Screenless Sand Control Completions

New dimensions in sand management
Applications
- Primary sand control completion for new wells expected to produce formation sand
- Remedial sand control completion
  - for wells without gravel packs that are producing sand
  - for failed sand control completion with screens
  - for wells with bypassed pay zones

Benefits
- Full wellbore access is achieved for
  - well logging
  - improved reservoir management
  - easier future recompletion.
- Overall well completion cost can be reduced through
  - less rig time being spent on sand control completion
  - elimination of operational risks associated with downhole tools
  - rigless through-tubing completion.
- Formation damage caused by completion brine is significantly reduced.
- By eliminating the use of a screen, no additional restriction exists in slimhole sand control completions.

Features
- Integration of field-proven techniques
- Economics, risks and benefits analyses
- Simultaneous stimulation and sand control
- Optimized perforating
- Near-wellbore chemical consolidation
- Tip screenout (TSO) fracturing
- Proppant flowback control with resin-coated proppant, PropNET™ proppant-pack additive or a combination of both

Screenless completion—an alternative sand control technique
Screenless completion is an alternative method to conventional sand control techniques. A comprehensive approach to managing sand inclusive of enhanced risk assessment, screenless completion methodology combined with field-proven techniques offers viable and effective strategies to prevent sand production throughout the life of the well.

Problems associated with sand production can adversely affect reservoir productivity and project profitability. If not properly addressed early, sand problems can compound to the extent that produced sand jeopardizes future well intervention options.

Applicable to both old- and new-well completions, screenless completion technology is particularly useful in competent formations that can be considered borderline on needing a gravel pack to prevent sand production.

Screenless completion employs existing field-proven methods, resulting in a fullbore completion without the use of a screen and surrounding gravel pack. Rather than using the bridging mechanism of a gravel pack in the annulus between screen and casing, formation sand is held back by a proppant pack with proppant-flowback-control additives inside the hydraulic fracture.

By not having gravel-pack screens in the well, screenless completion offers significant advantages to a conventional sand control completion, such as completion cost reduction, improved well conformance control and future flexible recompletion options. The screenless completion is an effective alternative method for controlling formation sand.

FracTROL® completion engineering service ensures present and future well productivity by combining certain techniques such as perforating, consolidation, fracturing and proppant flowback control. FracTROL techniques can be performed without a rig, overcoming the limitations of screened completions and providing a cost-effective method of sand control for both

Screenless sand control completions include three services—fracturing, chemical consolidation and perforating for sand control.
primary and remedial completions. By eliminating any skin associated with the gravel pack and screen, this technique also maintains full wellbore access to facilitate future well intervention.

Techniques include
- optimized perforating, including orientation, size, shot density and interval selection
- consolidation to stabilize formation sand in wells with existing perforations
- fracturing to stimulate production
- proppant flowback control with resin-coated proppant, PropNET additive or a combination of both
- pinpoint placement of hydraulic fracturing using the CoilFRAC® service.

Critical perforating procedures
Perforating provides a means of communication between the wellbore and the reservoir. In a fracture-stimulated reservoir, the perforation is the conduit between the fracture and the wellbore. In a cased hole completion, the perforation is the only avenue through which sand can be produced. Proper selection and execution of a perforating procedure is critical to the successful FracTROL completion.

For FracTROL completions, oriented perforations should be shot perpendicular to the minimum principal stress; i.e., aligned with the preferred fracture plane. General recommendations are
- 180° or 0° phasing perforations depending on knowledge of formation stress distribution
- the use of limited interval guidelines and placement of perforations
- shot density and charge type based on the desired pressure drop in either casing or cement.

The primary completion for new wells expected to produce formation sand

Remedial sand control completion for wells without gravel packs that are producing sand

Proppant flowback control with PropNET additive, resin-coated proppant or a combination of both keeps the proppant in place. In turn, proppant placed inside the hydraulically induced fracture halts sand production.
**Gel consolidation prior to fracturing**
If the FracTROL service is to be used for wells with existing perforations, these perforations need to be plugged or consolidated to prevent sand production. If the cement is to be used to plug the well, then reperforating should be performed prior to fracturing.

Consolidation, the process of bonding sand grains and formation fines, is also used to eliminate risks of sand production over time. Acid- and water-resistant bonds created between sand grains exhibit a certain elasticity needed to survive the fracture process. Placement of the gel must ensure coverage and consolidation of every open perforation.

**Fracturing for effective treatment**
Employing CoiFrac and TSO fracturing services combines the benefits of fracturing with the pinpoint placement of coiled tubing.

**Coiled tubing conveyance and selective isolation**
Conveyance by coiled tubing and selective isolation methods available with the CoiFrac service make multizone treatment possible all in one trip. By selectively and accurately placing proppant into each individual zone, the effects of varied stress and pressure are eliminated and volume is minimized. Multiple small treatments can be economically applied to maximize reserves in layered sands and to allow flexibility in conformance control.

**TSO improved fracture conductivity**
TSO fracturing is recognized as the most important tool for ensuring adequate fracture conductivity in high-permeability formations. In a high-permeability formation, one way to achieve an acceptable fracture flow is to substantially increase the fracture width. To increase width, the fracture is screened out at its tip and subsequently inflated. The development of cleaner nonpolymer fluids, such as the Schlumberger ClearFrac® fluid, has also contributed to significantly improved fracture conductivity values.

Reliable proppant flowback control is essential for a successful FracTROL completion. Currently, PropNET additive and resin-coated proppant are being used to prevent proppant flowback. PropNET additives are fibers that are intimately mixed with slurry and pumped into the well to keep the proppant in the fracture by means of a physical reinforcement mechanism. Proppant placed inside the hydraulically induced fracture halts sand production.

Successfully employed in more than 4000 treatments, PropNET additive does not require any shut-in time and is effective in reservoirs with temperatures to 400°F. Depending on bottom-hole temperature, desired chemical resistance, expected fluid velocities in the fracture and desired proppant-pack permeability, various materials and sizes of PropNET fibers are selected.
**Retain permeability through chemical consolidation**

Where fracturing is not possible, two conventional chemical consolidation systems are available to prevent the migration of formation sand and other fines to the wellbore—the K300 and SANDLOCK® V systems. The K300 furan resin system is used for in-situ formation consolidation, whereas the resin-coated SANDLOCK V technique is used for gravel packing the formation.

**K300 resin system—bonding of sand particles**

Resin system technology is based on polymerization reactions of resin injected into loose or unconsolidated formations in the near-wellbore matrix. The resin cures to a hard plastic that bonds sand and fines particles together so that they cannot migrate to the wellbore.

Once in place, the K300 resin helps prevent the migration of other loose sand and fines, offering higher retained permeability and better compressive strength than standard resin consolidation systems. Lower in initial cost and environmentally friendly, the K300 resin yields higher production rates.

The K300 system can be used to consolidate the formation before performing a fracturing treatment. Sand production from the perforations is prevented by the proppant pack using proppant-flowback-control technology. Perforations not in communication with the fracture are protected by the resin.

Used after perforating, this viscosity-controlled system works by “smoothing” the injection profile in water injection wells drilled in formations of varying permeability.

**SANDLOCK V service—creating an artificial sandstone network**

This resin-coated gravel-packing technique places a strong but highly permeable artificial sandstone gravel pack in perforation tunnels and outside the casing to prevent the migration of formation material into the wellbore.

A high-density resin-coated slurry is prepared in a thickened brine-carrying fluid and is pumped down the workstring through the perforation tunnels until a screenout is obtained. After the resin cures, the consolidated gravel pack in the casing is drilled out or a pilot hole is drilled through the sand pack, and the well is returned to production.

Resistant to deterioration by produced fluids and most treating chemicals, the SANDLOCK V resin-coated gravel requires less rig time as a result of the rapidly setting resin and thinning of the viscous carrier gel after placement. Well cleanup time is shortened and formation damage is lessened because a relatively small volume of fluid is used to place a large-volume gravel network.

Particularly suited for remedial sand control and for repairing damaged screens, the SANDLOCK V service is also effective in primary completions and injection wells. The slurry is squeezed into the perforations and against the formation. Once cured, the slurry forms a set network with a compressive strength of approximately 3000 psi and a permeability of 100 D with 20/40 mesh gravel.
Perforating solutions to manage sand
The tendency for a well to produce sand along with oil, water and gas depends on numerous factors such as formation strength, perforation stresses, flow rate and fluid type.

Perforation tunnel stability determines whether sand production will be a concern in a completed well. Perforation tunnel collapse or formation failure between perforations causes sand production in weak consolidated formations. Optimized perforating techniques, based on enhanced risk assessment, can delay or avoid sand production over a well's productive life.

As one of the screenless completion methods, optimized perforating can help prevent production of sand from within the formation.

Choosing conventional sand control or sand-prevention perforating
Perforation and formation stability and the ability to accurately predict them influence whether conventional sand control or screenless sand control strategies should be undertaken. Weak but consolidated formations that support a perforation tunnel are good candidates for perforating sand control techniques (formations that are too weak to support a perforation tunnel are unlikely candidates). Sand production in more competent formations generally arises from either tunnel collapse or loose sand in the tunnel.

When risk of sand production is determined to be acceptably low, screenless prevention techniques are optimal. When the risk is unacceptably high, conventional sand control methods are the preferred course.

Optimal use of screenless perforating technology
Schlumberger perforating techniques for sand control create more stable perforation tunnels in the formation, optimizing the hole size, penetration and perforation-to-perforation spacing for a given pressure drawdown across perforated intervals and flow rate per perforation. Underbalanced perforating enables loose perforation sand to be produced early, which helps avoid impaired productivity and sand issues during the later stages of a well's life.

Upgrading perforating performance involves optimizing parameters such as charge type, shot density, phase angle and, in some cases, orientation.

Charge type
Optimized shaped charges offer controlled hole size and penetration:
- Deep penetrating charges are used to enhance single-perforation stability during drawdown and depletion. They also, along with optimum perforation spacing, enhance the stability of the adjacent formation.
- Optimized charges are used to enhance hydraulic fracturing treatments.

Shot density
Higher shot densities increase the area open to flow, keeping pressure drawdown, flow rate and drag forces through each perforation below a critical value.

Phase angle
Optimizing the phase angle for a given wellbore radius and shot density maximizes the perforation-to-perforation spacing, which in turn decreases or avoids interaction between adjacent perforations and the surrounding rock.

Perforation orientation
Selective and/or oriented perforating is used to place the perforations away from less stable sectors in the formation (e.g., orientations) that have large contrasts between horizontal and vertical stresses.
Case histories

Million-dollar savings on cleanup

In a recent application of completion technology, a well was refractured using a combination of resin-coated proppant and PropNET additive to control proppant flowback. After the successful TSO fracturing stimulation, sand-free production was achieved and a savings in cleanup costs was realized.

The 4-month-old well had been previously fractured using a competitor product. Because the well was producing solids exceeding permissible levels to bring on production, sand control coupled with a restimulation effort was warranted. Schlumberger performed a restimulation treatment using the screenless completion technique. The interval had been perforated using oriented perforating techniques with limited interval guidelines for screenless completions.

To ensure success of proppant flowback control, 1.2% PropNET Gold additive was used in combination with 16 to 20 resin-coated proppant during the fracturing job. The treatment was performed successfully without cleanup problems and solids production ceased immediately after cleanup.

Back in production within a week, the well tested at over 30 MMscf/D at a savings of more than $1.2 million over typical cleanup costs.

Screenless techniques successful in horizontal wells

Early gravel-pack and perforated completions had failed in the weak chalk formations of the Valhall field. Following an engineering study, a screenless completion treatment inside cased horizontal wells was performed with excellent results. Since then, more than 100 successful treatments have been placed.

Between three and seven fracturing treatments have been performed in each horizontal well. A 5-ft interval was perforated with 180º phased perforations. A TSO fracture was placed, inclusive of proppant flowback control, to keep the proppant in the fracture.

Post-treatment data show an average sand-free production increase of 1000 to 3000 BOPD per fracture with an even inflow profile along the horizontal wellbore.

Increased production in heavy-oil steamflood environment

Fourteen zones in four wells were completed in high-permeability heavy-oil steamflood environments. Intervals up to 24 ft in length in vertical wells were perforated with 0º phasing perforations. The wells were subsequently fractured following screenless completion guidelines and using the CoilFRAC technique. These wells are producing sand free at rates 250 to 350 percent higher than rates in offset wells.