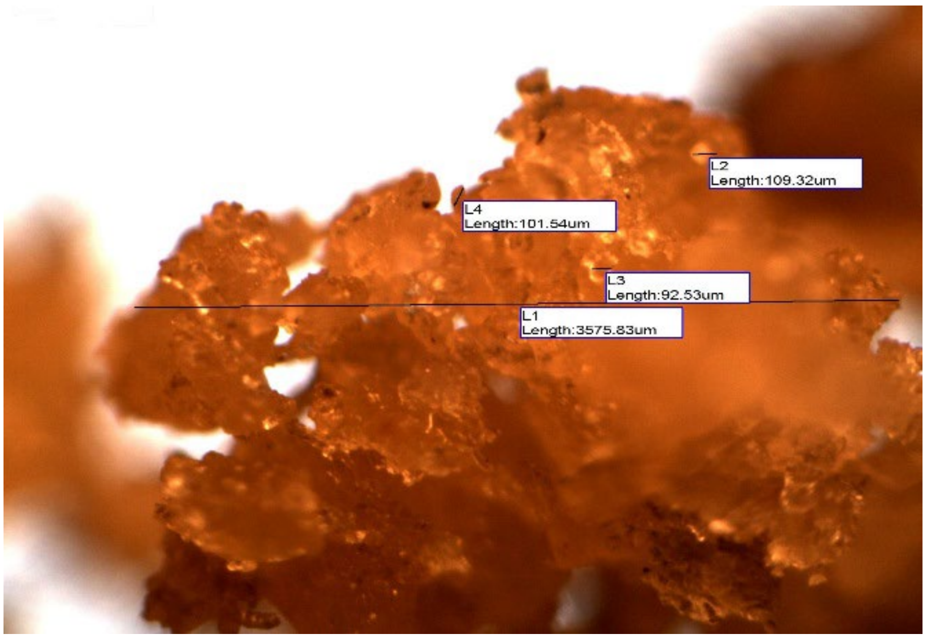

Figure 3 Inhibitor microencapsulated.

The Interfacial Polymerization

Creates the capsule shell at or on the surface of the droplet or particle by polymerization of the reactive monomers. The multifunctional monomer dissolved in the liquid core material, and it will be dispersed in an aqueous phase containing a dispersing agent. At this point, a co-reactant amine is added accelerating the polymerization process creating the shell capsule around the core liquid or substance.

In Situ Polymerization

- The capsule shell formation occurs because of polymerization monomers added to the encapsulation reactor. In this process, no reactive agents are added to the core material. Initially a low molecular weight prepolymer will be formed and as time goes on the prepolymer grows in size and deposits on the surface of the dispersed core material there by generating a solid capsule shell (e.g. encapsulation of various water-immiscible liquids with shells formed by the reaction at acidic pH of urea with formaldehyde in aqueous media.

- The polymerization process applied to this New Microencapsulation Technology process is an exothermic reaction that occurs readily at room temperature between the Polymeric ingredients, the solid additive and the Active ingredients creating a network cross linking of mainly covalent bonds. Initially, the polymeric ingredients are added to our blend and then the created polymer has the capacity to encapsulate and to absorb higher amounts of active ingredients such as Scale, corrosion, Paraffin, Asphaltene inhibitors, etc. without affecting their chemical properties. That encapsulation capacity can be increased by adding a solid additive to the final blend, creating a more stable and solid stick with enhanced capacity to encapsulate more active ingredients. Normally the process occurs almost immediately or until all the polymeric ingredients have reacted completely or the temperature has reached room temperature.
- The final solid mix is then mixed for a short period of time to ensure all the actives ingredients have been encapsulated completely into the final mix.
- The microencapsulation process is performed by blending inhibitor compounds with a water-soluble matrix (Figure 3.) and extruding it under pressure to form condensed chemical sticks that are stored and cured for placement into a screen that will after, be sealed and prepared for delivery to the field.
- The combination of compounds used depends on the chemical treatments that plans to be installed downhole. Different blends and concentrations have been developed taking into consideration the degree of chemical issues happening in the well. They include treatment for corrosion, paraffin, and scale deposition.

DELIVERY METHOD

For this specific application, there must be a control method to release the treatment. The New Chemical Treatment for Downhole Applications Tool is designed to control downhole corrosive and scale deposition environments and organic deposits (paraffin and asphaltene). Depending on the well conditions, a short-term treatment combined with a long-term treatment is the best option to extend the run life of problematic wells. However, if the chemical is released all at once, the long-term treatment would disappear that is why it is so important to simulate and estimate the quantity of internal phase that will go through the capsule shell. There are several factors that affect the release control such as solubility of the internal phase, type of polymer, Molecular Weight of the coating polymer, the capsuled particle size, and the environment temperature. All these factors are studied carefully to simulate the well conditions and make sure that the chemistry would be applied now and depth that was planned.

The encapsulated compound is encased in a screen-jacket metal tube. The tools are designed with 24 feet J-55 joint pipe base that contains 2 feet perforated pipe section along with 304 stainless steel v-wire screen that offers an optimal dispersion area for the chemical (Figure 4). This downhole assembly containing the chemical matrix, slowly delivers chemical treatment at the level of production perforations, releasing all the chemical compounds and offering a solution for chemical problems occurring downhole.

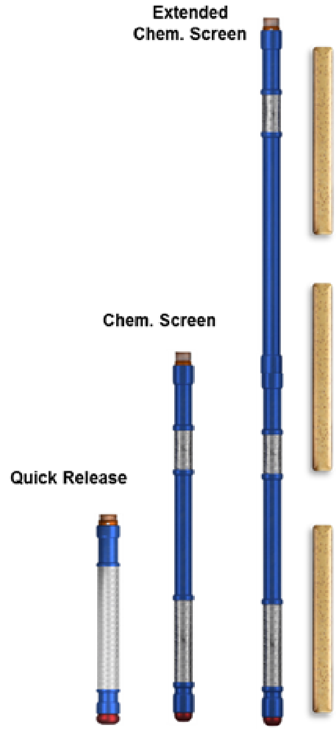

Figure 4 Chemical tools

Mechanism of Dispersion

The contact between the production fluid and the Chem sticks triggers the release of the chemical treatment (Figure 5). The chemical released from the Chem stick is now flowing upwards with the production fluid which allows the inhibition of scale, paraffin, corrosion depending on well conditions.

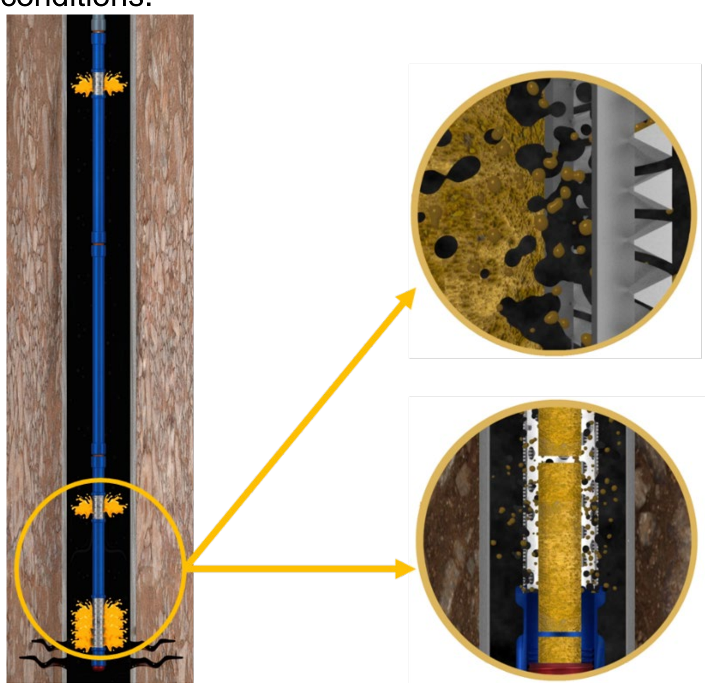

Figure 5 Mechanism of dispersion

RETRIEVABLE CHEM SCREENS

This tool (Figure 6) is designed specifically for wells with high lifting cost associated with chemical issues downhole, such as corrosion, scale, paraffin, asphaltenes, etc. The tool provides an even distribution of well-specific chemicals while offering an easy installation.

In Gas Lift or Plunger Lift applications, the tool is installed via slickline, seating inside the X or XN Nipple, and is held in place with a standard X-lock plug. After installation, the tool meets wellbore fluid, releasing the chemical thru the screen at the bottom of the well. It will offer a controlled dispersion, from the bottom up, which protects the artificial lift system. In the case of Sucker Rod Pump with an insert pump, the tool can be installed on the bottom of the pump, replacing the nipple strainer.

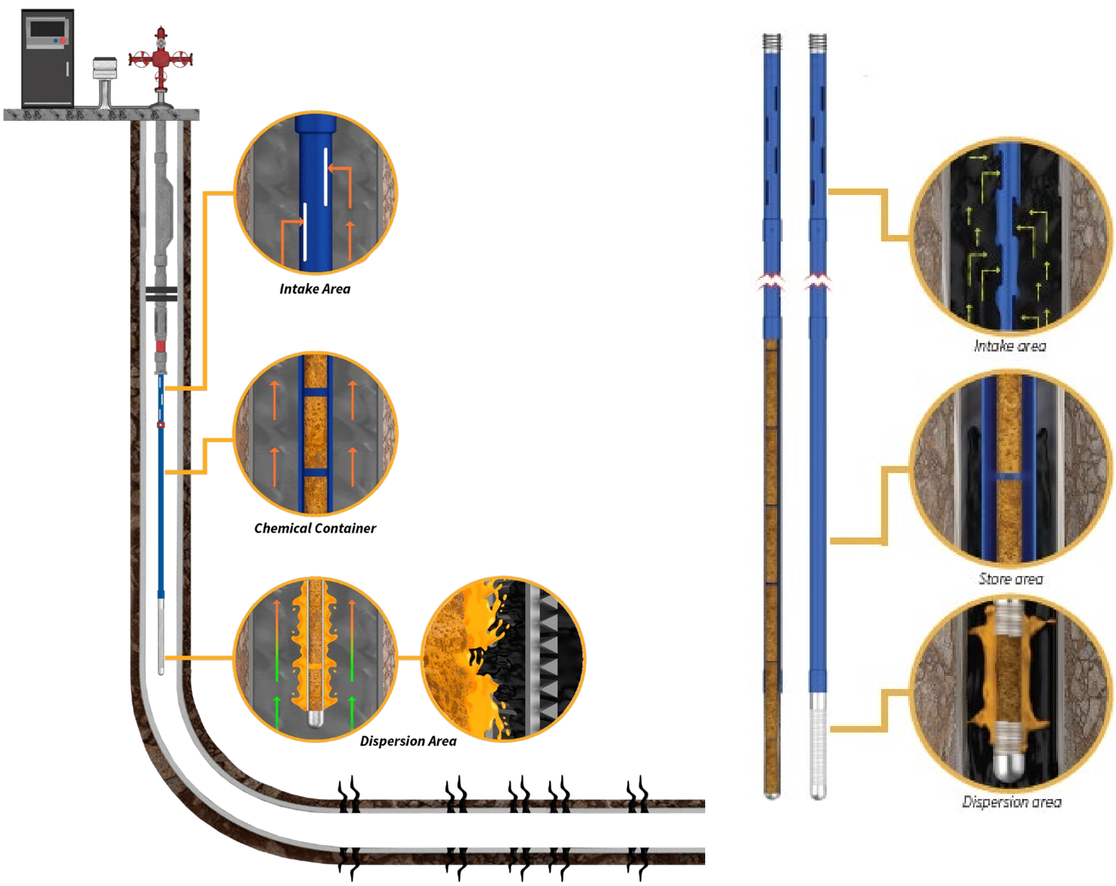

Figure 6 Retrievable chem screen

CHEM SCREENS

Chem screens is a technology that challenges the traditional concept of downhole chemical treatment. Through the micro-encapsulation technology, all the active components of the most effective liquid chemical treatments in the oil industry are processed in a solid stick that is then installed below the pump intake. The installation of this tool downhole allows the activation and dispersion of the chemical problems to be treated and inhibited faster and more effectively, thus prevents harmful effects on downhole equipment. Figure 87shows chem screen installed on ESP and rod pump, in both cases, the chem screens are installed below the pump intake ensuring a proper contact of the chemicals with the production fluid ensuring an effective dispersion of the treatment and as well as enough concentration.

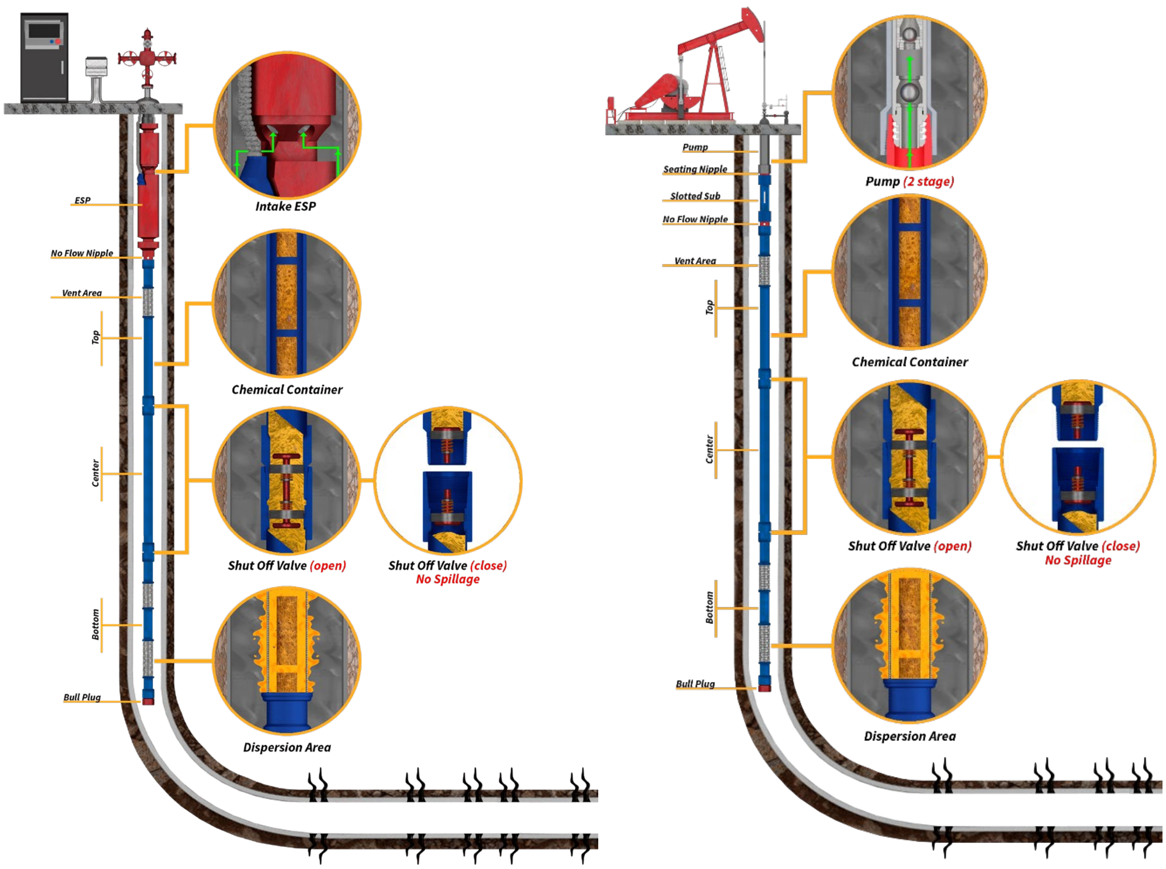

Figure 7 BHA of Chem Screens in SRP and ESP

CASE STUDIES

The Retrievable Chem Tool was installed in different wells located in the Loving County in West Texas and completed in the Wolfcamp formation. These wells have historically high water cut and low Gas-Oil Relationship (GOR), and all the wells have severe issues related with corrosion (caused by CO_2) and flow erosion, causing hole in tubing, which leads to unstable injection and production.

WELL A

Installed with Gas Lift, well conditions are presented in table No. 1 and production history is shown in Figure 8.

- Previous run: 05/2018 – 4/2022
- Pressure and Temperature log collected in Spring 2021 suggested hole in tubing.
- Workover in 4/2022

  - 4 holes in tubing
  - All TBG are red band below Jt. #125
  - GLV #4 #5 #7 failed the leak test due to iron scale deposition.
- Currently 500 mcf injection, 115 bbl oil, 550 bbl total liquid.
- Wireline chem tool installed 8/2022

Table 1 Well A

WELL CONDITIONS		
CASING #29	7	IN
LINER #11.6 (11,031'-18,705')	4.5	IN
LINER DRIFT	3.875	IN
TUBING	2-7/8	IN
CURRENT FLUID PRODUCTION	743	BFPD
CURRENT WATER PRODUCTION	576	BWPD
CURRENT OIL PRODUCTION	167	BOPD
GAS FLOW	233	MCFD
WCUT	77.5	%

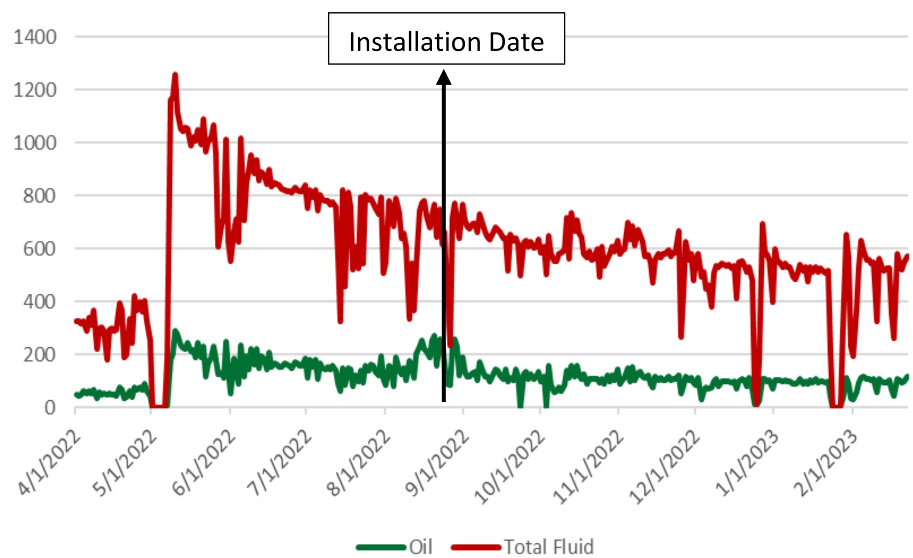

Figure 8 Well A - Fluid production

Figure 9 shows the chemical tracker for this well, the parameters measured were the iron, manganese, pH, chlorides, polytag and amines concentration. The treatment lasted for 213 days until the residuals were below the minimum effective concentration. Iron and manganese remained within controlled ranges during the monitored period, as the pH. At this point it is possible to replace the chemical treatment or continue with chemical treatment from the surface.

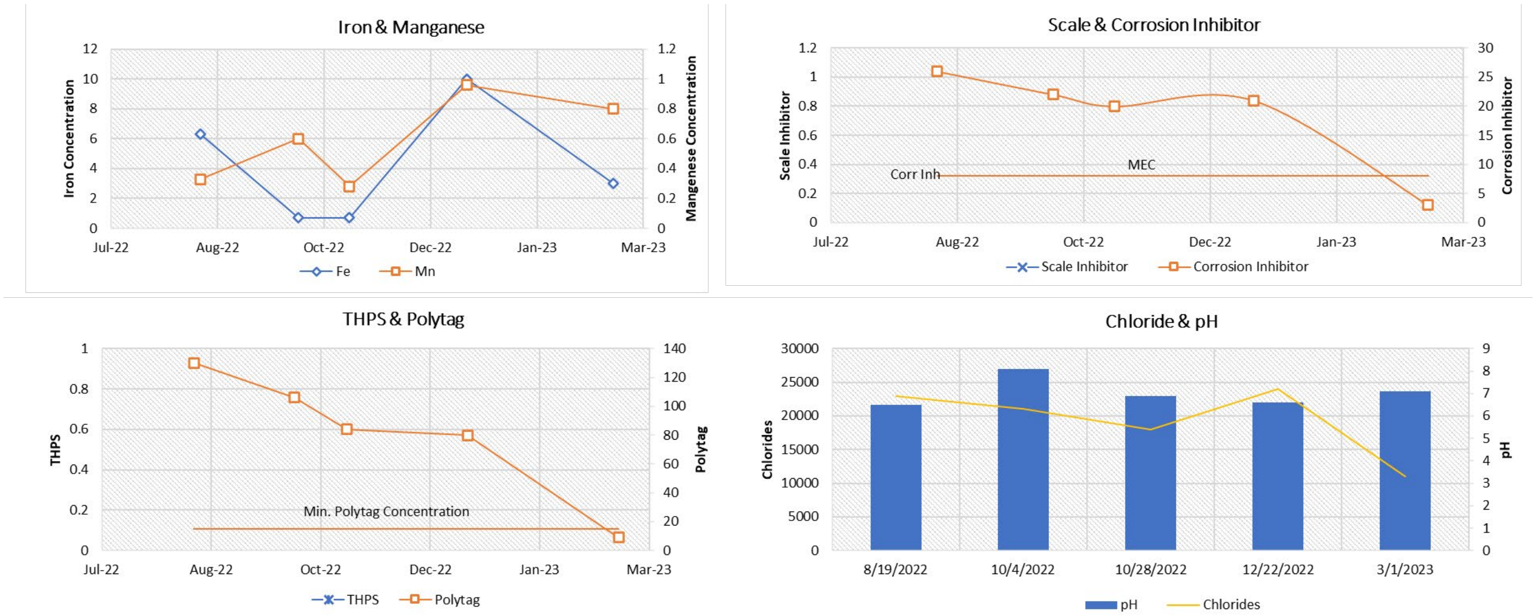

Figure 9 Chemical tracker Well A

WELL B

Installed with Gas Lift, well conditions are presented in table No. 2 and production history is shown in Figure 10.

- Previous run: 05/2018 – 4/2022
- Initially was expecting hung open GLV due to trash.
- Observed TBG to CSG communication.
- Unstable injection (~300 mcfpd)
- Production declines quickly, but no sudden drop
- Workover in 4/2022
- Hole in tubing on 14 joints of pipe
- All TBG are red band below Jt. #135
- GLV #4 and #7 failed the leak test due to iron scale deposition.
- Currently 500 mcf injection, 90 bbl oil, 470 bbl total liquid.
- Wireline chem tool installed 8/22

Table 2 Well B

WELL CONDITIONS		
CASING #29	7	IN
LINER #11.6 (11,031'-18,705')	4.5	IN
LINER DRIFT	3.875	IN
TUBING	2-7/8	IN
CURRENT FLUID PRODUCTION	743	BFPD
CURRENT WATER PRODUCTION	576	BWPD
CURRENT OIL PRODUCTION	167	BOPD
GAS FLOW	233	MCFD
WCUT	77.5	%

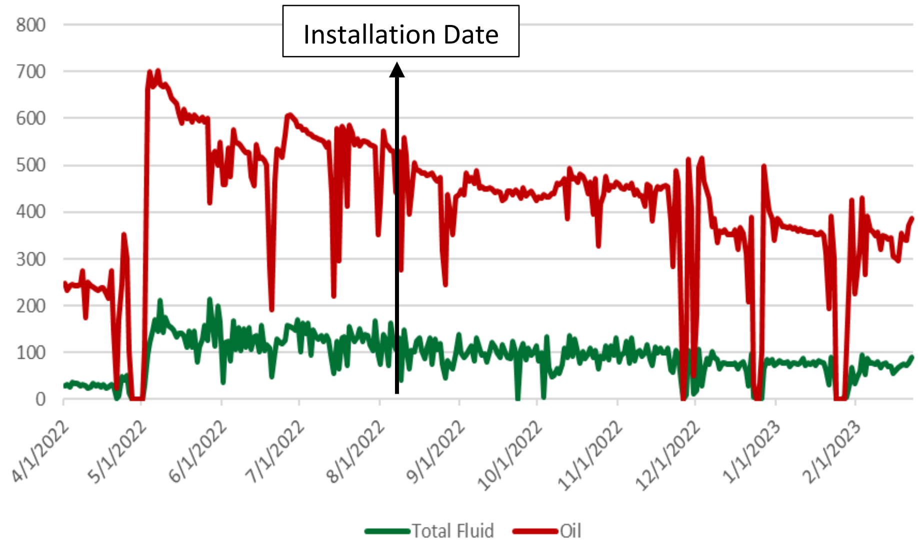

Figure 10 Fluid Production Well B

Figure 11 shows the chemical tracker for this well, the parameters measured were the iron, manganese, pH, chlorides, polytag and amines concentration. The treatment lasted for 213 days until the residuals were below the minimum effective concentration. Iron and manganese remained within controlled ranges during the monitored period, as the pH. At this point it is possible to replace the chemical treatment or continue with chemical treatment from the surface.

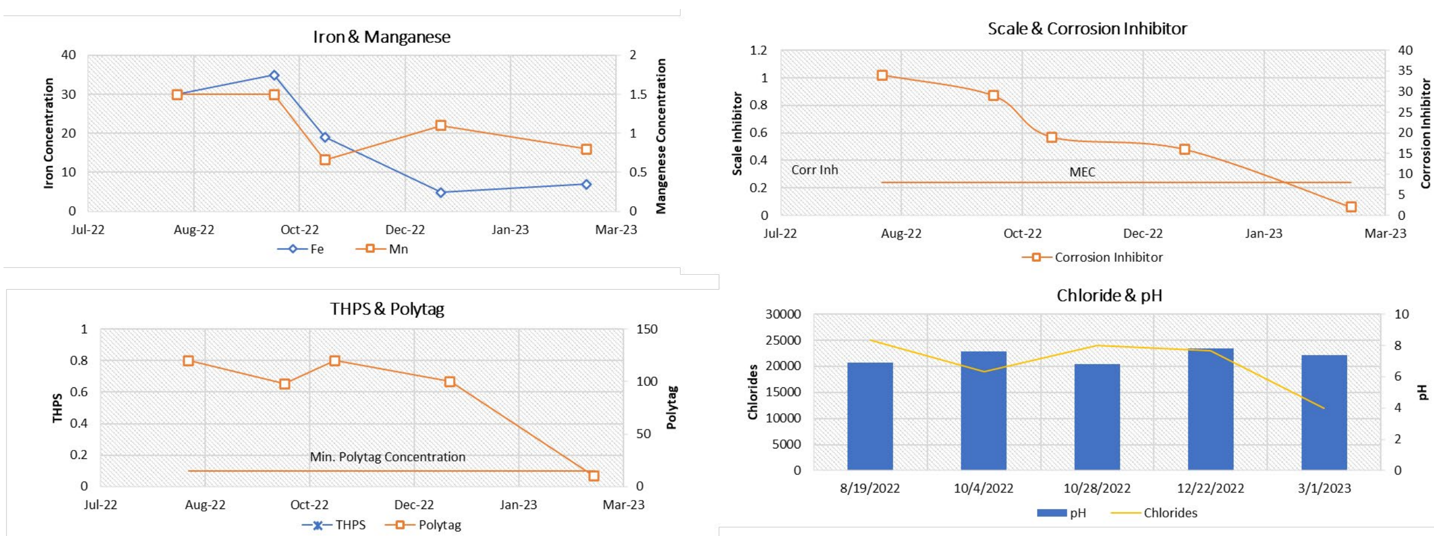

Figure 11 Chemical Tracker Well B

WELL C
Installed with Gas Lift, well conditions are presented in table No. 3 and production history is shown in Figure 12.

- Previous run: 05/2018 – 4/2022
- Unstable production since 1/2022
- Workover in 4/2022
- 1 hole in tubing
- All TBG are red band below Jt. #165
- GLV #4 #6 #7 failed the leak test due to iron scale deposition.
- Currently 500 mcf injection, 105 bbl oil, 485 bbl total liquid.
- Wireline chem tool installed 8/22

Table 3 Well C

WELL CONDITIONS		
CASING #29	7	IN
CASING DRIFT	6.059	IN
LINER #11.6 (11,117'-18,820')	4.5	IN
LINER DRIFT	3.875	IN
TUBING	2-7/8	IN
CURRENT FLUID PRODUCTION	781	BFPD
CURRENT WATER PRODUCTION	594	BWPD
CURRENT OIL PRODUCTION	197	BOPD
GAS FLOW	266	MCFD
WCUT	76.1	%
GOR	1,350.2	SCF/STB
GLR	340.6	SCF/STB

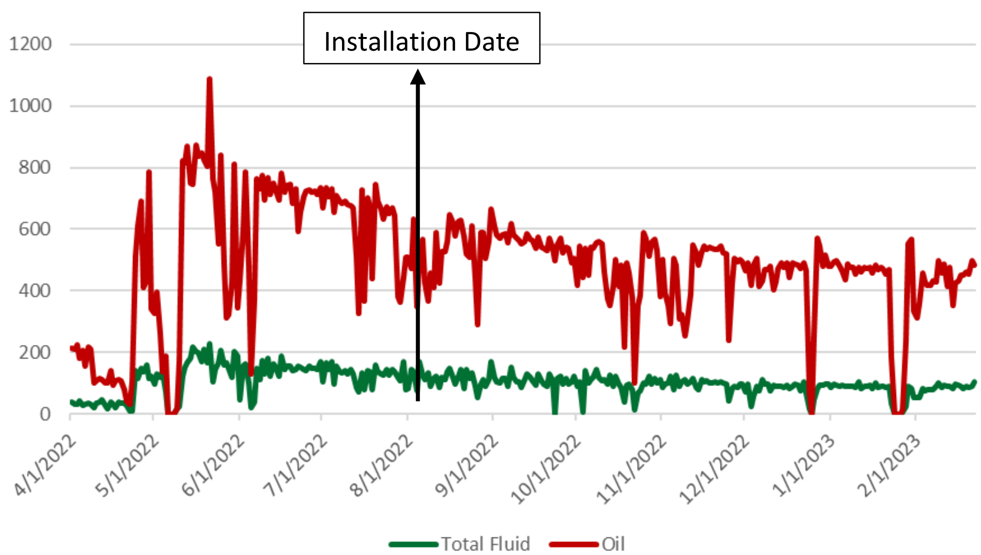

Figure 12 Fluid production Well C

Figure 13 shows the chemical tracker for this well, the parameters measured were the iron, manganese, pH, chlorides, polytag and amines concentration. The treatment lasted for 213 days until the residuals were below the minimum effective concentration. Iron and manganese remained within controlled ranges during the monitored period, as the pH. At this point it is possible to replace the chemical treatment or continue with chemical treatment from the surface.

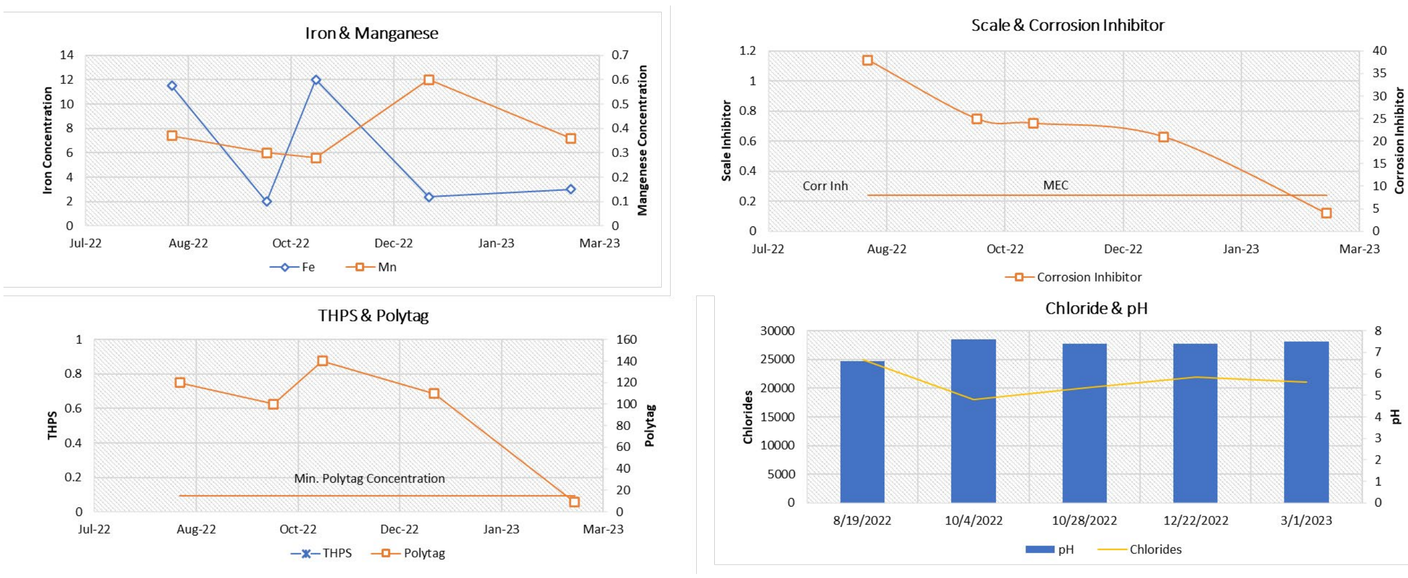

Figure 13 Chemical Tracker Well C

CONCLUSIONS

- The creation of the micro-encapsulated chemical matrix offers an economical and optimal solution for chemical problems occurring when producing fluids.
- The chem screen can be seen a cost effective, simple installation alternative to cap string in order to treat the bottom of the well and can be used as a complement to conventional treatment to attack specific problems.
- The installation process for the chemical screens has proven to be simple, with methods through a workover or wireline process.
- The variation of production can affect the results nevertheless; Through monitoring and sampling, the wireline chem screens can be replaced when the treatment is complete.

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