

An illustration on the left side of the page shows a person in a dark suit climbing a tall, narrow, light-colored rectangular structure. The person is positioned about halfway up, holding onto a rope that runs vertically along the structure. The background is a solid teal color.

THE SCALE OF THE PROBLEM

Joshua Leasure, CARBO, USA, describes a proppant-delivered solution to the widespread problem of scale deposition in the oilfield.

Scale deposition downhole is a widely recognised and commonly experienced oilfield production problem. Once the water in a reservoir is produced, the natural chemical composition of its surrounding environment is disturbed, often causing scale deposition to occur. Scale depositions are solid deposits, which can be both organic (i.e. paraffin, asphaltenes) and inorganic (i.e. calcite, barite, halite) in nature. Halite scale in particular (NaCl or 'salt') was once regarded as uncommon, but has grown into a flow assurance issue that now affects a rising number of oil and gas basins across the US and worldwide. These scale deposits can cause major blockages in tubulars and proppant packs, severely limiting the efficiency and effectiveness of downhole pumping equipment, restricting oil flow and halting production. Scale remediation efforts can necessitate costly workovers and pump repairs, which lead to production downtime and lost revenues.

The process of scale formation

The most common scale deposits encountered in the oilfield are calcium carbonate and barium sulfate. Calcite typically forms as brine water moves from its point of origin in the reservoir, where it was trapped prior to fracturing and in a state of equilibrium. As the brine water flows towards the wellbore and out of the well, it is subject to a reduction in pressure. This causes calcite solubility to decrease and scale begins to form. This behaviour is referred to as a 'self-scaling' process. Barite tends to form when waters of different chemistries mix. This mixing and scale formation can occur when there are multiple producing zones or when incompatible fluids are comingled downhole. Typical offshore fields utilise water flooding to maintain reservoir pressure. The injection of seawater into the formation can also cause scale deposition.

Approaches to treating scale

Scale is initially deposited near the wellbore and treating it ranges from 'challenging' to 'impossible.' For calcium carbonate deposits, an acid solution can be used to soak the scale for a day or more – an approach that goes some way to dissolving it. However, this method requires the well to be shut-in and a crew to be mobilised to the well to carry out the work.

While production assurance and scale inhibition chemicals have traditionally been added as a liquid in the fracturing fluid, a significant portion of the chemical immediately returns during the initial flow back, typically necessitating reapplication of the inhibitor chemicals using a squeeze treatment or continuous injection. The operational expenditure associated with repeating these treatments can be substantial.

Traditional remediation of halite can be accomplished by dissolving the scale in fresh water. This means the operator needs to factor in the cost of fresh water, trucking, manpower, anti-scale additives and disposal of additional produced water. These treatments need to be repeated frequently, in the order of multiple applications per week.

Bearing in mind the drawbacks to the traditional methods for handling scale, a standalone inhibition strategy often proves to be a far more efficient and effective approach. To this end, CARBO developed a one-time scale inhibitor that is designed to be used with the completion, blocking scale at its point of origin, and can be engineered to last for the effective life of the well based on anticipated production profiles.

Proppant-delivered scale inhibition

Traditionally, liquid inhibitor added to frac fluid has a short effective period and is inefficient due to the large volume of chemicals required. Particulate chemical carriers added during frac can impair conductivity. Alternatively, SCALEGUARD is a proppant-delivered scale-inhibiting technology, comprised of a porous, ceramic proppant engineered with a controlled release technology and infused with scale-inhibiting chemicals. It has to date been deployed across the US, in every major basin including the Gulf of Mexico and Alaska, as well as Canada. The water-activated technology is designed to be placed throughout the entire fracture as part of the standard fracturing process, with a single treatment capable of safeguarding the production system, from the fracture through the wellbore, to the surface processing equipment for the life of the well. Serving as both a scale inhibitor and proppant, the technology has no impact on fracture conductivity or integrity, nor does it create excessive fines that restrict or block hydrocarbon flow spaces – a common risk with low strength particulate-based carriers. Controlled release technology significantly lengthens treatment life and reduces initial inhibitor washout, ensuring that scale-generating water is constrained at a controlled rate so that levels remain above the minimum inhibitor concentration (MIC) determined for each application. By placing the production assurance chemicals directly in the fracture where they are required and avoiding chemical washout, the technology provides effective, long-term protection while reducing chemical consumption and treatment costs. SCALEGUARD is designed to last the life of the well and effectively minimises the well maintenance and the remediation issues encountered by the well's production team in the latter stages of the well's life, lowering overall costs of well production.

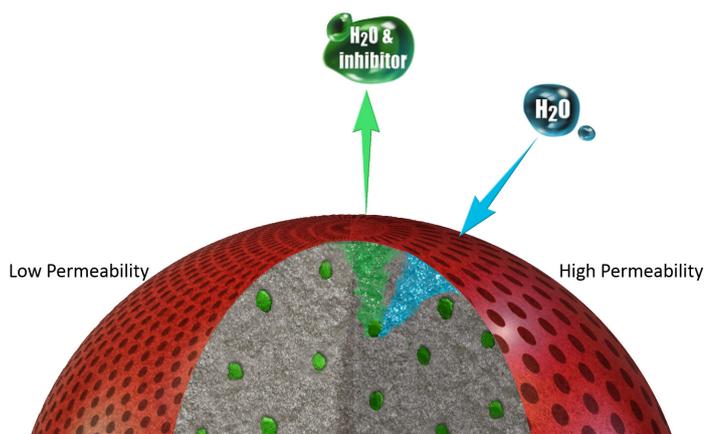


Figure 1. SCALEGUARD has a unique controlled release technology that ensures a predictable release of the infused chemical in the well. This provides a significant reduction in initial chemical washout and results in an extended treatment life.

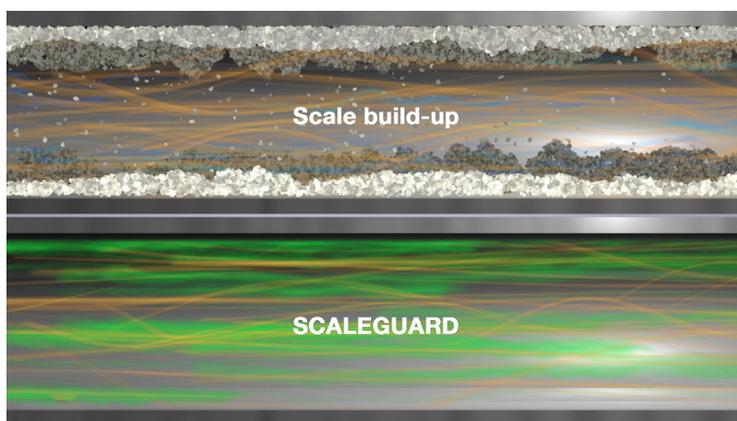


Figure 2. SCALEGUARD technology reduces production maintenance requirements and costs, avoids workovers and eliminates the potential for catastrophic production system failures.

Case studies

Permian Basin, West Texas

The operator wanted to increase production and estimated ultimate recoveries (EUR) from a well in the Permian Basin's water-rich residual oil zone where produced water volumes averaged 4000 bpd with a 60/40 oil cut. In these operating conditions, scale deposition was a persistent and costly production assurance issue.

Solution

SCALEGUARD was pumped uniformly throughout the fracture network, blocking scale formation at its source. The technology was initially earmarked for six San Andres wells, to be completed with an average of 14 to 16 stages and stimulated with a blend of 100 mesh and 30/50 white sand pumped at an average rate of 180 000 lb/stage. CARBO specialists conducted a water chemistry analysis of the six targeted wells as a prelude to develop the MIC and placement release rate to extend the treatment length. Engineered for the individual well characteristics, SCALEGUARD was mixed with the 30/50 regular sand.

Results

Since the initial treatment, no scale has been observed in the six wells, one of which was eventually completed with a field-high 32 frac stages. SCALEGUARD proved to be a cost-effective option for increasing reservoir drainage in areas where exorbitant produced water volumes pose severe production assurance issues.

Uinta Basin, Utah

An operator was experiencing persistent build-up of carbonate and sulfate scales in its wells in Utah's Uinta Basin. The operator relied on liquid phosphonates and particulate-based inhibitors to prevent production restricting deposits, which continued to re-emerge. In this geographical area, excessive volumes of produced water are exacerbated by a long history of flooding, causing scale to form quickly and frequently. Rod pumps and downhole tubulars can be seized with scale in a matter of days. Compounding the reduced production, persistent scale build-up can reach the point where a costly squeeze is the only remediation option. The operator was looking for an alternative and longer-lasting solution that would sustain oil production for multiple years without such frequent remediation.

Solution

A field trial was arranged with five vertical wells completed similarly and stimulated with a blend of SCALEGUARD technology and 20/40 northern white sand. Beforehand, CARBO specialists conducted extensive yard tests and modelling, taking into account the water chemistry, production rate and other well characteristics, to determine the precise MIC and placement release rate.

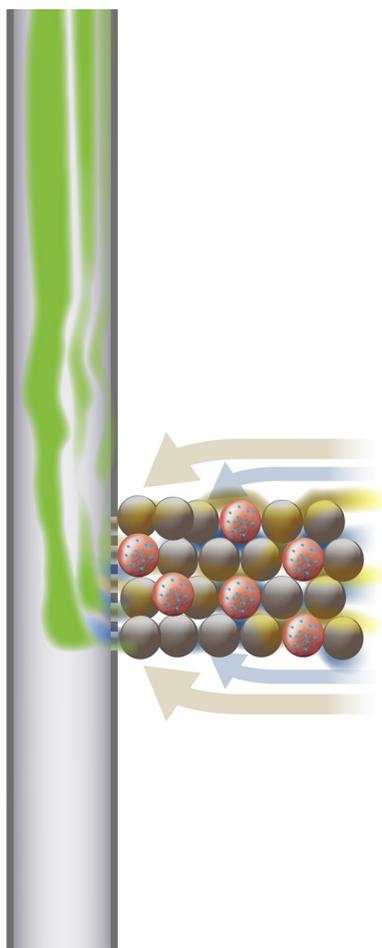


Figure 3. Scale-inhibiting chemicals infused within the proppant are released into the fracture only on contact with water to deliver efficient production assurance.

Results

The controlled release of the inhibitor by SCALEGUARD technology has worked as designed with the five wells sustaining production for more than one year with no downhole scaling issues. After treatment, production has sustained rates achieved prior to the scale deposition. Water samples show the scale control consistently remaining well above the MIC, effectively saving the operator costs associated with oft-repeated scale remediation. The SCALEGUARD technology field trial has allowed for additional proppant-delivered solutions to counter other production choking problems within the area, such as paraffin.

Manitoba, Canada

An operator targeting the Bakken/Spearfish formation of Manitoba, Canada, was producing from a 22 stage horizontal well, comprising an aggregate 130 000 lb of natural sand proppant. After the well had been on line for approximately a year, the operator experienced a steep decline in production, which was quickly attributed to severe scale deposition. The only alternative was to pull the pumps and drill out the well to remove the scale deposits, which dramatically reduced the overall value of the producing asset.

Solution

Following a subsequent CARBO evaluation that included the specific well characteristics and produced water chemistry, the operator modified its stimulation strategy accordingly. To reduce the near-wellbore pressure drop, the sand proppant was replaced with 20/40 CARBOECONOPROP low-density ceramic proppant. To treat the produced water before it reached the wellbore, and thereby prevent scale from forming, the client pumped the SCALEGUARD proppant-delivered scale-inhibiting technology.

Results

SCALEGUARD prevented scale remediation after 12 months of production and continued treatment for multiple years. By preventing the near-wellbore build-up of scale and keeping downhole equipment free of deposits, the technology helped in maintaining productivity and avoided unnecessary costly remediation.

Conclusion

This technology can significantly reduce production maintenance requirements and costs, avoid workovers and reduce the potential for catastrophic production system failures. Furthermore, a new porous ceramic proppant-based chemical delivery system with halite inhibitor infused is currently in development and expands the types of scales that can be treated. After field trials in the North East of the US, the new technology is opening the door for applications for preventing other types of production assurance issues.

Chemically infused and encapsulated, high strength proppant such as SCALEGUARD, shows promise as not only a viable solution, but also as a superior economical choice for challenging environments, as in the Lower Tertiary of the Gulf of Mexico. This particular solution to scale inhibition has proved to be extremely easy to institute and requires little to no intervention after it has been placed. In challenging offshore and remote global locations, operators can sometimes be days or months away from being able to remediate any issues once they arise. Considering these offshore/deepwater logistical constraints and the cost of alternative scale inhibitor delivery solutions, such as chemical injection systems and remedial chemical squeezes, these proppants act as a form of 'insurance policy' for operators, one which prevents the scale from forming in the first place and enables them to operate the wells with an added degree of confidence in their integrity. ■