

WELLBORE CONSTRUCTION MULTISTAGE COMPLETION

2024

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INTRODUCTORY TO MULTISTAGE COMPLETIONS

Introduction

Multistage completions have emerged as a key technology in the oil and gas industry, revolutionizing the way hydrocarbons are extracted from unconventional reservoirs. These unconventional resource plays were previously difficult to economically produce using conventional oil and gas recovery technologies. These formations often have low permeability and require stimulation techniques, such as hydraulic fracturing, to enhance production rates and maximize hydrocarbon recovery. The use of multistage completion techniques have changed the landscape by maximizing the productivity and recovery rates of these resources.

Multistage completions involve dividing the horizontal wellbore into multiple isolated sections or stages, allowing for targeted stimulation and production optimization. By precisely controlling the hydraulic fracturing process in each stage, operators can enhance reservoir contact and maximize the recovery of hydrocarbons.

The applications of multistage completions extend beyond unconventional oil and gas wells. This technique has also found relevance in geothermal energy extraction, carbon capture and storage (CCS), matrix and acidizing treatments, and other subsurface operations. The principles of isolating and stimulating different sections of a reservoir to optimize fluid flow can be adapted to various resource extraction or storage scenarios.

The implementation of multistage completions involves a sophisticated approach that includes careful completion planning, reservoir communication, and fracturing design. Each stage is treated as an independent entity, requiring specialized tools and equipment to isolate and control fluid flow. This enables operators to selectively stimulate specific sections of the reservoir, optimizing production rates and overall recovery.

Baker Hughes adopted a focus on the unconventional resource products and it has been developed into the Multistage Completions product line. This product line has now become a standard international technology for a variety of applications. Baker Hughes Multistage Completions product line is focused on products to

enhanced well production and increase hydrocarbon recovery by providing an innovated portfolio to allow single- or multi- entry pathways to hydraulically stimulate a reservoir in an open hole or cased hole completion.

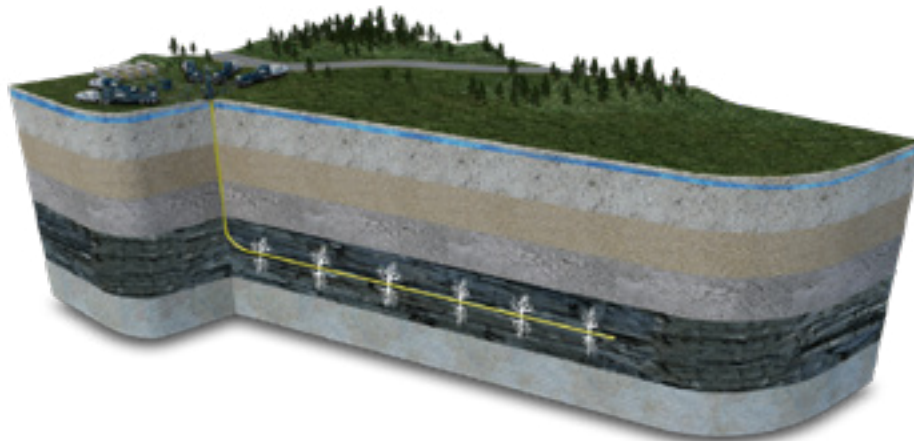
The portfolio consists of three product focal points:

- Ball Activated Completions
- Tubing Activated Completions
- Wireline Conveyed Completions

The handbook provides an overview of the application and technologies utilized to implement multistage completions in the following key applications:

- Tubing and ball activated completions installed as part of a production liner
- Wireline conveyed completions system run inside and previously installed liner
- Through tubing solution for restimulation of previously installed completions

Baker Hughes has broad capabilities for multistage fracturing, including reservoir evaluation, drilling, completion, pressure pumping, and water management services. This handbook describes our multistage completion options for hydraulic fracturing. Offering industry-leading experience and in-depth technical support in all types of multistage completions, Baker Hughes can help improve operational efficiency and increase production from hydraulically fractured wells. We provide a wide range of completion technologies to match your reservoir and operational requirements. Our capabilities include leading solutions for the three methods of multistage fracturing completions.



FRACTURING BASICS

Our FracPoint™ multistage fracturing system delivers the efficiency of ball- or dart- activated sleeve completions in cemented or open hole applications, enabling fracturing in an industry-leading number of stages. Used in thousands of wells, the FracPoint system can be adapted to match specific reservoir requirements with various liner tops, openhole isolation options, frac sleeves and toe ports. The Baker Hughes disintegrating frac balls extend the number of stages and minimize the need for intervention.

The OptiSelect™ system uses tubing (coil tubing or work string) to open sleeves and conduct fluids for hydraulic fracturing. The system can be used to frac a nearly unlimited number of stages in cemented or openhole applications. Tubing actuation provides precise control over the fracturing operation and requires less water and proppant than other methods. The system can also be paired with the EasyCut™ sand jet perforating technology to allow sand jet perforating to replace the use of frac sleeves.

The OptiStriker™ SJ and Frac SL™ systems are intervention based systems that facilitate economical restimulation of older well to enhance recovery and overall production.

Hydraulic Fracturing Basics

The main application for multistage completions is in the stimulation process of reservoirs known as Hydraulic Fracturing. The process involves injecting a high-pressure fluid mixture, typically consisting of water, sand or proppant agents, and chemical additives, into a wellbore to create fractures or fissures in the rock formation. The tip of the fracture extend away from the wellbore in opposing directions according to the natural stress of the formation. These fractures act as pathways for oil or natural gas to flow more freely towards the well, enhancing the productivity of the well.

The process of hydraulic fracturing is typically conducted in several stages. Communication through the well casing and wellbore is achieved by several different completion techniques, to allow the fluid mixture to enter the target formation. Once the fluid is injected, the high pressure causes the rock to crack, and the proppant agent, usually sand or ceramic beads, is carried into the fractures, preventing them from fully closing when the pressure is released. This enables the hydrocarbons to flow to the wellbore more efficiently, increasing extraction rates. This technique is primarily used to extract hydrocarbons from unconventional resources like shale or tight sandstones formations, unlocking vast reserves that were previously inaccessible.

The applications of hydraulic fracturing are primarily focused on unlocking unconventional oil and gas resources. These resources were previously inaccessible or uneconomical to extract using traditional drilling methods. Hydraulic fracturing has revolutionized the energy industry by enabling the extraction of vast reserves from shale formations worldwide, contributing significantly to the global energy supply.



MULTISTAGE COMPLETIONS APPLICATIONS OVERVIEW

Products and Systems Overview

The equipment used to complete unconventional oil and gas wells is as varied and complex as the wells themselves.

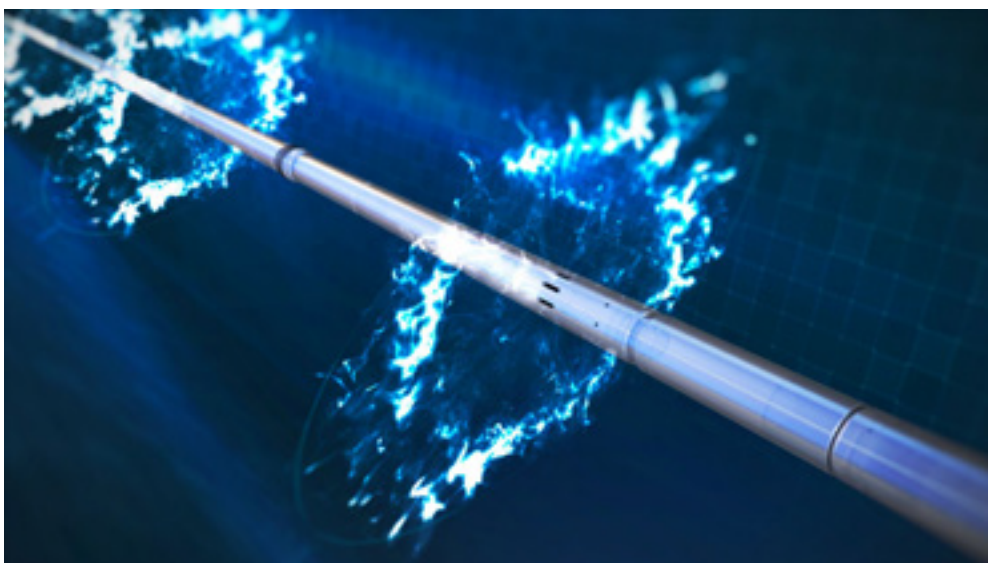
An efficiently designed and implemented multistage completion can help ensure an optimal communication with the reservoir for an effective stimulation treatment, minimizing the equipment and services required during the operation. Ultimately reducing overall capital and operational expenditures, optimizing the production and extending the life of the well to accelerate your return-on-investment.

The Baker Hughes' extensive line of multistage completion products and systems help do all these and more. From the liner top to the toe of the well, you can depend on comprehensive fit-for-purpose engineered solutions that can reliably withstand extreme downhole conditions during the hydraulic stimulation treatment for a variety of applications.

To illustrate this, we have selected a group of application examples. These examples include brief explanations of the functionality of each component of the multistage completion according to their respective position in the string.

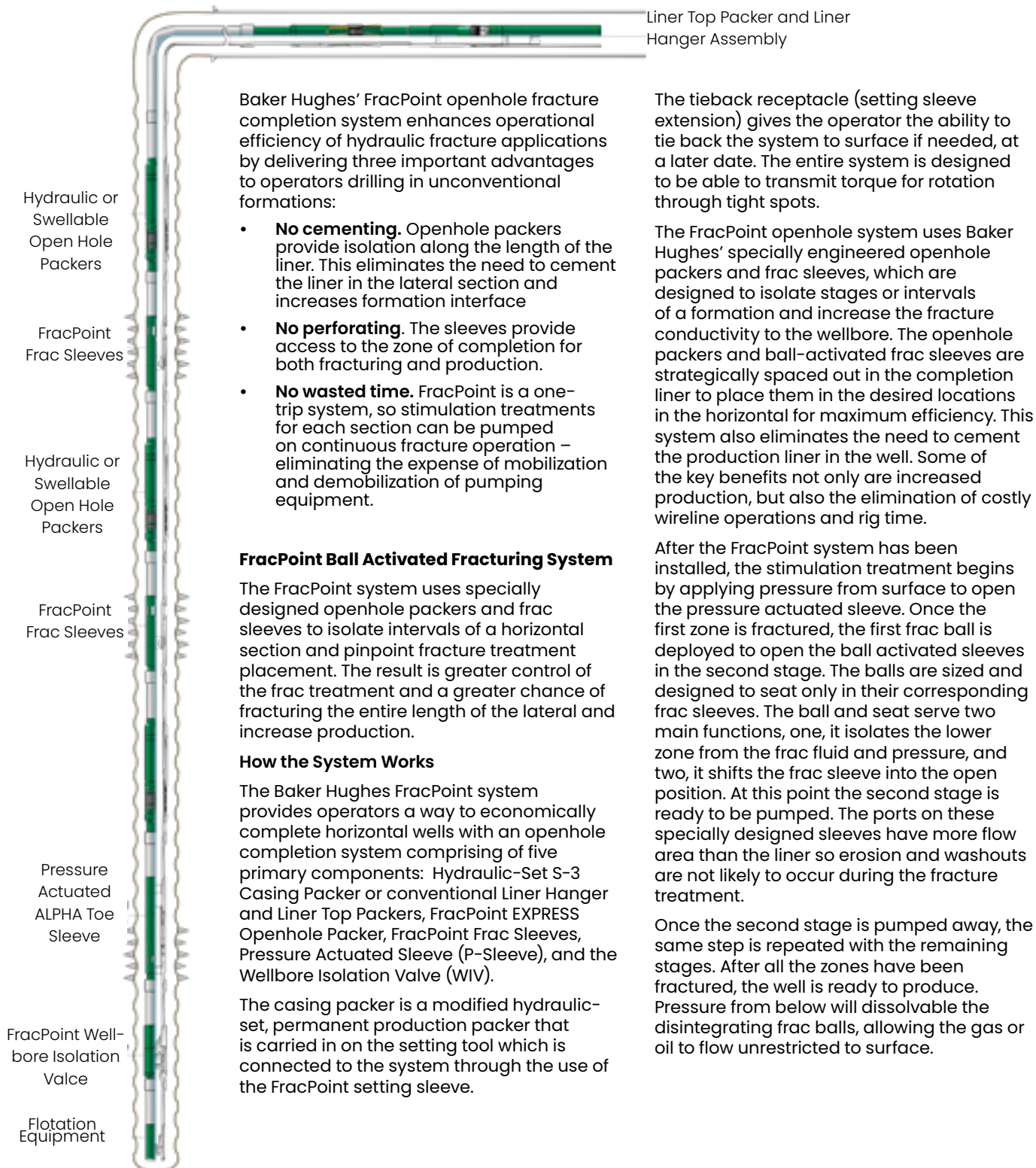
Multistage Completion Comparison

	Ball Activated	Smart/Non Graduated	Tubing Actuated	Plug and Perf	Disolvable Plugs
Number of Stages	Limited	Limited	Virtually Unlimited	Virtually Unlimited	Virtually Unlimited
Frac Placement	Fixed	Fixed	Fixed with Sleeve	Flexible	Flexible
			Flexible with Sand Jet Perforating		
Contingency	Limited ID	Limited ID	Full Casing ID	Full Casing ID	Full Casing ID
Frac Logistics	Pressure Pumping	Pressure Pumping	Pressure Pumping	Pressure Pumping	Pressure Pumping
			Coil Tubing	Wireline	Wireline
Frac Operations	NonStop	NonStop	Frac, Shut down, move CT BHA	Rig Up/Rig Down between Stages	Rig Up/Rig Down between Stages
				Coil Tubing	Coil Tubing
Post Frac	No Mill out, Restricted ID	No Mill out		Mill Out Plugs, Full Production ID	Clean Out Run, Full Production ID
		Full ID			

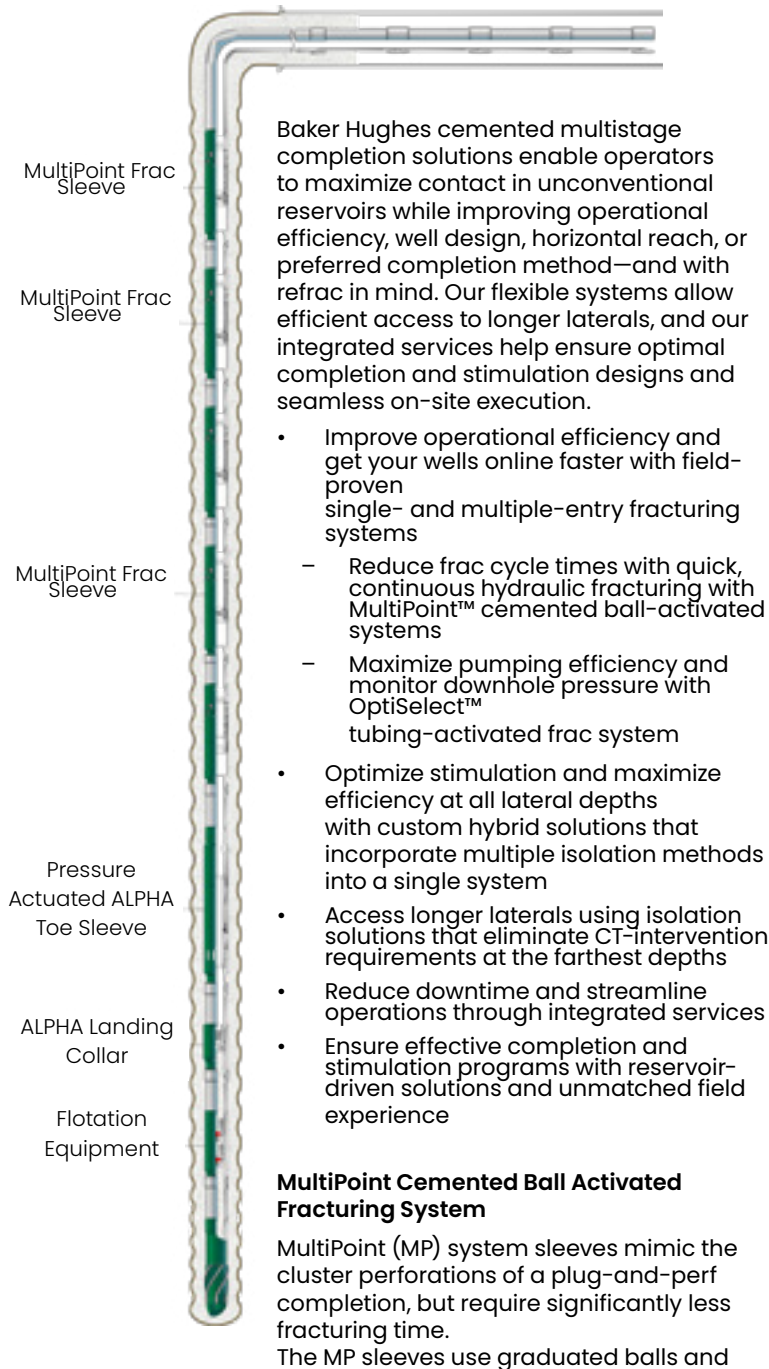


APPLICATIONS

Liner Deployed Completions – FracPoint Openhole Fracture Completion System



Liner Deployed Completions – Cemented Multistage Completion Solutions



ball seats to open up to five sleeves per stage with a single ball allowing multiple-entry fracturing for increased efficiency. The system consists of three main components:

- Single or multi-entry MP frac sleeves
- Alpha pressure actuated toe sleeve
- Cementing accessories

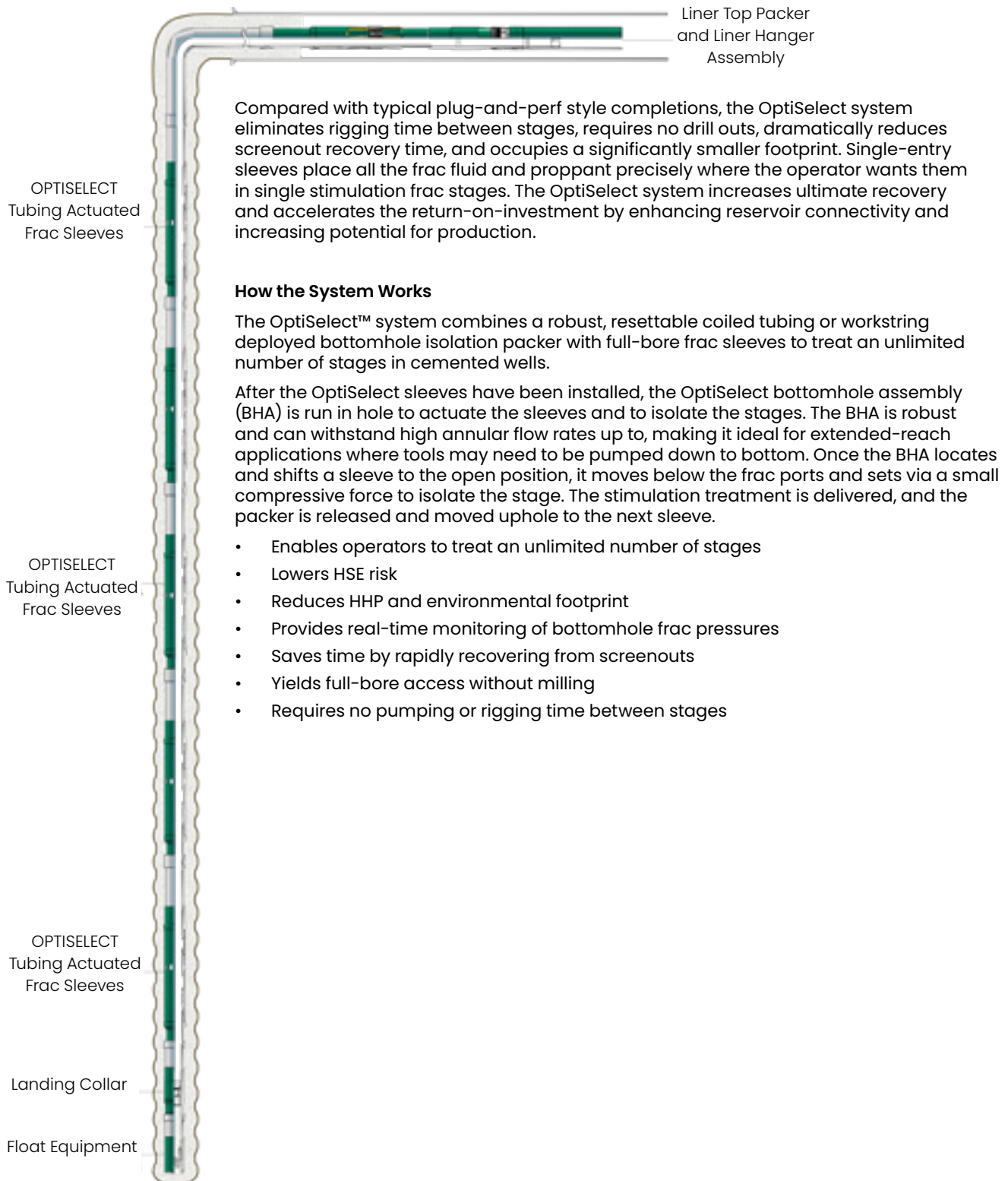
How the System Works

Each stage contains a predetermined number of subsiding ball seats and one hard seat. As the frac ball engages the ball seats, hydraulic pressure opens the sleeve and the ball seat subsides, allowing the ball to pass through to the next seat. When the ball lands on the hard seat in the lowermost sleeve, increased pressure opens the sleeve and the frac treatment is delivered through all open sleeves in that stage for maximum reservoir contact and enhanced drainage.

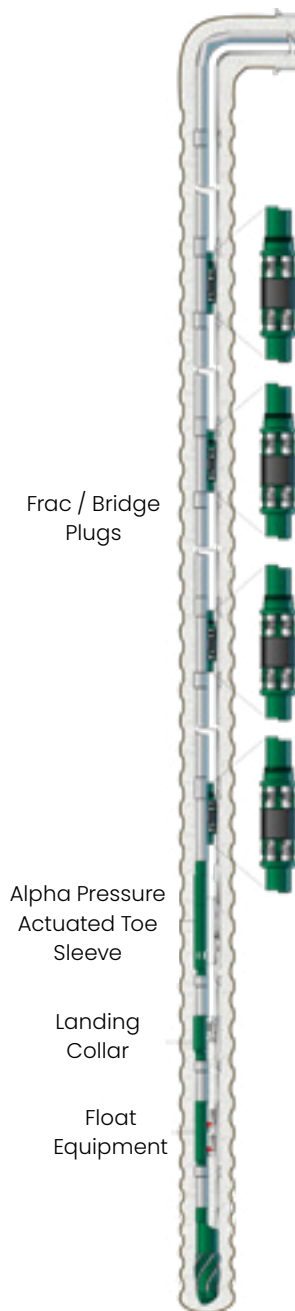
- Creates multiple entry points by opening up to five sleeves per stage with a single frac ball
- Requires no through-tubing intervention during or after the frac
- Eliminates the rigging up and down of equipment between stages, enabling nonstop fracturing operations
- Significantly reduces fracturing time compared to a plug-and-perf operation
- Ensures an unobstructed flow path without intervention using disintegrating frac balls fracture treatment.

Once the second stage is pumped away, the same step is repeated with the remaining stages. After all the zones have been fractured, the well is ready to produce. Pressure from below will dissolvable the disintegrating frac balls, allowing the gas or oil to flow unrestricted to surface.

Liner Deployed Completions – OptiSelect Tubing Actuated Fracturing System



Wireline Conveyed Completions – Plug and Perforation with Frac and Bridge Plugs



The “plug-n-perf” technique is a widely-used approach used in the unconventional, multi-stage completions in the process of hydraulic fracturing. The plug and perf consist primarily of drillable material (mostly composite) or dissolvable Frac Plugs or Bridge Plugs, but also include and other devices that are deployed on wireline. However, if necessary, these same devices can be configured to be run on coiled tubing or other deployment methods.

How the System Works

In the plug and perf technique, a series of specially designed frac or bridge plugs are sequentially installed at precise intervals along the horizontal section of the well. These plugs are composed of materials that can withstand the high pressure and temperature of the fracturing fluid. Once in place, each plug acts as a temporary barrier, effectively isolating a specific section of the wellbore from the rest.

After the plugs are in position, the well is perforated in each isolated section using shaped charge perforating guns. Generally, the perforating guns are lowered into the well in the same trip as the isolation barrier and once detonated, they create small holes in the casing and surrounding rock formation. These perforations serve as channels for the fracturing fluid to access the reservoir, initiating the hydraulic fracturing process. Once the hydraulic fracture of the entire wellbore has been completed, and depending on the type of plug selected, the tools can be milled with through tubing intervention milling bottomhole assemblies or will dissolve when exposed to the produced fluids, leaving the fullbore inside diameter of the casing for production.

Plug and Perf Operations offer unparalleled flexibility and precision, allowing operators to control the location and length of fractures. This level of control is crucial for maximizing hydrocarbon recovery and optimizing production rates. The number of perforation clusters, the placement of the plugs, and the design of the hydraulic fracture can be customized to suit the reservoir’s unique characteristics. This adaptability leads to increased efficiency and optimal reservoir drainage.

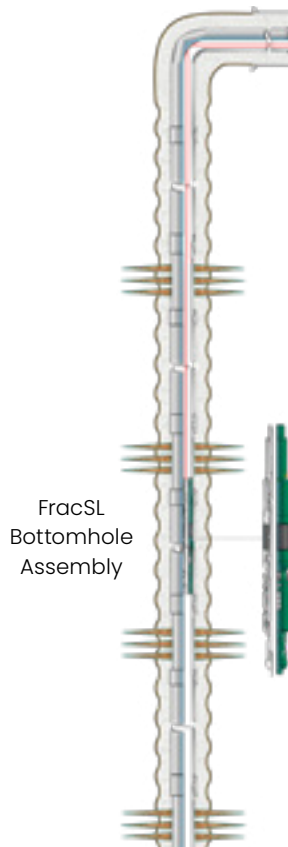
While Plug and Perf operations have proven to be effective in many reservoirs, certain challenges must be addressed. The process is time-consuming, and it involves multiple steps, which can lead to increased operational costs. Moreover, the use of temporary plugs requires precision and can be logistically complex, demanding specialized services in the frac site. Additionally, the effectiveness of the plug and perf operation may vary depending on the reservoir’s geology, stress regime, and rock properties.

One of the significant challenges with Plug and Perf Operations is ensuring the efficient isolation of each section during the fracturing process. If a plug fails to seal correctly, it can result in less effective fractures and reduced hydrocarbon recovery.

After the fracturing process is complete, retrieving the frac plugs and cleaning the wellbore can be time-consuming and costly. Utilizing dissolvable frac plugs or other innovative technologies can streamline this aspect of the operation.

As the plug and perf operation remains a vital technique in the oil and gas industry, contributing to increased production and hydrocarbon recovery rates, Baker Hughes offers solutions for drillable or dissolvable frac and bridge plugs through strategic partnerships which have been extensively qualified according to our internal design criteria.

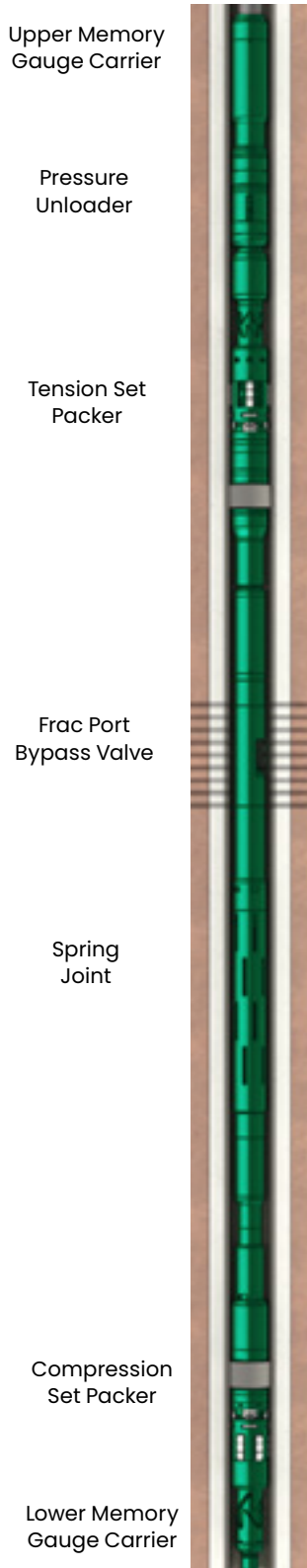
Wireline Conveyed Completions – FracSL Refracturing System



The Baker Hughes Slickline Refrac tool, Frac-SL, utilizes pump down flow rates in combination with a flow baffle feature that allows flow to set a resettable packer. The assembly is deployed via slickline or wireline and enables the well to be stimulated top to bottom in a single trip. The hydraulic fracture program will include pumped diverters at the end of each stage, isolating that stage from the remaining stimulation operation. The assembly will be set, unset, and reset multiple times until all stages are complete, from heel to toe. This unique approach allows a well to be refractured without the need to run new casing or complete costly post frac intervention.

Upon completion of all hydraulic fracturing operations, the tool is designed to allow fluid and debris bypass. This enables the tool to be pulled out of the hole and retrieved at surface. Where the contingency is needed, the tool can be left below the lowest perforations in a sump or retrieved as part of a separate cleanout/fishing trip. Fluid flow can be applied against the tool in conjunction with tension on the cable to detach the bottom hole assembly from a pinned release mechanism, rope socket.

Tubing Conveyed Completions – OptiStriker Straddle Packer System



The OptiStriker™ straddle packer system enables aggressive, targeted restimulation of individual perforation clusters in existing wells to boost production—efficiently and effectively. Unlike other re-stimulation techniques, the OptiStriker system's targeted stimulation technique uses only the amount of fluid and horsepower needed to treat each cluster, minimizing operational requirements and costs by more than 30% compared to other restimulation techniques, such as diverters, expandable liners, plug-and-perf methods, and more traditional coiled tubing (CT) systems.

How the system works

The OptiStriker system features two rugged and resettable coiled tubing (CT) packers, offering an industry-leading pump rate and a differential pressure rating to enable high-rate, high-volume treatments that optimize well restimulations and maximize production.

During cased hole operations, the two packers work in unison to straddle and isolate individual clusters within the wellbore, ensuring that fluids are directed to areas that may have been untreated or undertreated during the initial stimulation.

After the packers are set in the wellbore, a controlled volume of fluid and proppant can be pumped through the CT or workover tubulars and delivered to specific areas, precisely delivering only the prescribed amount of fluid and proppant directly into the intended area. Fluids may enter the formation through the original perforations, or additional perforations can be created using the system's sand-jet perforator, eliminating the need for a dedicated tubing-conveyed-perforating run. This allows the target and delivery of efficient and effective restimulation treatments reliably for maximum ROI without altering your existing completion design.

- Reduce waste and eliminate treatment uncertainty
 - Deliver precise treatment volumes
 - Maximize return-on-investment (ROI)
- Increase treatment effectiveness
 - Large ID and rugged resettable coil tubing packers
 - Enable high rate, high volume treatments
 - Additional perforations can be created with sand-jet perforator, eliminating need for dedicated perforating run.
- Ensure reliable operations
 - Mechanical packers do not rely on applied pressure and only contact casing wall when set
 - High expansion capabilities ensure complete seal, regardless of casing irregularities
 - Circulation ports enable quick and easy cleanouts and recoveries from screen-outs
 - Overcomes deficient annular velocity with debris management

SYSTEMS COMPONENTS

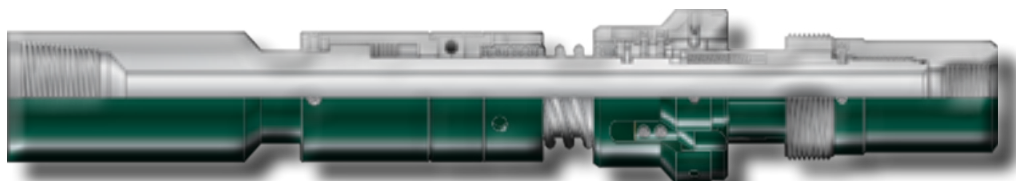
Liner Deployed Completions

Liner Top Options

The multistage liner deployed systems have two configurations for running tools that can be selected based on the application: one for completions that are expected to require consistent rotation during installation, and another for situations in which rotation is minimum or not anticipated. The ability to mechanically or hydraulically release must be taken into account with either running tool configuration.

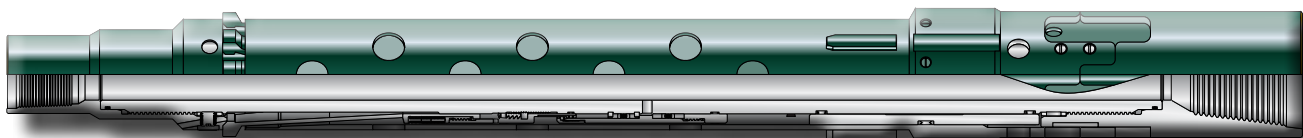
Multistage Completion Installation Using a 2RH Running Tool for Mechanical Release

When rotation of the completion assembly is not expected or the required rotation is minimum, the FracPoint system can be run with the 2RH™ running tool and the hydraulic liner top for mechanically disconnecting from the completion string. This is not the recommended deployment option when the conditions are expected to require rotation during installation.



Multistage Completion Installation Using a HRD-E Running Tool for Hydraulic Release

The FracPoint system is run with the HRD-E™ running tool for hydraulically disconnecting from the completion string when mechanically releasing is difficult, and also for when the conditions are expected to require rotation when the assembly is installed.



Liner Top Equipment: Top Packers and Hangers



Several configurations of liner top packers and hangers are compatible and available to be deployed with a multistage frac system lower completion. The most common are:

FracPoint Hydraulic-Set Casing Packer with FracPoint Setting Sleeve

The FracPoint hydraulic-set packer which is designed for high-pressure and high-tensile forces associated with fracture treatments casing packer is based on the proven Model D permanent packer line. The packer is set in the casing to provide anchoring, sealing, and support for the openhole portion of the system. The FracPoint setting sleeve is attached to the FracPoint hydraulic-set casing packer so that it can be carried in by the setting tool.

Features and Benefits

- High tensile and pressure ratings to withstand forces associated with fracture treatments
- Large bore to provide full-bore access to the liner
- Two opposed sets of full-circle, full-strength slips, to ensure the packer will stay where it is set
- Interlocking, expandable metal back-up rings, contacts the casing and creates a positive barrier to packing element extrusion
- Setting sleeve available with different profile configurations for a variety of setting tools and setting mechanisms.

Conventional Liner Top Packer and Hanger



The Baker Hughes patented ZX™ seal element is recognized industry-wide as today's premier high-performance sealing solution for liner top packers. The innovative ZX™ seal element is constructed to endure exceptionally high circulation rates in demanding wellbore environments. The ZX seal element is available in multiple configurations of liner top packers compatible with multistage frac systems, for example, the ZXP and ZXHD. This line of products are known as the industry leader in annular

Features and Benefits

- Expanded seal technology
- Creates gas-tight annular seal
- Compatible with most wellbore environments
- Bonded ZX seal
- Reduces risk of swab off
- Allows for circulation and displacement of the drilling fluid system prior to mechanically setting the Liner Top Packer

Baker Hughes' broad capabilities for liner hanger products are an industry standard in this space. With a comprehensive suite of systems, including both mechanical and hydraulic options with a broad range of ratings and features, Baker Hughes liner hangers deliver the performance needed, whether you are operating on land, or in the world's deepest HP/HT wells. Flexible, versatile and premium liner hangers options are available to exceed the requirements of any hydraulic fracturing application. Compatible options with a multistage frac system includes the FLEX-LOCK, HCM and Bakerline liner hangers.

Features and Benefits

- Proprietary slip/slip seat design
- Creates lower and more uniform stresses in parent casing
- Eliminates axial load induced radial stresses on the hanger mandrel
- Prevents collapse of the hanger mandrel under heavy loading, dramatically increasing hanging capacity over traditional cone-type hangers
- Protects slips from debris during reaming and drilldown applications
- Premium hydraulic cylinder seals (optional)
- Offer high performance for HP/HT applications

OH FracPoint System Accessories

FracPoint EXPRESS III Ball Activated Frac Sleeve

The Baker Hughes FracPoint™ EXPRESS III frac sleeve makes it possible to fracture horizontal wells in multiple stages and increases the capability of ball-activated multi-stage fracturing systems to over 71 stages for maximum production. The system uses specifically designed swellable or hydraulic-set packers and ball-activated sliding sleeves to isolate stages and enable fracturing of the individual zones. As the ball reaches the sleeve, it shifts open and isolates the previous stage or zone below, exposing a new section of the lateral.

The FracPoint™ EXPRESS III frac sleeve has an integrated body lock ring for maximum assurance that once shifted, the sleeve remains in the open position throughout the stimulation treatment and the lifecycle of the well. The FracPoint™ EXPRESS III frac sleeve has a patented ball and seat interface and employs the unique material properties of the proprietary Baker Hughes disintegrating frac balls.

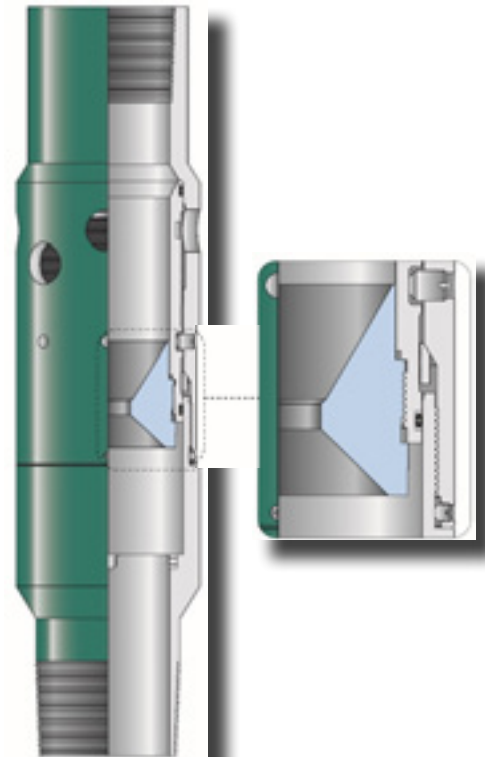
Disintegrating balls are stronger than composite frac balls and can hold pressure without deforming, in an industry-leading number of stages.

Applications

- Uncemented, horizontal, deviated, and vertical wells.
- Zonal Isolation during multi-stage fracturing.
- Isolating acidizing treatments

Features and Benefits

- Ball-activated frac sleeve system
 - Achieves pumping efficiency of frac sleeve system
- Disintegrating frac balls
 - Ensure a clear flow path without the need for milling
- Patented ball and seat combination
 - Eliminates extrusion with specially designed ball and seat interface
 - Allows for higher pressure rating
- Up to 13,000 psi burst at 350°F rating
 - Wide range of pressure and temperature conditions.
- Available in premium thread configurations
- Insert locks in open position
 - Internal Body Lock Ring ensures that sleeve will stay in the open position for the life of the well.
- Internal anti-rotation mechanism
 - Ensures that the ball seat will not rotate in case of a millout.
- Millable ball seats
 - Manufactured from an easy to mill cast iron alloy to facilitate the milling.



SYSTEM COMPONENTS

FRACPOINT EXTREME BALL ACTIVATED FRAC SLEEVE

The effectiveness of the fracture operation is often restricted by the pressure rating of the frac tools. This is especially true in extremely tight formations where pressures exceed 10,000 psi to perform the frac job. As wells continue to be drilled deeper, longer and in more challenging formations, high-performance completions technologies are critical to maximize stimulation efficiency and production.

The Baker Hughes FracPoint™ EXTREME ball-activated frac sleeve provides a fit-for-purpose engineered frac sleeve capable of withstanding extremely high pressures during hydraulic fractures. Built on industry-leading technologies, the FracPoint EXTREME frac sleeve maximizes completion flexibility with high stage count options at pressures up to 15,000 psi. The system uses a patented ball-and-seat interface to withstand this high-pressure rating and is compatible with dissolvable frac balls to open the sleeves, eliminating the need for ball flow back and related operational time and risks.

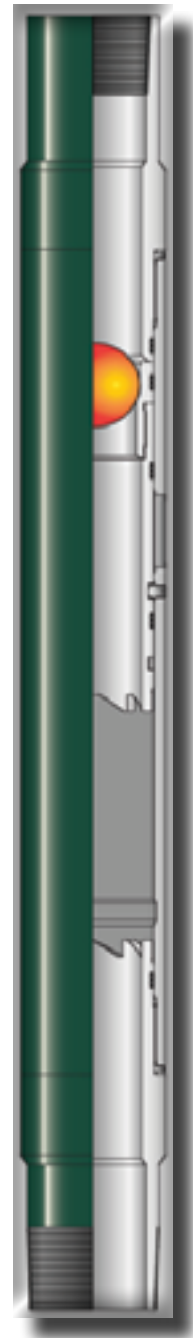
Dissolvable balls are stronger than composite frac balls and can hold pressure without deforming in an industry-leading number of stages. As the ball reaches the sleeve, it shifts open and isolates the previous stage or zone below, exposing a new section of the lateral. The sleeve features a locking mechanism to ensure it remains open throughout the entire treatment. The sleeve's easy-to-mill ball seat also offers an anti-rotational feature that allows for efficient removal, if required.

Applications

- Uncemented horizontal, deviated, and vertical wells
- Open Hole or cemented multi-stage completions
- Extremely tight formations
- Extended-reach laterals
- High pressure hydraulic fracturing
- Isolating proppant or chemical treatments
- Stimulating sandstone, carbonate and shale plays

Features and Benefits

- Optimizes pumping efficiency of frac sleeve system
- Increase frac performance in extremely tight formations
- Eliminates extrusion with specially designed ball and seat interface
- Increase stimulation efficiency with industry-leading stage count capabilities
- Enables optimal setting depth with the ability to rotate and withstands high circulation rates through the sleeve during deployment
- Reduces risk of washouts through frac ports with greater flow area than the casing string
- Achieve first oil sooner with dissolvable frac ball options



FRACPOINT CMB II RECLOSABLE FRAC SLEEVE

The FracPoint™ CMB II reclosable frac sleeve enables selective multistage stimulation and post frac zonal isolation by reclosing the selected zones. Built on industry-leading technologies, the FracPoint CMB II frac sleeves maximizes multistage completion flexibility with high stage count options at higher pressures ratings. The CMB II maintains all the advantages of the FracPoint frac sleeves family with the added ability to selectively close frac sleeves after stimulation in order to shut off production from particular zones.

The CMB II uses the Baker Hughes proprietary CM™, high strength, non-elastomeric seal compounds that are chemically inert and stronger than any commercially available seal technologies. The CMB II also incorporates a diffuser ring made of high-strength thermoplastic, placed between the frac ports and the upper packing unit, to prevent damaging the packing unit due to the sudden rush of fluids or gas during the opening sequence of the tool.

This robust seal stack configuration allows the CMB II reclosable frac sleeve to withstand high pressure differential up to 15,000 psi providing a reliable seal after closing the sleeve more than 30 times. The CMB II reclosable frac sleeve is available in two versions:

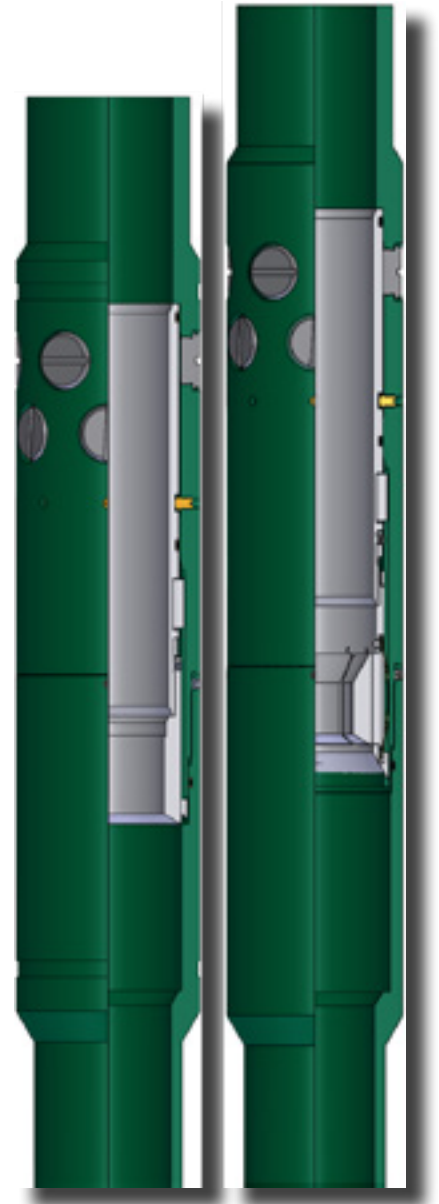
- Initial ball activation with mechanical multi-shift open and close cycles – the sleeve incorporates an internal ball seat that can be easily milled out, allowing the sleeve to be shifted multiple times on slickline, coiled tubing, or stick pipe using industry-standard shifting tools.
- Fully mechanical multi-shift open and close cycles – the sleeve can be shifted multiple times on slickline, coiled tubing, or stick pipe using industry-standard shifting tools.

Applications

- Multistage completions requiring hydraulic fracturing using acid or proppant
- Long string or liner completions in vertical, deviated, or horizontal wells for cemented and uncemented applications
- Water production elimination
- Hydraulic re-fracturing operations

Features and Benefits

- Ball-activated completion design – Enables non-stop fracturing treatment with ball-activation
- Ability to selectively mechanically open and close sleeves
 - Isolate zones after stimulation to eliminate water production
 - Facilitates refracturing operations by allowing isolation of previously stimulated zones
- Disintegrating frac balls – Dissolve in the well to enable unobstructed production without intervention
- High pressure rated seal stack is manufactured from proprietary, high-strength, non-elastomeric compounds that are chemically inert and 30% stronger than commercially available materials
- Specially designed diffuser ring made of high-strength thermoplastic is critically spaced between the flow ports and the packing unit
 - Prevents damage to the upper packing unit during shifting by controlling the rush of fluid or gas across the seals, enabling slow equalization of high differentials



FRACPOINT SAND CONTROL

High pressure stimulation of tight formations is occasionally combined with flowback of proppant and formation sand during the onset of production. This is generally attributed to the characteristics of unconsolidated formations and their response to high pressure hydraulic stimulation.

The Baker Hughes FracPoint™ Sand Control system helps our customers to overcome these challenges by offering a fit-for-purpose engineered solution that combines the superior operational efficiency of ball activated frac sleeves with the effective sand control of multi-membrane filtration sand screens. This combination of technologies delivers a robust completion design and a unique intervention-less solution to enable the stimulation at high pressure and provide sand exclusion on production.

The system comprises of a series of incrementally sized high strength disintegrating frac balls to open and close stimulation frac sleeves while simultaneously also opening sand control production sleeves. The design allows for several sand control production sleeves in one stage to maximize reservoir contact for unrestricted production. The system allows to efficiently complete the frac treatment and start sand-free production of the well without any intermediate manipulation of downhole tools with coiled tubing or wireline, reducing the overall completion costs and operating expenditures of the project.

Features and Benefits

- Allows to stimulate and produce from extremely tight unconsolidated formations
- Enables HPHT completion construction with 15,000 psi pressure rating
- Effective sand control with conventional multi-membrane filtration sand screens
- Intervention-less system, no Wireline or Coiled Tubing during stimulation and initial production
 - One ball size to open Frac Sleeve and a second ball size to open one or more Sand Control Production Sleeves and close the Frac Sleeve of the corresponding stage.
- Sand Control Production Sleeves are isolated from frac fluid/pressures until opened and are never subject to differential unloading, even when initiating production
 - The system allows to install multiple sand control production sleeves per stage, all opened with a single ball size.
- Provides the ability to selectively close the sand control production sleeves to shut off water production
- Modular system can be deployed with hydraulic packers or swell packers
- Rotational capability to overcome hole restriction or ledges during deployment
- High circulation rate limits to allow conditioning of the well and displace settled solids or cuttings to prevent screen plugging during production.



DeepFrac Deepwater MultiStage fracturing System

DEEPFRAC™ is a deepwater multistage fracturing service leveraging tools and techniques perfected in unconventional land applications to help revolutionize the efficiency—and the economics—of offshore completions. The Deepfrac deepwater multistage fracturing system is a frac sleeve is designed with two (2) inner sleeves, the lower one, a stimulation sleeve and the upper inner sleeve, a flow back control sleeve.

The DeepFrac™ deepwater multistage fracturing system allows a highly modular frac treatment of 20+ stages while eliminating proppant flow back during production. It provides all of the flexibility and efficiency of openhole unconventional frac systems with the added benefit of maintaining proppant control at the reservoir.

A frac ball is dropped at surface and shifts open the stimulation sleeve, isolating the previous stage below and exposing a new section of formation for stimulation. Once the stimulation of the zone is completed, a second ball is then dropped to shift the flow back control sleeve located in the same chassis, closing the stimulation ports. This operation allows communication with the formation, controlled proppant flow back and production using the BeadScreen™ bonded-bead flowback control media. The service simplifies operations, accelerates completion times, and enables rapid stimulation of 20+ stages in a single trip.

Features and Benefits

- Ball-activated completion design
- Enables nonstop fracturing treatment
- Eliminates need for coiled tubing and wireline operations during the frac job – Allows for up to 20 stages
- Integrated Stimulation and Flowback Control
- Shut off stimulation sleeve and use BeadScreen™ bonded-bead flowback control media for production
- IN-Tallic frac balls
- Disintegrate in the well to enable unobstructed production without through-tubing intervention.



FracPoint Pressure Actuated Toe Sleeve (P-Sleeve)

The Pressure-Actuated Sleeve (P-Sleeve) allows for interventionless formation access in open hole completions through applied tubing pressure, and can be used as the first stage during hydraulic fracturing stimulation.

Prior to initiating fracturing of the first stage in the FracPoint™ Open Hole System, a closed completion string prevents communication between the tubing and the open hole annulus. Therefore, a ball cannot be circulated down to actuate equipment but, but pressure can be applied from surface.

The P-Sleeve contains an internal unbalanced piston, where the cross-sectional area at the top of the piston is larger than the cross-sectional area below the piston. Applying pressure to the completion string creates a net downward force on the P-Sleeve's internal sleeve. At a predetermined differential pressure, a set of shear screws shears, and the internal sleeve shifts downward, uncovering frac ports and establishing communication between the completion string and the formation. The first fracturing stage can now commence, as well as circulation of the first frac ball to the lowermost frac sleeve.

Features and Benefits

- Actuated by applying tubing pressure on an internal piston area
 - Enables interventionless formation access to begin hydraulic fracturing operations or circulate down the first frac ball
 - Allows for an additional frac stage without a dedicated ball seat size
- Increased flow area
 - Frac ports have twice the flow area of the frac string to reduce the possibility of washouts
- Internal locking ring
 - Holds the sleeve permanently in the open position once shifted open



FracPoint Wellbore Isolation Valve

The FracPoint™ Wellbore Isolation Valve (WIV) is a ball-activated closeable circulation valve. The valve is placed at the bottom of the completion string and is run into the well in the open position so circulation can take place while the system is installed. An internal micro-annulus allows for communication in the open position, but is shut off once the internal sleeve shifts into the closed position.

After the completion system is in place, a ball is circulated down to the integral ball seat in the valve and a predetermined pressure is applied from surface to shift the valve into the closed position, thus isolating the tubing from the annulus. Pressure can now be applied in the tubing to actuate hydraulic equipment, such as open hole packers, casing packers, liner hangers and inflow control devices with multi-tasking valves.

Features and Benefits

- Ball-activated closure mechanism – Allows circulation while running in hole until an activation ball is circulated down to the internal ball seat and shifts the valve closed
- Internal locking ring – Permanently locks the tool in the closed position once closed
- Internal secondary sealing system – Eliminates the risk of fluid loss or pressure communication between tubing and annulus after valve has shifted closed
- High torque rating – Allows for drill down capabilities



Cemented MultiPoint System Accessories– MultiPoint Ball Activated Frac Sleeves

The MultiPoint (MP) sleeve system for cemented applications enables the use of cement to provide annular isolation between the completion and the reservoir, while providing the fracturing efficiency of ball-activated frac sleeves. It uses different size ball and ball seat increments to open up to five sleeves in a stage with just one frac ball. Each stage contains a pre-determined number of sleeves with segmented ball seats and a final sleeve with a hard seat that stops the ball at the bottom of the stage, providing isolation from the previous stage.

When the frac ball engages the segmented ball seat, hydraulic pressure opens the sleeve. The ball seat expands, and the ball passes through to the next ball seat. After the ball has opened all segmented sleeves in the stage, it lands on a hard seat in the final lowermost sleeve. Fluid pressure is then increased to treatment levels and the formation is fractured through the opened sleeves without any need for through-tubing operation to perform the frac job.

MP sleeves mimic the multiple cluster perforation configurations and the use of cement isolation often used in plug-and-perf-style completions. The ball seats do not restrict production, which means through-tubing intervention is not required after the frac job.

Features and Benefits

- Ball-activated completion design
 - Allows the use of cement to isolate the annulus
 - Enables nonstop fracturing treatment with ball-activation
 - Eliminates need for coiled tubing and wireline operations during the frac job
 - Eliminates through-tubing intervention after treatment
- Segmented ball seat design
 - Uses one frac ball to open up to five sleeves
 - Mimics multiple cluster perforations by opening and fracturing through multiple sleeves simultaneously
- Customizable frac port nozzle flow area for jetting or limited entry design
- Erosion resistant frac nozzles
- IN-Tallic frac balls
 - Disintegrate in the well to enable unobstructed production without through-tubing intervention



MultiPoint EXTREME Frac Sleeve

The MultiPoint EXTREME frac sleeve provides the ability to fracture extremely tight formations up to 15,000psi through multiple entry points simultaneously. Based on the design of proven MultiPoint sleeves, the high pressure rated MP EXTREME allows to install multiple sleeves in the target zone and open them all with the same size of frac ball. This technique mimics the multi-cluster approach from the plug-and-perf, with the added efficiency of a ball actuated completion, allowing the operators to perform a continuous pumping stimulation throughout the well, overall reducing the time spent treating the formation, cost and risk associated with well intervention and simultaneous operations.

Like its predecessor, the MP EXTREME uses graduated segmented and hard seat sleeves to communicate with the formation. A single ball is launched and displaced to the target zone, and when it lands on the first segmented seat sleeve and opens it, the ball seat mechanism expands allowing the ball to be displaced downhole to open the subsequent sleeves. When the ball lands on the hard seat sleeve of the stage and opens it, it provides isolation from the previous stage and diverts the new stimulation to all the frac ports of the opened sleeves uphole.

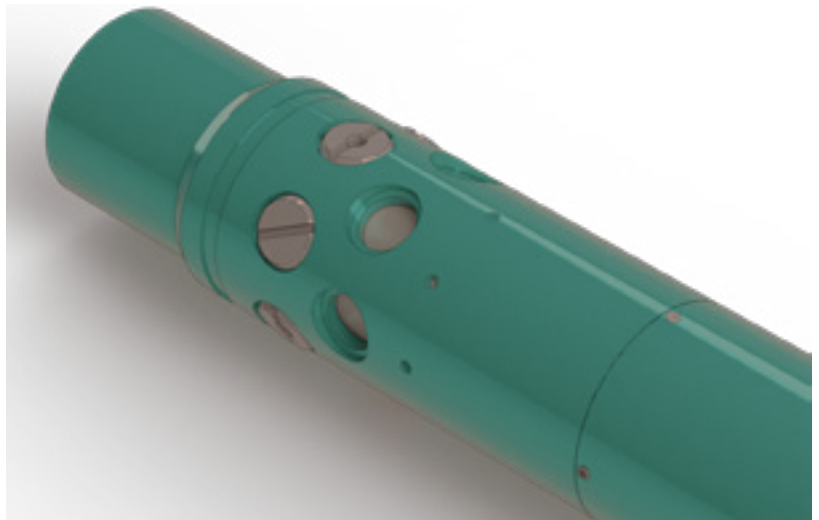
The system uses a patented ball and seat interface to withstand this high-pressure rating and it is compatible with dissolvable frac balls to open the sleeves, which eliminates the need for ball flow back and related operational time and risks.

Dissolvable balls are stronger than composite frac balls and can hold pressure without deforming, in an industry-leading number of stages. As the ball reaches the sleeve, it shifts open and isolates the previous stage or zone below, exposing a new section of the lateral.

The sleeve features a locking mechanism to ensure it remains open throughout the entire treatment. The sleeve's easy-to-mill ball seats offer an anti-rotational feature that allows for efficient removal, if required.

Features and Benefits

- Up to 15,000-psi burst at 350°F rating
 - Allows for a wide range of pressure and temperature conditions.
- Up 15,000-psi ball on ball seat rating
 - Allows for high pressure fracturing operations.
- Provides the ability to stimulate the formation through multiple entry points simultaneously
- Customizable frac port nozzle flow area for jetting or limited entry design
- Erosion resistant frac nozzles
- Available in premium thread configurations
 - Easily manufactured to customer requirements.
- Insert locks in open position
 - Ensures that sleeve will stay in the open position for the life of the well.
- Available in standard or sour service versions
 - Offering a wider range of configurations to satisfy operator's well conditions.
- Anti-rotation mechanism
 - Ensures that the ball seat will not rotate in case of a millout.



ALPHA Pressure Actuated Toe Sleeve

The Baker Hughes Adjustable Alpha Sleeve Pressure-Actuated Toe Sleeve provides intervention-less access to the formation for pump-down operations or the first stage of hydraulic fracturing. Ideal applications are cemented or uncemented plug-and-perf and frac sleeve completions, as both completions methods required access to the formation in order to pump down a frac ball, frac plug or coiled tubing assembly. Using the Alpha Sleeve eliminates the need for a dedicated tubing conveyed perforation trip or a wet shoe. Activation of the sleeve is achieved through applied pressure at surface. Applied pressure acts on a frangible trigger device that, when activated, floods the sleeves' internal drive chamber and shifts the sleeve open.

Applications

- Unconventional reservoirs
- Cemented or uncemented applications
- Long string or liner completions in horizontal, deviated or vertical wells
- Plug-and-perf or frac sleeves completions
- Proppant or acid hydraulic fracturing

Features and Benefits

- Intervention-less access to the formation
- Accurately controlled actuation device
- Anti pre-opening features - Pressure balanced inner sleeve that shifts 'up' to open
- Cement resistant design - Special material coating and lubricant, Redundant actuation mechanism.
- Locks in the open position - Internal lock ring holds the inner sleeve permanently in the open position after actuation
- Available with integrated ball seat for casing test up to 12,500 psi using a disintegrating ball
- Large flow area through the open frac ports ensures high debris tolerance and a low pressure drop

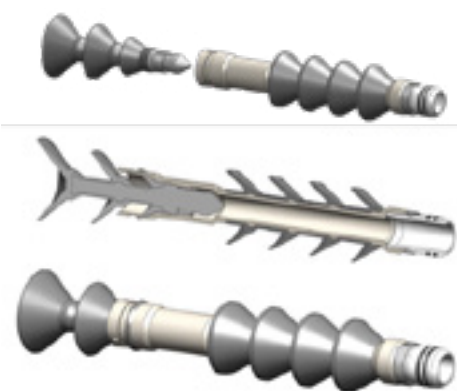


Cementing Accessories

The Alpha Wiper Plug (AWP) wipes the casing of a long string or liner completion clean from cement, while also lands, latches and seals in the Alpha Landing Collar (ALC). The AWP and ALC system is used together with the Alpha pressure actuated toe sleeve to provide a redundant pressure seal above the shoetrack when opening the Alpha Sleeve from surface, in the event the shoetrack cement does not have the required competence to hold pressure. The AWP and ALC can also be used without the Alpha Sleeve, as a standalone system.

The ALC is installed in the casing above the float equipment, and acts as a no-go for the AWP. It includes a seat, matching the AWP nose profile. Upon latching in the ALC, a threaded latch ring on the AWP nose profile engages the ALC seat, mechanically locking it in place. Simultaneously, the seal on the AWP nose profile engages the seal surface in the seat, creating a pressure seal from above and below.

The ALC comes in two variations, Type 1 and Type 2. The Type 1 is the standard version and contains the seat for the AWP. The Type 2 also includes the seat for the AWP, and in addition an integrated shear-out ball seat with retaining pins (baffle). The ALC Type 2 enables activation of hydraulic equipment such as a liner hanger by circulating down a setting ball from surface to the ALC Type 2 ball seat.



Dissolvable Frac Balls

The Baker Hughes' disintegrating balls are composed of nanostructured material that is lighter than aluminum and stronger than some mild steels, and disintegrates when exposed to an appropriate fluid. The disintegration process works through electrochemical reactions that are controlled by nanoscale coatings within the composite grain structure. The nanomatrix of the material is high strength and has unique chemical properties that conventional materials do not.

The disintegrating balls maintain shape and strength during the hydraulic fracturing treatment and then disintegrate before or shortly after the well is put on production. The balls disintegrate over time by exposure to the ions in brine fluids, so the disintegration occurs with most fracturing and wellbore fluids, meaning no special activation fluid is required.

The rate of disintegration depends on temperature and the concentration of the ions. Acids disintegrate the balls at a much higher rate, in a chemical reaction that is independent of temperature. This enables the option to pump acid on the ball after completing the hydraulic fracturing operation, in order to significantly speed up the disintegration process.

Applications

- Completions utilizing disintegrating frac plugs or ball-actuated frac sleeves for multistage hydraulic fracturing
- Proppant or acid hydraulic fracturing
- Pressure testing casing using ball seat sub and disintegrating ball

Features and Benefits

- Disintegrates in brine, a common frac and formation fluid
 - Requires no special fluid or intervention to remove the balls
 - Prevents balls from being trapped on the ball seat by differential pressure, blocking production from stages below
 - Prevents balls from piling up in the low point of the well and choking or blocking production.
- Lighter than Aluminum
- Stronger than some mild steel, resulting in increased ball-on-seat pressure rating compared to composite materials



OPTISELECT System Accessories–OPTISELECT Frac Sleeves Sleeve and Bottomhole Assembly

The OPTISELECT coiled tubing actuated frac system from Baker Hughes, delivers targeted stimulation treatments for a nearly unlimited number of stages with efficiency and ease, to help operators control costs and improve production potential in unconventional wells. The OPTISELECT features reclosable multi-shift sleeves and a robust, resettable bottom-hole assembly (BHA), which includes an annular packer and shifting mechanism, to not only deliver a flawless fracturing operation, but also enable operators to open and close the sleeves as needed over the life of the well.

Unlike other coiled tubing (CT) fracturing systems, the OPTISELECT BHA uses industry-proven B™ shifting keys—built on decades of reliable and repeatable downhole shifting success—to open and close the sleeves. The integrated locating and shifting feature of the BHA only requires mechanical motion, omitting the need for hydraulic pumping at surface to help operators reduce water usage and heating costs. Weight indications will be seen when the sleeves are moved up or down. Confirmation of a shift occurs by passing the keys through the sleeve a second time. When properly shifted, no weight fluctuations are seen on surface as the keys pass through the sleeve. This ensures proper BHA spacing and depth throughout operations, enabling uninterrupted fracturing from toe to heel.

The OPTISELECT sleeves offer added operational flexibility because they can be opened and closed over the life of the well. This enables operators to close sleeves to shut off non-productive or water bearing stages, close and re-open sleeves to selectively stimulate stages, or close sleeves after fracturing to allow the formation to heal while the remaining fracs are completed.

Simplified operations

After the OPTISELECT sleeves have been installed, the OPTISELECT BHA is run in hole to actuate the sleeves and to isolate the stages. The BHA is robust and can withstand annular flow rates up to 12 bbl/min (2 m³/min), making it ideal for extended-reach applications where tools may need to be pumped down to bottom. Once the BHA locates and shifts a sleeve to the open position, it moves below the frac ports and sets via a small compressive force to isolate the stage. The stimulation treatment is delivered, and the packer is released and moved uphole to the next sleeve. The process is repeated for each stage. The BHA design utilizes a four-position J-slot operation to decrease CT cycling requirements, reducing overall CT costs and time. If the sleeves are desired to be closed after each stage, a standard Otis B shifting tool can be run below with keys having only the closing profile.

Data-driven optimizations

A circulation sub with customized flow nozzles is positioned directly above the BHA to circulate out any sand that settles on or around it, helping to ensure reliable packer release. The circulation sub also enables real-time bottom-hole pressure monitoring, so treatments can be adjusted on-the fly and premature screen-outs can be avoided. If a screen-out occurs, the sand can be circulated out by simply pumping down through the CT, significantly reducing NPT.

In addition to delivering real-time pressure data, the OPTISELECT BHA can also collect pressure and temperature data during treatments by installing memory gauges above and below the isolation packer. This data can be used to conduct post-treatment analysis on stimulation effectiveness, to help customers optimize future jobs and evaluate re-stimulation potential.



OPTISELECT System Accessories–OPTISELECT Frac Sleeves Sleeve and Bottomhole Assembly (Cont.)

Increased production potential

Because the OPTISELECT sleeves have no inside diameter (ID) restrictions, poststimulation milling is not required for production to begin. This also helps to simplify future access. And, if additional reservoir access is needed after the sleeves have been installed, the circulation sub can perform abrasive jetting to establish additional reservoir entry points along the well.

Features and Benefits

- Enables treatment to a nearly unlimited number of stages
- Reduces water usage with fully mechanical manipulation to locate and shift sleeves
- Features open-frac-close ability in all sleeve sizes
- Reduces CT cycle requirements and associated costs
- Recovers quickly from screen-outs
- Eliminates ID restrictions
- Special engineered seal technology to guarantee pressure integrity after multiple open and close cycles
- Industry-proven B™ shifting profiles and matching keys – fully mechanical operation, no flow required to activate shifting keys. Shifting keys work independently of each other, enabling operation even in the presence of debris
- Optional robust dual shifting tool BHA to manipulate the sleeves and deliver the stimulation treatment without the isolation packer.

Limited Entry Liners–Salinity Insensitive Metallic Barrier Assembly (SIMBA)

The Salinity insensitive metallic barrier Assembly was designed to economically optimize stimulation treatment and production in limited entry liners deployed in carbonate formations, or any formations requiring acid or chemical treatments. The assembly offers a high pressure, high temperature (HPHT) nozzle that is mounted in the base pipe. Its liner can be deployed conventionally, allowing circulation during the deployment down to the liner toe. This eliminates the need to run an inner string of pipe inside the liner string, saving rig time and associated costs during installation.

Multiple assemblies can be installed in a casing joint and will initially hold pressure between the tubing and the annulus during the deployment of the liner. Following a controlled time, they will then open up to allow pressure communication via the nozzle. The body of the assembly provides a metal-to-metal seal with the base pipe improving the pressure integrity of the liner string. This eliminates the need for an elastomeric compound because the seal mechanism is in the assembly.

The assembly is initially plugged with IN-Tallic Damorphe, a proprietary salinity insensitive dissolvable alloy. The IN-Tallic Damorphe dissolvable alloy is completely inert when exposed to reservoir drilling fluids (non-aqueous fluids) so the liner can be deployed safely to the bottom of the well. This eliminates the risk of premature degradation or corrosion of the dissolvable alloy and provides pressure integrity in the liner string during the operation. The IN-Tallic Damorphe dissolvable plug in the assembly also offers superior thermal stability versus any polymeric-molded plug available in the market, providing longer lasting seal integrity in extended reach laterals wells.



Once the liner is at planned setting depth, the reactivity of the IN-Tallic Damorphe can be triggered by spotting a wide variety of common completion brines, thus dissolving the material and allowing casing communication with the formation in a consistent and repeatable time window. Once the IN-Tallic Damorphe plug has dissolved, the stimulation treatment can be pumped through the assembly.

The patented internal venturi shape geometry of the assembly has been engineered to improve flow performance compared to a conventional nozzle. Its unique shape ensure maximized flow velocity at all pumping rates, delivering an efficient stimulation treatment with less overall horsepower utilization. This also enables maximized fluid formation impact to establish ideal cavity formation. After the stimulation treatment has been completed, the well is put back on production through the multiple assemblies.

Wireline Conveyed Completions–ASTRA HPHT Frac / Bridge Plug

HPHT (ASTRA) Millable Plug is a drillable plug designed to withstand the rigors of a high-pressure / high-temperature fracture operation in a harsh environment. After operations are completed, the plug can be quickly removed with conventional milling tools. The ASTRA™ HPHT Plug enables the operator to isolate several zones in a well, independently treat or test each zone, and then remove the plugs in an underbalanced environment in one trip. The plug includes features to enable field redress from a single-direction, ball-sealed plug to a bi-directional bridge plug. The underbalanced removal is typically accomplished with coiled tubing deployed downhole motors and milling tools.

The ASTRA™ HPHT Plug is set like conventional frac plugs utilizing the E-4™ wireline pressure setting assembly. The plug may also be deployed on coiled tubing or pipe and set hydraulically with the J™ hydraulic setting tool. The HPHT Plug utilizes an aluminum or dissolvable ball to isolate the zones below the plug from the stimulation or treatment applications occurring above. The plug can be run with the ball on seat, or the ball can be dropped prior to the frac job. Once the ball is dropped, this plug will provide isolation whenever the pressure above the tool is greater than the pressure below the tool. Comingled testing and production of zones both above and below the tool can occur once a higher-pressure differential from below is established. The operator can independently treat or test each zone. The plug may also be run converted to a bridge plug, holding pressure from above and below.

Features and Benefits

- High pressure, high temperature
 - The HPHT plug is capable of withstanding differential pressures of 15,000 psi from above in combination with 350°F. When configured as a bridge plug, the plug is also capable of withstanding differential pressures of 12,500 psi from below.
- Acid resistant
 - The plug may be coated with an acid resistant coating to protect the plug during chemical treatments.
- Ball-drop, ball-on-seat, and bridge plug configurations available
 - Each plug can easily be configured to be run with a ball that is dropped from surfaced for isolation or with a ball caged on seat to allow flowback while eliminating the need for ball pump down, or as a bridge plug that holds differential pressure from both directions.
- Robust, easy-to-mill:
 - The HPHT plug is constructed out of a high-performing, drillable aluminum alloy with material properties that are suited for easy removal. In addition to the millable material, the HPHT plug was specifically designed to be effectively milled out. The clutching feature from the mandrel to the wedge in the bottom, the cone slots to prevent rotating, and the direction of the Body Lock Ring threads proved beneficial to mill-out.



Composite Plugs Strategic Partnerships

Composite frac plugs are devices utilized to divert hydraulic fracturing treatments in unconventional, multistage completions. The plugs are activated by deploying a ball to seat in the plug to divert the hydraulic fracturing treatment to the zone located above the plug. Composite frac plugs can be deployed on either wireline or coiled tubing. The operator can independently treat each zone and then remove the plugs in an underbalanced environment. The underbalanced removal typically occurs on coiled tubing or threaded pipe with downhole hydraulically activated mud motors and milling tools. As the plug and perf operation remains a vital technique in the oil and gas industry, contributing to increased production and hydrocarbon recovery rates, Baker Hughes offers solutions for drillable or dissolvable frac and bridge plugs through strategic partnerships which have been extensively qualified according to our internal design criteria.



Tubing Conveyed Completions–OptiStriker Straddle Packer System

The OptiStriker™ straddle packer system enables aggressive, targeted restimulation of individual perforation clusters in existing wells to boost production—efficiently and effectively. Unlike other re-stimulation techniques, the OptiStriker system's targeted stimulation technique uses only the amount of fluid and horsepower needed to treat each cluster, minimizing operational requirements and costs by more than 30% compared to other restimulation techniques, such as diverters, expandable liners, plug-and-perf methods, and more traditional coiled tubing (CT) systems.

Reduce waste and eliminate treatment uncertainty

During well re-stimulations, you can waste a lot of time and money if you don't know where your treatments are going. The OptiStriker system offers a reliable CT straddle packer system to deliver precise treatment volumes—exactly where you want them to go—reducing waste and increasing the effectiveness of your restimulations for maximum return-on-investment (ROI). The OptiStriker system is also commonly run on 2 3/8 in. or 2 7/8 in. tubing strings.

Increase treatment effectiveness

The OptiStriker system features a large inside diameter (ID) and two rugged and resettable coiled tubing (CT) packers, offering an industry-leading pump rate of 20 barrels per minute (bbl/min) and a differential pressure rating of 10,000 psi (689 bar) to enable high-rate, high-volume treatments that optimize well restimulations and maximize production.

During cased hole operations, the two packers work in unison to straddle and isolate individual clusters within the wellbore, ensuring that fluids are directed to areas that may have been untreated or undertreated during the initial stimulation.

After the packers are set in the wellbore, a controlled volume of fluid and proppant can be pumped through the CT or workover tubulars and delivered to specific areas, precisely delivering only the prescribed amount of fluid and proppant directly into the intended area.

Fluids may enter the formation through the original perforations, or additional perforations can be created using the system's sand-jet perforator, eliminating the need for a dedicated tubing-conveyed-perforating run. This allows the target and delivery of efficient and effective restimulation treatments reliably for maximum ROI without altering your existing completion design.

Ensure reliable operations

Unlike other targeted stimulation systems that use swab cups to isolate zones, the OptiStriker system is the industry's first fully mechanical straddle system enabling operations in virtually all well conditions. The mechanical packers do not rely on applied pressure for activation—they only contact the casing wall when they are set. This prolongs system life by eliminating damage and wear caused by rubbing against the casing wall as the assembly is moved in the well.

High-expansion capabilities ensure the packers establish a complete seal—regardless of erosion damage from previous operations or casing irregularities, enabling higher treatment pressures and eliminating fluid leak-off. Risks associated with plugged hydraulic conduits are eliminated because the packers are actuated and released using only linear movement. Circulation ports above the bottom packer enable quick and easy cleanouts and prevent the system from becoming stuck in the hole.

Upper Memory
Gauge Carrier

Pressure
Unloader

Tension Set
Packer

Frac Port
Bypass Valve

Spring Joint

Circulation Sub

Compression Set
Packer

Lower Memory
Gauge Carrier



Tubing Conveyed Completions–OptiStriker Straddle Packer System– (cont)

In cases where damage to the casing or OptiStriker system occur, the BHA incorporates a shear-out contingency release system to remove the top packer slips enabling easy retrieval with standard fishing tools. Since the mechanical packers were designed to reliably set and unset numerous times, elastometer wear that is seen with cup style packers is eliminated, increasing system reliability and the number of sets that can be achieved in one run. This process allows the system to be operated safely even at low bottomhole pressures.

CT packers also offer easy circulation and wellbore cleanouts, enabling quick recoveries from screenouts. When the near wellbore requires cleaning to enhance conductivity, acid can be spotted via the CT and treatments can be pumped through it, enabling wellbore treatment—even when— casing integrity is a challenge.

Because the entire OptiStriker system is removed after operations are complete, original production ID is maintained, simplifying future access. When combined with Baker Hughes EasyReach™ lubricant, which reduces the coefficient of friction in cased hole wells, horizontal reach capabilities almost double—making successful CT applications in lateral lengths greater than 10,000 ft (3,048 m) routine.

- Upper Memory Gauge Carrier
 - Carries 2x 0.5" OD memory gauge probes that record pressure and temperature.
 - Enables recording P&T above the straddle section.
 - One gauge for external data (backside of tubing)
 - One gauge for internal data (inside of tubing)
 - Gauge data is downloaded post-job.
- Pressure Unloader
 - Acts as an equalizing valve and circulation point above the straddle section.
 - 3,000 lbf actuation force.
 - Apply tension to close it.
 - Apply compression to open it.
- Tension Set Packer
 - Pump-through Mechanical-set packer
 - Activates on Tension with 3,000 lbs. actuation force
 - 5-1/2": 10k psi rating at 200F
 - 4-1/2": 8K psi rating at 200F
 - Continuous J-track with 6 positions
 - Includes Emergency Shear Disconnect (straight pul
- Frac Port Bypass Valve
 - Enables pumping stimulation fluid out of the string.
 - Frac port opens when tool is compressed (set).
 - Frac port closes and bypass opens to bottom when unset.
 - Additional straddle length is achieved by adding tubing under this assembly.
- Slip Joint Spring
 - Enables operation of tension set and compression set packers on the same string.
 - Keeps weight on compression packer while allowing tension to be applied on the tension set packer.
 - Allows fluid to pass through for clean outs.
 - Requires up to 3,500 lbf and downward travel of 3 feet.
- Circulation Ported Sub
 - Enables circulation above OptiPacker for cleanouts when frac port is set to bypass mode.
- OptiPacker
 - Mechanical-set packer
 - Activates on Compression with 1,500 lbf actuation force
 - Continuous J-track with 4 positions
 - RIH-POOH-SET-POOH
 - Built in unloader for pressure equalization.
- EasyTag Casing Collar Locator
 - Enables depth correlation with casing tally.
 - Locates casing collars through weight indication.
 - Provides 2-5k lbf over pick up weight on coiled tubing.
 - Provides 2-10k lbf over pick up weight on stick pipe.
- Lower Memory Gauge Carrier
 - Records pressure and temperature below the straddle section.
 - Carries 1x 3/4" OD memory gauge.



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