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Proppant management can improve return on investment

Proper selection of proppants impacts the cost of well completion as well as production over the life of the well. Proper education and communication will ensure the right proppant is selected.

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As the oil and gas industry rushes ahead to develop unconventional resources, significant emphasis has been placed on well optimization to maintain this upward progression. Part of the increase in activity is due to the E&P industry's ability to manage costs while growing its long-term production. What once were new technologies of horizontal drilling and multistage completions are now commonplace, and that requires a significant amount of proppant and fluids to enhance production.

Since proppants account for a large percentage of operational costs and well performance, E&P companies are focused on best practices for managing this segment to help guide decisions. Important considerations such as proppant type and selection factors, lab testing vs. real-world performance, and new technologies are used to make the right choice to get the best results.

Common proppant types

Some of the types of proppants commonly used are curable resin-coated sand (CRCS), precured resin-coated sand (PRCS), uncoated frac sand (UFS), and uncoated ceramic (UC). CRCS is the only proppant type that bonds downhole, creating a unified proppant pack to help keep the fractures open and prevent proppant flowback. This leads to enhanced fracture flow capacity, maintaining proppant pack integrity and long-term production increases.

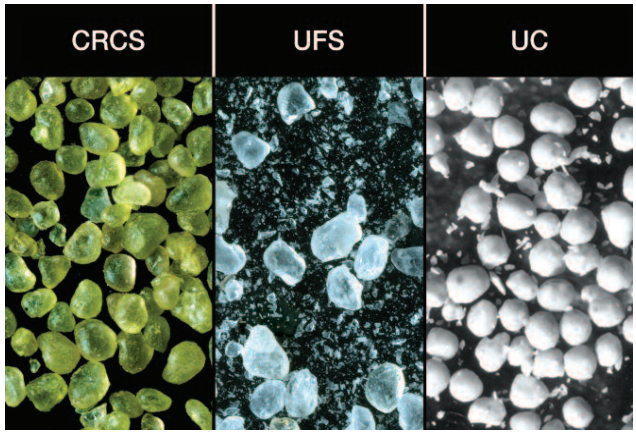
PRCS is an older technology. The proppants have a resin coating that encapsulates fines but will not consolidate downhole. Therefore, it does not give the added benefits of CRCS. UFS and UC are uncoated substrates that have no resin coating, so they do not bond in the fractures.

Proppant selection factors and testing

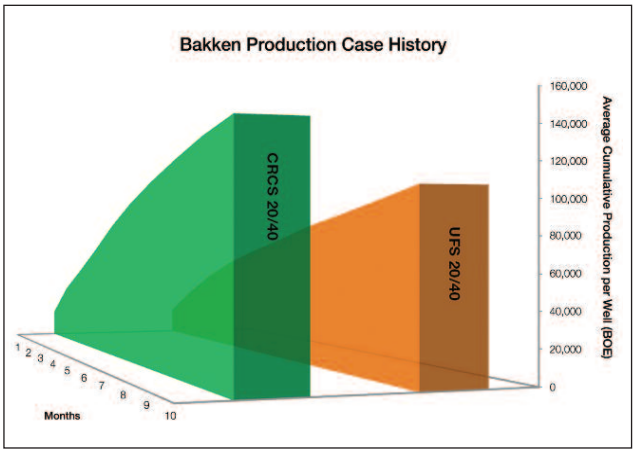
The traditional factors for selecting a proppant are size, strength, density, and cost, along with reference (baseline) conductivity as a performance indicator. However, there are other multiple selection factors that must be taken into account such as proppant fines generation and migration, proppant embedment in the fracture face, resistance to cyclic stress changes, and proppant flowback and pack rearrangement in the fracture.

Baseline conductivity tests are still not able to take many of these factors into account. Additional tests have been created to better mimic the conditions that proppants are exposed to downhole. Effective conductivity is a term used in the wet hot crush test that takes into account all these factors by derating the baseline conductivity based on the results of the performance testing.

Proppant fines generation can be measured by performing this test, which exposes the proppant to temperature, fluid, and closure stress for a specified length of time. This is unlike the traditional crush test, which is run at dry, ambient conditions and was initially designed only as a quality-control test and not as a performance test. Even more realistic is the cyclic stress test, which cycles varying stresses on the proppant pack. The test mimics the stress seen over the life of a well and measures the percent fines generation to show how the integrity of the proppant pack is maintained. Published research shows that just a 5% addition of proppant fines can lead to a 60% decrease in fracture flow capacity, according to Society of Petroleum Engineers (SPE) paper 3298. CRCS has the least amount of fines generated of all proppant types, according to SPE paper 135502.



Different proppant types – CRCS, UFS and UC – are shown after being tested with the wet hot crush test at 8,000 psi. (Images courtesy of Hexion Inc.)



The data from a Bakken case history showed CRCS resulted in a 34% average production increase per well over UFS.

Another important and often overlooked factor for proppant performance is quality. Proppant quality should begin with the raw material entering the process, including quality checks during the manufacturing process and to the well site, and finish with the continued performance over the life of the well. Evidence of poor quality such as severe dusting, which causes a performance and safety hazard, can be seen on site. The operator must understand what the supplier's proppant quality process is and check with field personnel to see how the proppant is handling on location. Also, special attention needs to be given to those companies trying to break into the proppant market.

Key E&P performance indicators

In addition to laboratory testing, proppant selection factors also must be tied to real-world production results by comparing cumulative production, declines, and estimated ultimate recovery. Production studies also should determine the return on investment by identifying at what point the increased production overcomes any additional cost. For example, although CRCS has shown increased performance over UFS, the additional cost must be justified and time to payout calculated.

An additional way of looking at performance is on a macro prospective. Statistically speaking, the larger the dataset, the more normal the distribution becomes. Many of the small operational differences become less impactful on the dataset. Another important cost assessment is any added operational costs, even those seen on the production side. If proppant flows back and damages surface and artificial lift equipment, significant incremental costs are incurred. These are in addition to the lost production and downtime for any repairs and replacements.

New technology

Hexion released its Black Pro™ and OilPlus™ proppants, both of which have unique resin chemistries. Black Pro proppants have a quick bond time, so the well can be turned around faster. These also have resin rehealing characteristics, which are important for maintaining proppant pack integrity during the cyclic stress encountered over the life of the well. OilPlus proppant is designed for oil-rich and liquid-rich reservoirs to enhance oil production and has been used in every major oil play in North America.

E&P-driven specification

E&P engineers are now commonly specifying to the service company what type and specific proppant they want based on key selection factors and well conditions. Even when specifying, it is important to understand the type and performance differences between the proppants to ensure correct specification. For instance, if a resin-coated proppant is specified on the job design, this could be interpreted as either a CRCS or a PRCS since both have a resin coating. Since both types of proppant cost relatively the same, the preferred option for the operator is a CRCS. Proper education and communication will ensure the right proppant is delivered to the well site.

Big picture planning

The key to proppant management is to look at the big picture and see how all the pieces interrelate, from laboratory testing to production results. One datapoint in isolation will not tell the whole story. The challenge for the E&P company, which is the end user, is to ask questions, seek out experts, and continue to be aware of the new technology available. With this in mind, the overall driver for the industry should be a question of how to make better wells and how to do so more efficiently. E&P