Cased Hole Sand Control Techniques
Gravel Packing, Frac Packing, and Screenless Completions
The need for sand control in cased hole environments is driven by geomechanics, the discipline dealing with the interaction of rocks, stresses, pressures, and temperatures—a discipline in which Schlumberger has extensive experience and expertise.

Sand production occurs as a result of a combination of geomechanics and other factors: weak rocks and earth stresses, compacting reservoirs, shear and collapse forces, formation and environmental complexities, and general wellbore instabilities.

The techniques for controlling sand production vary almost as much as the environments where they are required. Three of the most commonly used techniques are gravel packing, frac packing, and screenless completions. These techniques form the basis of the broad, unique Schlumberger sand control offering.

Sand control experts—At your service
Schlumberger provides a full range of products and services for these techniques and can deliver the solutions you require to meet your downhole sand control challenges. Our sand control experts, highly trained and experienced, help you optimize fluid performance, fracture geometry, and conductivity and thus enhance the reliability and longevity of your completion and maximize the productivity of your reservoir.
Gravel Packing

Gravel packing involves the placement of gravel across a perforated interval, in the screen-casing annulus, and in the perforation tunnels to prevent the production of formation fines and sand. This technique is typically less complex than other sand control options. Nevertheless, a clear understanding of rock mechanics and reservoir characteristics is required to design the most effective gravel-pack completion. The decision to gravel pack is based on factors such as risks related to job execution, reservoir challenges, and projected costs.

Gravel packing involves three main steps:
- perforating strategy
- gravel and screen selection
- fluid selection and gravel placement.

Perforating strategy. A clear perforating strategy is developed to ensure clean perforation tunnels that can be fully packed with gravel.

Gravel and screen selection. Gravel must be properly sized if sanding is to be controlled and permeability maintained. Screens must also be sized correctly to provide an adequate inflow area and prevent screen plugging. To help with screen and gravel selection, Schlumberger developed Sand Advisor software. This software is based on our extensive database of actual particle-size distribution and laboratory sand retention test results.

Fluid selection and gravel placement. Gravel carrier fluids range from simple brine to viscous fluids—either gels or viscoelastic surfactant (VES) fluids such as the ClearPAC® gravel-pack fluid. The appropriate fluid, selected according to reservoir conditions and surface logistics, is designed to ensure complete packing in the annulus and perforation tunnels. At Schlumberger, gravel placement is simulated with SandCADE® gravel-pack design and evaluation software using the selected fluid data.

Identifying the Most Appropriate Technique

Reservoir geomechanics, risk and cost considerations, and long-term recovery goals are all critical to identifying the potential sand control options for cased hole environments and making the best choice—a gravel pack, a frac pack, or a screenless completion.

SandCADE Software

SandCADE software is used to design, execute, and evaluate sand control treatments. Its capabilities include gravel placement simulation, postjob evaluation, and pressure matching using downhole gauge data. An Alternate Path™ module for shunt tube friction simulation, also available in the package, is supported by more than 20 years of actual field and test data.

“Achieving effective sand control gives you the best chance of meeting your production goals. To do that, you need access to experience, cross-disciplinary domain expertise and experience, and a range of techniques and technologies. Schlumberger has those resources and can help you make the right choices for your wells.”

—Bob Holicek, North America Offshore Deepwater Theme Manager
Frac packing combines fracturing and gravel packing. Frac packs, or STIMPAC* treatments, as they are referred to at Schlumberger, prevent sand production and create wide, highly conductive fractures connecting the reservoir to the wellbore. The process involves pumping proppant into the formation at rates and pressures that exceed the fracture pressure of the formation. The goal is to bypass any near-wellbore damage remaining from the drilling and perforation phases.

The decision to frac pack is based on factors such as reservoir quality, the existence of near-wellbore damage from drilling and perforating, rock mechanics data supporting fracture containment within the zone of interest, and production and recovery objectives. When properly designed and executed, STIMPAC treatments result in better reservoir connectivity and lower skin, compared with conventional gravel packs. As a result, this technique is generally chosen over gravel packing unless technical or economical constraints dictate otherwise.

Frac packing involves three main steps:
- analysis of rock mechanics properties
- gravel and screen selection
- design and execution of a tip screenout (TSO) fracturing treatment.

**Analysis of rock mechanics properties.**

Rock mechanics data are needed to optimize fracture geometry by achieving a TSO. The data can be obtained through core testing. It can also be derived from wireline-acquired data by using the unique Schlumberger dynamic-to-static rock properties conversion. This conversion uses equations based on core analyses of a wide variety of formation types. Young’s modulus and Poisson’s ratio are critical parameters for determining formation stress and fracture length and width. Both are required in designing the optimum TSO fracture treatment.

**Gravel and screen selection.** As with gravel packs, gravel and screens used in frac packs must be properly sized. Sand Advisor software is used to analyze formation particle-size distribution and aid gravel and screen sizing and selection.

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**Fracture Width Calculation Based on Young’s Modulus, Poisson’s Ratio, and Net Pressure**

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\frac{P_{\text{net}} h}{2w} = \frac{4(1 - v^2)}{E} \]

- \( w \): fracture width
- \( v \): Poisson’s ratio
- \( E \): Young’s modulus
- \( h \): half height of the fracture
- \( P_{\text{net}} \): net pressure

The fracture width calculation incorporates rock mechanics properties, such as Young’s modulus \( E \). This equation is used in the design and evaluation of a STIMPAC, or frac pack, design.
**Design of a TSO fracturing treatment.**

The tip screenout (TSO) technique is used to achieve high fracture conductivity in high-permeability reservoirs. In a TSO, slurry dehydration causes the proppant to pack off at the tip of the fracture, stopping any further extension of the fracture. When additional slurry is pumped, the width of the fracture increases proportionally to the net pressure as the proppant packs toward the wellbore (see fracture width calculation figure).

The TSO design involves an understanding of rock mechanics properties, fluid selection, and data analysis to calibrate the treatment design. The CoolFRAC* fracturing service (see frac pack treatment comparison figure) optimizes fluid design, tailoring the fluid to the specific characteristics of a reservoir. This approach bases the fracturing fluid gel and breaker concentrations on the bottomhole cool-down temperature. During the prefrac stages of a STIMPAC treatment, the fluids circulated and pumped into the formation produce a cooling effect on the formation.

In the design of the frac fluid, which is based on the cool-down temperature, a lower gel concentration can be used, thus reducing the efficiency of the fluid and increasing the ability to achieve a TSO. Using the cool-down temperature also allows the breaker concentration to be increased without sacrificing fluid integrity. The result is maximized retained permeability and wider, more conductive fractures.

Before the fracturing treatment, the designed fluid is used in the DataFRAC* fluid calibration test to determine the closure pressure and fluid leakoff coefficient, both critical to optimizing the treatment design and creating a highly conductive fracture. These parameters are specific to individual formations and often to individual wells.

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In a field with seven wells, three were frac packed with the aid of the CoolFRAC service and four were frac packed without. Production in the three was higher because of the lower gel and higher breaker concentrations that were part of the successful TSO designs. The fluids, designed using the CoolFRAC service and bottomhole cool-down temperatures, resulted in higher retained permeability. Production in Well B3 was limited by the tubing’s inside diameter.

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**FracCADE Software**

FracCADE* fracturing design and evaluation software is used to optimize the design of STIMPAC treatments. It is a field-validated fracturing simulator developed on the principles of hydraulic fracturing. The software uses parameters such as Young’s modulus and provides a range of models, from 2D models to extensive, laterally coupled, 3D simulators. It includes fully integrated capabilities for real-time monitoring and postjob evaluation.
Screenless completions involve three main steps:
- oriented perforating
- chemical consolidation
- design and execution of a TSO with proppant-flowback control.

Screenless completions use chemical consolidation treatments and proppant packs with proppant-flowback control additives to keep formation sand and proppant from entering the wellbore. The technique eliminates the skin associated with screens and gravel packs and provides full wellbore access, thereby preventing sand production throughout the life of the well and facilitating future well interventions. Applicable to both remedial and new well completions, this technique is especially useful for the remediation of failed conventional gravel packs.

Chemical consolidation. Chemical consolidation treatments produce a bonding reaction with formation sand to keep the sand from entering the wellbore. The acid- and water-resistant bonds between sand grains exhibit the elasticity needed for the grains to remain in place after the fracture treatment.

Schlumberger offers a variety of consolidation chemicals, including the K300 furan resin and SANDLOCK® V epoxy-based systems. Both are used for in-situ formation consolidation of the near-wellbore matrix to cover a wide range of temperature and permeability applications.

Design and execution of a TSO fracturing treatment with proppant-flowback control. During the TSO treatment, a resin-coated proppant is pumped into the fracture. The PropNET fiber additive can also be pumped in the last stages of the fracture treatment to keep the proppant from flowing back into the well.

Oriented perforating. Oriented perforating in poorly consolidated formations optimizes phasing, hole spacing, and orientation of the perforations. Oriented perforating techniques over an optimized interval can delay or prevent sand production throughout a well’s productive life.
Sand Control Services

Design review and execution support
Schlumberger Operation Support Centers (OSCs) provide 24-hour support through a four-tiered approach that coincides with the Schlumberger Design, Execute, Evaluate, and Improve processes. A group of experts helps field location staff review the personnel plan and job design and participate in real-time monitoring to ensure job execution success.

Real-time monitoring and support
Real-time data transmission adds value to stimulation projects. Data gathered during different stages of the pumping treatment are transmitted in real time from the stimulation vessels through the Schlumberger InterACT® real-time data delivery system. The information is then used to optimize treatment design and monitor job execution. The monitoring and support allow for faster decision making and integration of technical expertise and support anywhere in the world.
Confidence in completions

Schlumberger’s broad offering for cased hole sand control provides multiple options and gives you a wide range of choices for each scenario that you face. From simple, conventional completions to complex multizone wells, you can be confident of meeting your sand control objectives anywhere, every time.