

# Gravel Pack System



**PetroForge  
Technology**



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## Sand Production & Control

The biggest problem to producing oil and gas from highly transmissible reservoirs is production of sandstone at some point in the productive lifespan.

The restraining forces that hold the sandstone grains in place and the production stresses created by well fluids moving through the formation matrix causes well to produce sand.

The production of small particles that are less than 40 micron is generally not harmful to the formation but moving larger load-bearing solids can damage the formation and the well equipment. Controlling load-bearing solids production stops the movement of these solids. This is detrimental to long term productivity.

Also extended sand production can cause reduction in production, Erosion of casing, tubing and surface equipment, Loss of formation stone, making selective treatments difficult and contributing to formation, and Production interruptions due to sanded-up flowlines and separators.

### **Objectives of sand control systems:**

- Control the movement of load-bearing solids.
- Create minimal negative impact to the well's productivity
- Remain effective for the well's productive lifespan
- Control the inflow of hydrocarbons from the reservoir into the well and delivers sand-free production, optimizing long-term well performance and boosting recovery factors.

Gravel packing, frac packing, and stand-alone screens are the more commonly practiced methods of sand control in cased-hole and open hole wells.

## Gravel Pack Completion

Gravel pack completion requires installing a screen and packer into the wellbore across the producing interval using a work string and specialized tool system.

Gravel pack sand is pumped into the well to fill the annulus around the screen and voids in the formation.

The gravel pack sand supports perforation tunnels or the open hole, keeps formation grains in place, enables the passage of formation fines without plugging, and creates minimal pressure drop from the formation and into the production stream.

## Gravel Pack Completion System

The **GRAVEL PACK COMPLETION SYSTEM** requires retrievable seal bore packer with a gravel pack extension, crossover tool, and screens are to be deployed into a cased well that has been perforated into the production zone. The screens use a snap-latch locator seal assembly installed on the bottom that seals into permanent sump packer. The snap-latch locator serves to provide a surface indication that the gravel pack assembly is properly located in the sump packer. With the assembly in place, the upper packer is set, and the crossover tool is manipulated to its various positions to pump the gravel as well as any other treatments planned.

The **squeeze position** is used to stimulate the formation or prepack the perforations. The **circulating position** is the standard crossover tool position that places gravel into the screen and casing annulus. Proper leak off while circulating the gravel pack in place serves to fill the perforation tunnels. After placing the calculated amount of gravel pack sand in place and achieving a sand out, the crossover tool is raised to the **reverse position** and all excess slurry remaining in the work string is reverse circulated to the surface for disposal. The crossover tool is removed, and the well is ready for the installation of the production tubing.

With the retrievable seal bore packer remaining in the well as the production packer, the operator maintains the flexibility of inserting a production seal assembly into the packer, isolating the casing above the packer from well pressure and produced fluids or suspending the tubing above the packer, as in a well lifted by reciprocating rod lift or an electric submersible pump. Production tubing or artificial lift strings can be retrieved and rerun without disturbing the gravel pack setting.

The gravel pack system is generally rated to pressures of 6,000 psi and maximum gravel-packing rates of 6-12 bpm, depending on the crossover tool size.

## Features, Advantages, and Benefits

- Sand-Free Production,
- Optimizing Long-Term Well Performance
- Boosting Recovery Factors

## Components & operation

### Service Tool Assembly

- Hydraulic Setting Tool
- Washdown Crossover Tool

### Gravel-Pack Assembly

- Retrievable Seal Bore Packer
- Extension
- Closing Sleeve
- Shear Sub
- Blank Pipe
- Well Screens
- Snap Latch Seal Assembly
- Sump Packer

- The first well requirement is a **Sump Packer** that serves as the foundation for the total completion. The packer can be set using electric line for accurate placement to ensure that perforating guns and the sand-control assembly are properly positioned while relying on pipe measurements.
- A repeatable **snap-latch seal assembly** installed on the bottom of the screens serves to give indication of the packer bore being unobstructed and the screens being on-depth before setting the gravel-pack packer and sealing the end of the screens from the annular space being gravel-packed.
- The **Washdown Gravel-Pack System** permits circulating through a concentric passage in the crossover tool and down the wash pipe inside the screen during the deployment process. This is accomplished by having a modified crossover port assembly in the crossover tool. A movable piston in ported sub, when run in the well, isolates the crossover ports and is open through its center. The piston includes a seat for the packer-setting ball and a flapper that serves as the low bottomhole-pressure check valve. When the setting ball is dropped and pressure is applied to set the packer, exceeding the setting pressure causes the piston to move down. This exposes the gravel-packing ports of the closing sleeve and causes the flapper to spring downward and functions as a check valve, enabling circulated fluid to return up the casing, but preventing fluid and pressure from the casing to transmit down the wash pipe. The setting ball serves to plug the open bore of the crossover tool and divert pumped fluids through the crossover ports.
- Once the packer is set, the service tool is released from the packer and the tool can be placed in various positions, depending on the pumping operation and path of pumped fluids.
- For stimulating the formation prior to the gravel pack, the crossover tool is placed into the **squeeze position**, so the acid is forced into perforations which helps to open or breakdown the perforations, improving the chances of filling the perforation tunnels with clean, high-permeability gravel-pack sand.
- Then, the crossover tool is raised to **circulating position** and gravel pack sand is pumped up to the bottom of the sand screens.
- After filling the annulus with sand that covers the well screens, a pressure increase is seen in the pump pressure. If sufficient sand is pumped to accomplish the gravel pack, the crossover tool is raised to the **reverse position**, placing the gravel-pack ports above the packer. Switching the lines at surface to pump down the casing allows reverse-circulation of all the sand slurry remaining in the work string to surface to be discarded.
- After all excess slurry is removed from the well, the crossover tool can be placed back into the **circulating position** so that fluid can be pumped again to confirm a successful annular gravel pack, pulled from the packer to monitor the well, placed in the reverse position to change out well fluids, or pulled from the well.
- When the crossover tool is raised from the packer assembly, the shifting collet on the crossover tool automatically closes the closing sleeve below the packer isolating the ports that the sand slurry was pumped through.
- The work string and crossover tool can be retrieved to surface.

## Gravel Pack Packer

The packer is used with the gravel-pack hydraulic setting tool, washdown crossover service tool, and closing sleeve extension. The packer can be run in a non-gravel-pack application, such as one with standalone sand screens, liners, or tubing-conveyed perforating guns suspended beneath.

The packer is provided with ECNER array packer element to have an excellent sealing with ease in pack off and resistance to swabbing. Components of the packer are rotationally locked to help in milling when packer is locked and cannot be retrieved.

## Applications

- Conventional and high-rate gravel packing
- Installation of standalone screens
- High-pressure production and injection
- Stimulation and fracture
- tubing-conveyed perforating completions

## Features, Advantages, and Benefits

- The slips are below the element to prevent the buildup of debris in and around them, reducing the times for circulation and total retrieval.
- The retrieval mechanism is protected from debris and flow and must be actuated to release the packer, ensuring trouble-free retrieval on the first attempt.
- The components are rotationally locked to prevent them from spinning, which reduces milling time if the packer cannot be retrieved normally.

## Specifications

Casing				Tool	
OD (in.)	Weight (lb./ft)	ID (Min.) (in.)	ID (Max) (in.)	OD (Max) (in.)	Seal bore (in.)
5-1/2	20.0 - 23.0	4.670	4.778	4.500	3
	14.0 - 20.0	4.778	5.012	4.625	
7	29.0 - 35.0	6.004	6.184	5.813	4.000
	23.0 - 32.0	6.094	6.366	5.938	
	20.0 - 26.0	6.276	6.456	6.026	
9-5/8	47.0 - 53.5	8.535	8.681	8.281	4.750
	36.0 - 43.5	8.755	8.921	8.539	

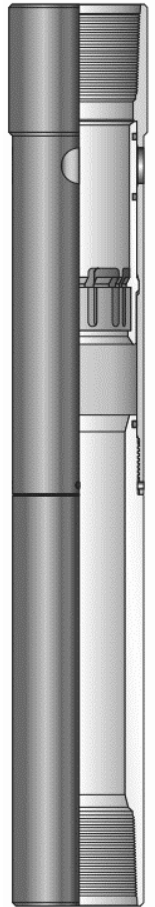


## Closing Sleeve

The closing sleeve provides the control path to the annulus for sand-slurry flow in gravel-pack completions. After the slurry is placed, the sleeve closes and provides reliable, long-term isolation of the inside of the well screens from the slurry. The sleeve can be repeatedly opened and closed using collet feature.

The sleeve is connected below the retrievable seal bore packer with extensions installed above and below the sleeve housing to accommodate the crossover tool during operation. A shifting tool installed as part of the crossover tool opens and closes the sleeve. The sleeve is usually run in the open position, enabling the work string to fill with fluid as the gravel-pack assembly is run in the well. After the assembly is on depth and the packer is set, the sand slurry is pumped through the sleeve port, entering the annulus around the screen.

A seal bore is provided below the sleeve to accommodate seal section on crossover tool and seal below the ports, isolating the slurry flow path. After the job, the sleeve is closed to isolate the annulus above the screen from the flow stream, preventing inadvertent sand flow through the gravel-pack ports.



## Applications

- Gravel packing
- Fluid change in open hole completions

## Features, Advantages, and Benefits

- Can be opened and closed multiple times maintaining the sealing integrity.
- The large flow area for the sand slurry reduces the risk of erosion, contributing to a better gravel pack completion.

## Specifications

Seal Bore (in.)	OD (Max) (in.)	ID (Min) (in.)	Flow port area (Sq.in.)
3.00	4.53	3.00	10.125
4.00	5.82	4.00	7.069
4.75	7.40	4.75	

## Gravel Pack Shear Sub

Gravel-pack shear sub is installed below the gravel-pack assembly and above the well screens. The shear sub provides a predetermined shear value that enables easy retrieval of the packer, while leaving the screen in place. The shear value of the sub is readily verifiable and adjustable in the field. During workover operations, it eliminates the need to cut blank pipe below the packer.

The nonrotating feature transmits torque through the string, enabling rotation of the screens during deployment. In fishing operations, when the shear sub is sheared and removed, the OD of the portion remaining in the well is of similar diameter with the thread OD of the original pipe string, ensuring the remaining sub does not impede fishing attempts or running a wash pipe over the screen setting.



## Applications

- Gravel-pack completions
- Stand-alone-screen installations.
- Workover and fishing operations

## Features, Advantages, and Benefits

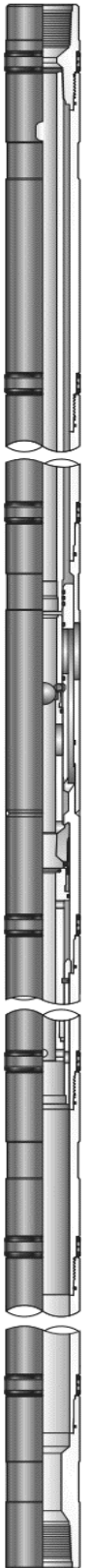
- Adjustable shear rating
- Enables rotation of the screens during deployment.
- Facilitates the fishing of the screen assembly, as overshot and wash pipe will pass over the bottom sub.
- Longer sealing stroke provides more assurance of keeping seals in contact in the event of prematurely shearing the sub, preventing pumping sand inside the screen or having an unwanted flow path



## Washdown Crossover Tool

Washdown crossover tool enables circulation through the crossover tool and wash pipe to the bottom of the screen assembly. When the packer setting ball is dropped and pressure is applied, a piston shifts downward, redirecting the fluid path through the ports of the crossover tool, and the return path for circulating fluid is established.

Washdown crossover tool can be placed in the squeeze, circulating, or reverse positions with simple upward and downward movement of the work string. To place the tool in the squeeze position, simply slack weight off on the packer. The crossover ports align with the ports of the gravel-pack extension, and fluids can be pumped straight into the formation without transmission of fluid or pressure to the casing annulus above the packer. Raising the crossover tool exposes the return ports to the casing annulus; fluid pumped down the work string circulates in the annulus, around the screens, up the wash pipe, and through the return bypass of the crossover tool, into the annulus above the packer. To achieve the reverse position, raise the crossover tool further until its ports are above the packer and the formation is isolated while reversing out or circulating above the packer. Should the need arise to circulate while tripping into the well with the gravel-pack assembly, fluid pumped down the work string travels through a straight path through the crossover tool and down the wash pipe to the end of the screen.



## Applications

- Single or multizone gravel packs
- Squeeze or circulate gravel packs.
- Open hole gravel packs
- Standalone-screen installations

## Features, Advantages, and Benefits

- enables circulation through the crossover tool and down the bottom of the screen assembly, before the packer is set.
- Primary and secondary ball seats provide a packer setting contingency in the event low bottomhole pressure causes a premature shear of the primary seat, eliminating the need to pull an unset packer out of the well.
- Large flow ports minimize turbulence, reducing erosion and damage to the gravel-pack sand.
- Large return area reduces backpressure and fluid loss, improving the chances of a successful gravel pack.
- Durable, bonded seals are resistant to damage from sand, improving tool longevity.
- Flapper-style reverse-out check valve isolates the formation from hydrostatic pressure and casing pressure while reversing, preventing fluid loss, which could be damaging to the formation or result in rig downtime.

## Hydraulic Setting Tool

Hydraulic Setting Tool is used to convey and set all wireline-set seal bore packers, including PetroForge seal bore packers on production tubing or coil tubing. The HST sets the packer by applying surface pressure until the preset shear force is achieved. The HST provides a bottom connection that accepts common wireline-type setting-tool adapter kits. A stackable piston arrangement allows variable setting pressure to be tailored to well requirements.

## Applications

- All wireline-set type seal bore packer completions.
- Deviated and horizontal wells
- Large-casing packers

## Features, Advantages, and Benefits

- Heavy-duty construction for pushing tools into deviated or horizontal wells.
- EUE tubing connections standard.
- Accepts common wireline adapter kits.
- Automatic tubing string fill and drain.
- Adjustable start-to-set pressure.
- Stackable piston arrangement to adjust setting pressure.
- HST allows circulation before the packer is set.

## Specifications

Size (in.)	Tool OD (in.)	Standard Thread Connections	Bottom Connection Configuration
1-1/2	2.13	Blank for 1-1/2 MT	#05 BAKER E-4
			2-1/8" GO
2-3/8	3.63	2-3/8" EU 8 RD	#10 BAKER E-4
2-7/8	4.38	2-7/8" EU 8 RD	#20 BAKER E-4