TEMPRESS®

Through-Tubing Well Intervention Tools

Hot, Deep, Extreme Reach and Depleted Well Solutions

Tempress Technologies

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TEMPRESS®

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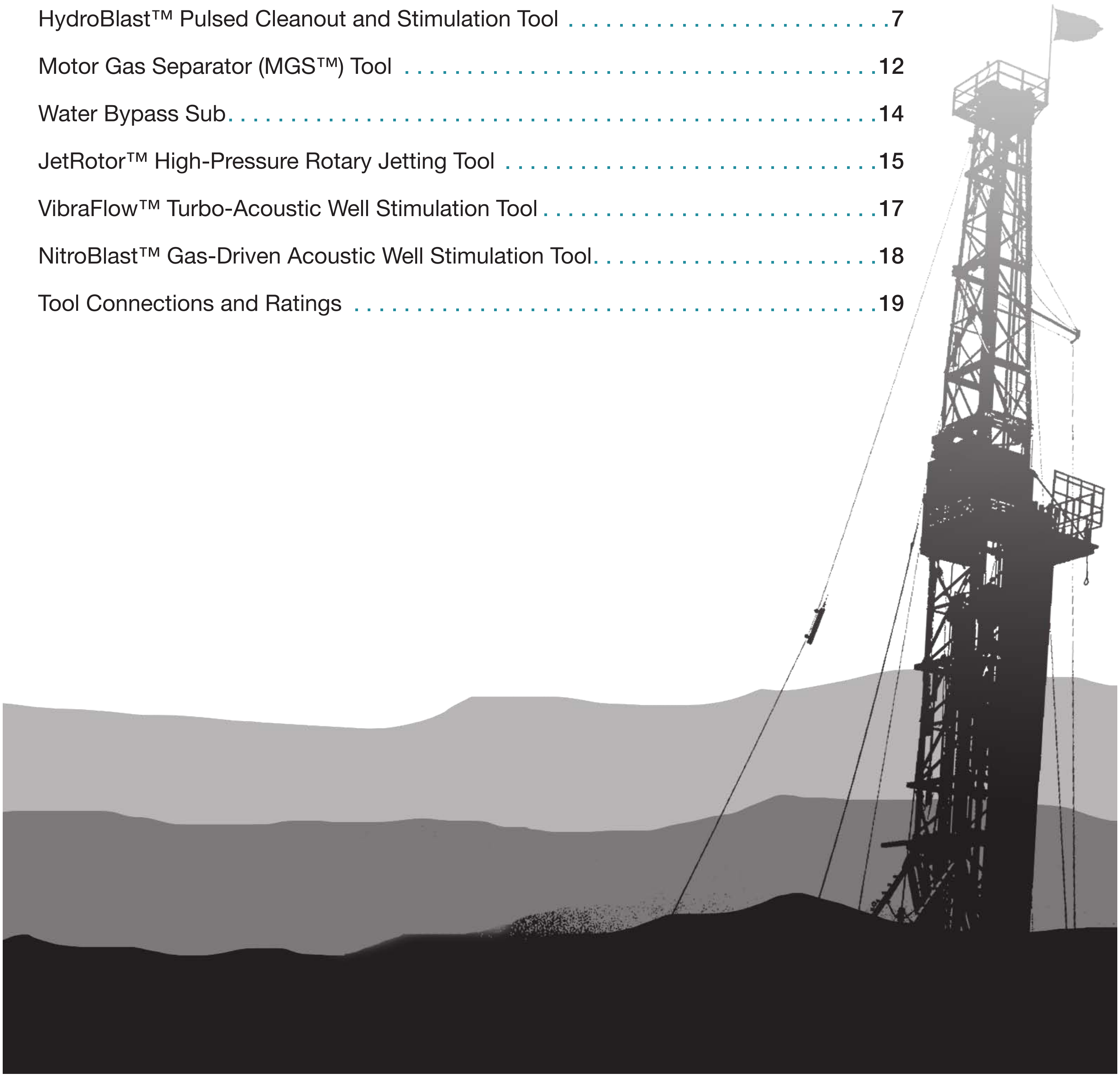


Tempress Technologies develops tools for the most demanding oil and gas well service applications and provides expertise in gas and fluid dynamics, stress analysis and engineered systems. Our standard products are described in this catalog. Please contact Tempress or visit our website for more information on our tools and services.

TEMPRESS®

HydroPull™ Extended-Reach Tool

This tool incorporates a cycling valve that momentarily interrupts the flow to create water-hammer pressure pulses inside coiled or jointed tubing used in horizontal well interventions. The water-hammer effect generates traction forces that pull the tubing into the well at 20 ft/min (6 m/min) or more. These pulses also vibrate the tubing, which reduces friction drag and extends the lateral range of the tubing by delaying the onset of helical buckling and lockup.

The tool is designed to run above a downhole motor for milling applications. The pressure pulsations improve weight transfer in long horizontal wells for faster, more reliable milling.

Applications

- Fishing
- Coiled and jointed tubing
- Composite bridge plug milling
- Ball seat milling
- Sand cleanout
- Valve shifting
- Extreme-reach well service

FEATURE	BENEFIT
Pull action	Pulls tubing into long tortuous wells Reduces plug milling time Eliminates the need for friction-reducing beads and chemicals **Over 50% increase in lateral reach!**
Flow pulsation	Better hole cleaning Fewer short trips **Mill 15+ plugs a day**
Low pressure differential	Effective on small coil or high-pressure wells
High reliability	Multiday extreme-reach jobs without tripping Multiple jobs without redress
Polymer gel compatibility	Effective sweeps minimize short trips
Nitrogen compatibility	Effective on commingled fluid for depleted well service

U.S. Patents 6,237,701 and 7,139,219; International and U.S. Patents Pending

TEMPRESS®

HydroPull™ Extended-Reach Tool

SPECIFICATIONS			
Tool diameter	1.69 in. (43 mm)	2.12 in. (54 mm)	2.88 in. (73 mm)
Connected length (with screen sub)	40.0 in. (1016 mm)	43.6 in. (1106 mm)	58.7 in. (1491 mm)
Design flow rate	1.0–2.0 bpm (160–320 lpm)	1.5–2.5 bpm (240–400 lpm)	1.8–3.0 bpm (300–550 lpm)
Average pressure differential*	200–1100 psid (1.4–7.6 MPa)	600–1700 psid (4.1–12 MPa)	200–500 psid (1.4–3.4 MPa)
Pulse amplitude* (proportional to flow rate)	1.5-in. CT 1000–1700 psi (38-mm CT 7–11 MPa)	1.75- or 2-in. CT 1000–1600 psi (44- or 51-mm CT 7–11 MPa)	2-in. CT 900–1300 psi (51-mm CT) 6–9 MPa)
Traction force* (proportional to flow rate)	1300–2000 lbf (600–900 daN)	1700–2800 lbf (800–1300 daN)	2200–3200 lbf (1000–1400 daN)
Pulse cycle rate* (proportional to flow rate)	6–12 Hz	8–14 Hz	4–8 Hz
Maximum temperature	400°F (200°C)		
Fluid compatibility	Water, brine, weighted mud, 1% acid, polymer gel		
Gas compatibility	Air, carbon dioxide, nitrogen, or multiphase		

**Values calculated using the Tempress Well Circulation Model.*

Flow Rate Effect

The traction force is linearly proportional to the flow rate in the coil. The standard configuration is recommended for most applications. Low-impact and high-impact versions are available in the 2.88-in. (73-mm) size for special applications; contact Tempress for more information.

Two-Phase Flow

The HydroPull™ tool is designed to operate on two-phase flow. The presence of nitrogen dampens the pulse. The tool can also be run with a Tempress Motor Gas Separator (MGS™). The HydroPull™ tool may be run with straight gas downhole if required.

TEMPRESS®

Coiled Tubing Connection

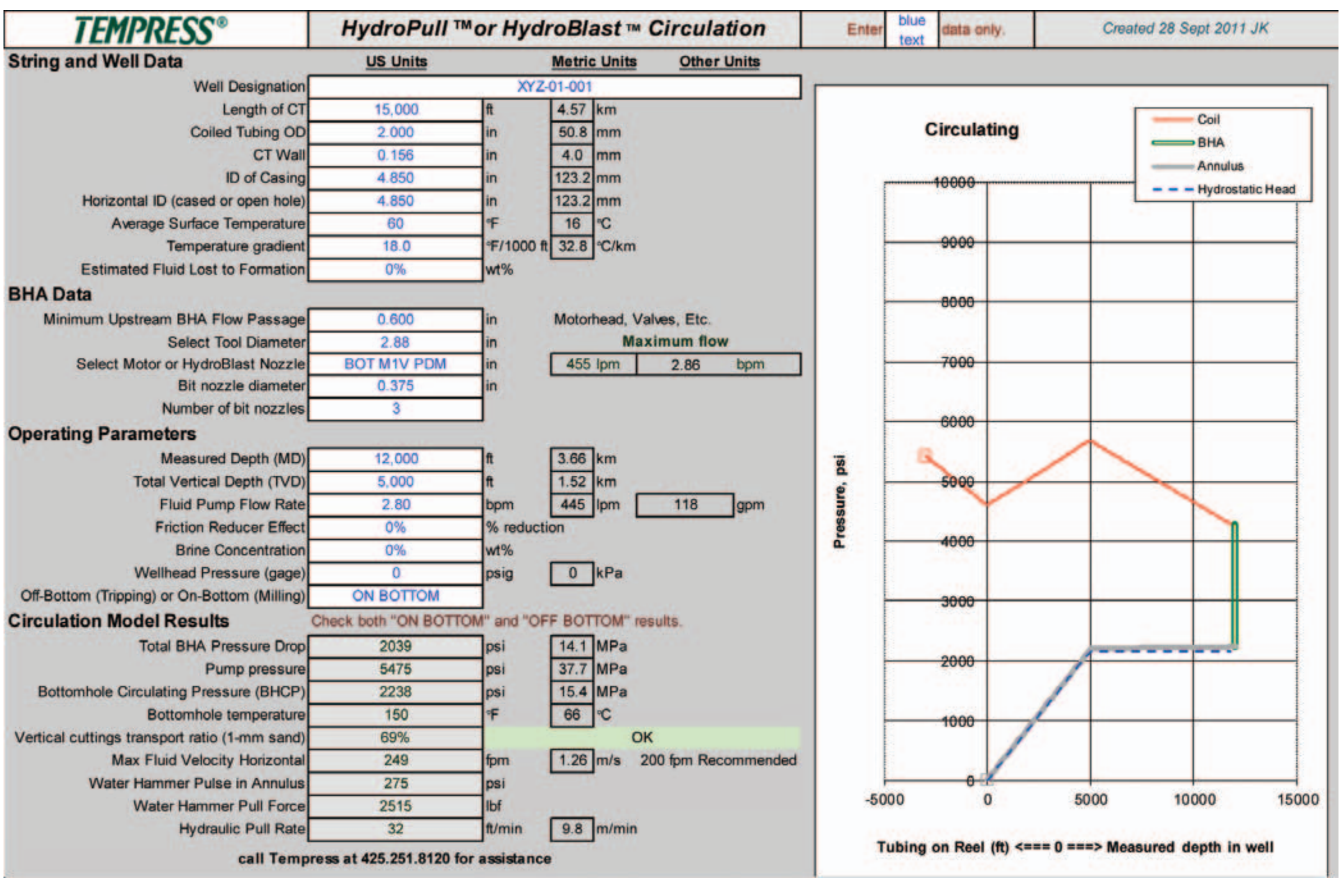
A high-quality coiled tubing connection is required to prevent leakage and failure when the HydroPull™ tool is operated at the high end of its design flow rate range. Refer to the HydroPull™ Operation Guide for pressure test and pull test recommendations.

Last Chance Screen

Fluid should be clean with no sand. A last chance screen is included with each tool to prevent gravel and other debris from blocking the tool. The screen openings are 0.06 in. (1600 microns) to 0.16 in. (3900 microns) depending on tool size and job requirements.

HydroPull™ Application Software

A proprietary software program is available for HydroPull™ tool job planning. The software evaluates circulating pressures in the well, BHA, and supply tubing based on job parameters. The program calculates pump pressure requirements, the transport of sand and cuttings in the horizontal and vertical sections of the well, and the rate at which the tool will pull tubing into the well. A screen shot of the software is provided below.



HydroPull™ Operation Guide

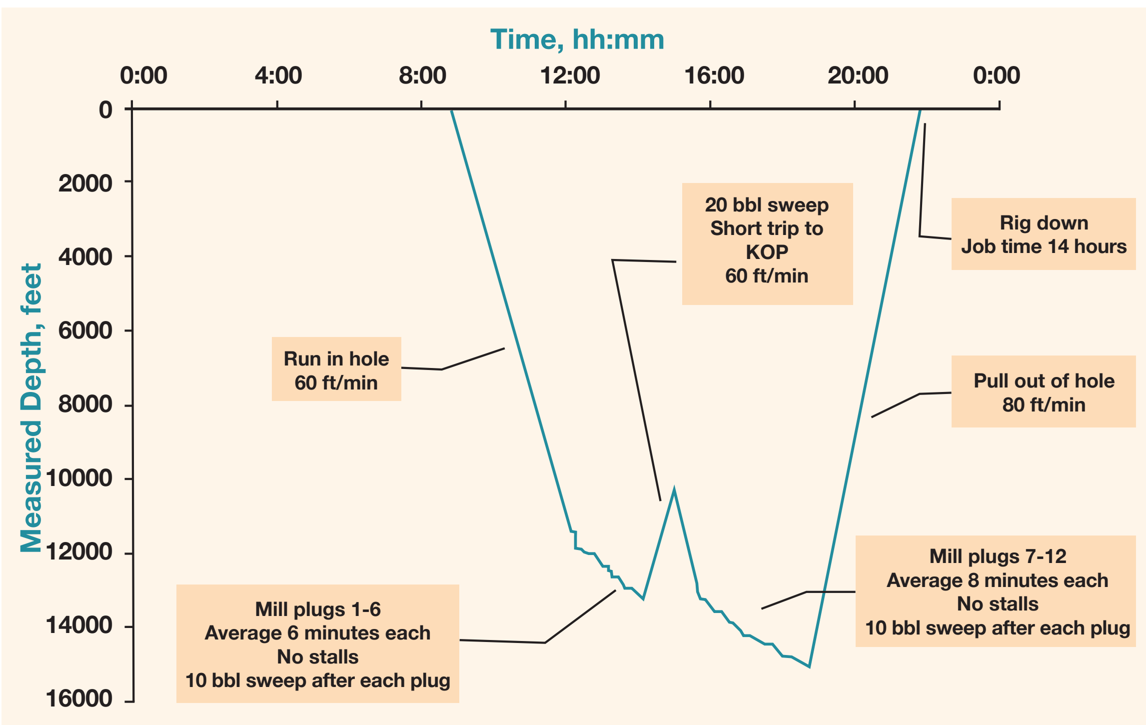
An operation guide is included with the HydroPull™ tool that provides operating instructions and reporting requirements.

Case Histories

The HydroPull™ tool has been run in over 1500 wells in the U.S., Canada and the Middle East since its introduction in 2010. Half of these jobs were completed in less than 24 hours, while one-quarter required only 2 days. Runs of 3 or 4 days are common for extreme-reach wells. A few case histories are summarized below.

South Texas Composite Bridge Plug Millout

This job used a 2.88-in. (73-mm) HydroPull™/ Baker VIP Motor in 5.5-in. (140-mm) casing. This was one of three jobs with an average plug milling time of 7 minutes. Only three stalls were observed out of 35 plugs milled total. A 10-bbl (1590 L) sweep was pumped after each plug was milled, and one short trip was completed after milling 6 plugs. ***The average time to complete each job was only 14 hours.***



Extended-Reach Bridge Plug Milling

This job involved milling 15 bridge plugs from 5-in. (127-mm) casing in a horizontal well with TVD of 14,430 ft (4400 m) and MD of 18,510 ft (5640 m). The bottom hole temperature was 325°F (163°C). The first 9 plugs were milled without a HydroPull™ tool, but progress stopped at 16,820 ft (5127 m) MD because of friction lockup of the 1.75-in. (44-mm) coil. A 2.88-in. (73-mm) HydroPull™ tool was rigged up and operated at 1.5 to 1.75 bpm (238 to 278 lpm) above a motor and mill to remove the last 6 plugs. The plug-to-plug milling and tripping times in the last 6 plugs were the same as in the first 9 plugs. ***TD was reached at 4080 ft (1244 m) horizontal, representing an extended horizontal reach of 70%.***

Case Histories cont.

Bridge Plug Milling in a High-Pressure Well

This job involved milling 14 bridge plugs over 4000 ft (1220 m) of horizontal 5.5-in. (140-mm) casing. The tool was operated on water with friction reducer at 2.5 bpm. The pump pressure while milling with 2-in. (51-mm) coil was 4900 psi (34 MPa) with 1750 psi (12 MPa) wellhead pressure. The total job duration was 36 hours. The average plug milling time was 26 minutes, with times improving as the coil operator became familiar with the new tool. ***This job illustrates the tool's ability to mill bridge plugs efficiently in a pressurized well because of the low pressure differential through the tool.***

Bridge Plug Milling

This job involved milling 11 bridge plugs from 13,426 to 17,346 ft (4092 to 5287 m) inside of 5.5-in. (140-mm) 20# casing. The first 6 plugs were milled without the HydroPull™ tool in an average time of 40 minutes each. The coil then locked up at 15,502 ft (4725 m). A HydroPull™ tool was rigged up, and the last 5 plugs were milled in an average time of 52 minutes each. ***The horizontal reach was extended from 2076 to 3920 ft (633 to 1195 m) – a 90% increase.***

Milling Bridge Plugs with Two-Phase Flow

A 2.88-in. (73-mm) HydroPull™ tool was run with a motor and mill on 2-in. (51-mm) coil to mill bridge plugs inside 5.5-in. (140-mm) casing from 7500 to 13,000 ft (2286 to 3962 m) MD on four horizontal gas well completions (5500-ft/1676-m horizontal). For the first job, a Tempress Motor Gas Separator (MGS™) tool was run below the HydroPull™ tool and above the motor. The tools were operated at 3.25 bpm (517 lpm) with 0.5 bpm (80 lpm) fluid, or gas equivalent, bypassed by the separator. Eight bridge plugs were milled in an average time of 8 minutes each. In offset jobs running a competitive vibrating tool instead of the HydroPull™ tool, the average milling time was 40 minutes per plug.

For the next two wells, the Tempress Motor Gas Separator (MGS™) was run above the HydroPull™ tool and motor to reduce the pulse amplitude. Each job involved milling 8 bridge plugs with fluid. The average milling time per plug was 15 minutes.

On the last well, nitrogen was run to maintain circulation while drilling the last two bridge plugs. ***Nitrogen dampened the pulse amplitude but did not reduce the milling speed.***

Extreme-Reach Tandem Run on Jointed Pipe

This job involved drilling bridge plugs in 4.5-in. (114-m) casing from 9855 to 20,499 ft (3004 to 6248 m) MD using jointed pipe with rotation. The well path was tortuous, and it was not possible to reach the bottom after 9 days of operation with a single HydroPull™ tool. A second tool was installed 3000 ft (914 m) above the first and TD was reached in 3 days. ***The low pressure differential through the tool ensured the success of this extreme-reach plug millout.***

Eliminate Use of Friction-Reducing Beads

These jobs required milling bridge plugs in 5000 to 6000 ft (1524 to 1829 m) horizontal 5.5-in. (140-mm) casing to 11,700 to 12,000 ft (3566 to 3658 m) MD. Prior to this work, the operator had been specifying friction-reducing beads and chemicals. The wells are inclined up to 95° with some heavy sand accumulations. Thirty-one composite bridge plugs were milled using the HydroPull™ tool, and 37 were milled without the HydroPull™ tool using beads and chemicals. The 2.88-in. (73-mm) HydroPull™ tool was operated on 2-in. (51-mm) tapered coil with a motor and mill using water at 2.5 bpm (397 lpm). ***In the toe of the well, the average plug milling time was reduced from 147 to 36 minutes, a factor of 4. In the heel, the plug milling time was cut in half.***

TEMPRESS®

HydroBlast™ Pulsed Cleanout and Stimulation Tool

The HydroBlast™ tool incorporates a cycling valve that momentarily interrupts the flow to create intense water-hammer pressure pulses that vacuum the wellbore, pulling fines and debris from behind completions and out of the formation. The tool is equipped with multiple high-pressure side-firing jets for efficient well cleaning.

When the well is allowed to circulate flow, the tool generates alternating suction and pressurized pulses over a large area of the completion. The induced flow flushes debris out from behind complex screened completions and pulls fines out of the near wellbore formation. Pulsation of the return flow assists in moving sand and debris in the horizontal and inclined sections of the well.

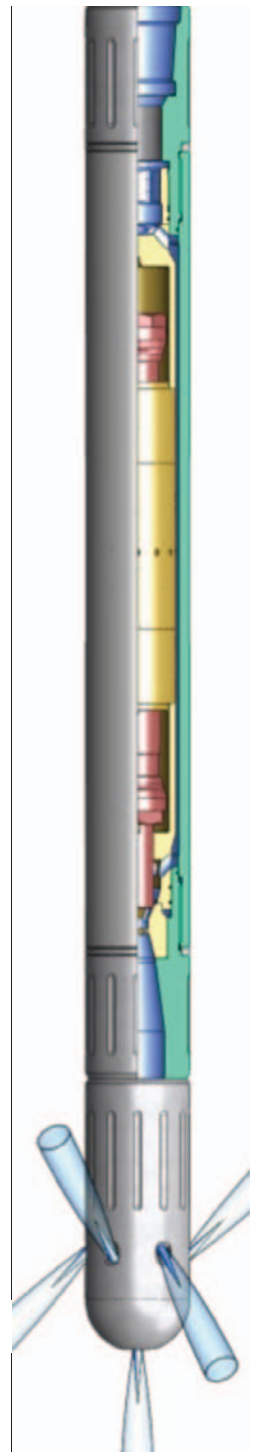
When the well is shut-in, the valve causes the flow of acid or other stimulation fluid to pulsate. Case histories have demonstrated increased production from acid and solvent squeeze treatments.

Applications

- Sand cleanout
- Acidizing
- Chemical placement
- Screen and perforation cleaning
- Scale removal
- Extended-reach well stimulation

The upstream pressure pulses also act to pull tubing into horizontal well sections. **Two-in. (51 mm) coil can be pulled over 8000 ft (2438 m) into 5.5-in. (140-mm) casing.**

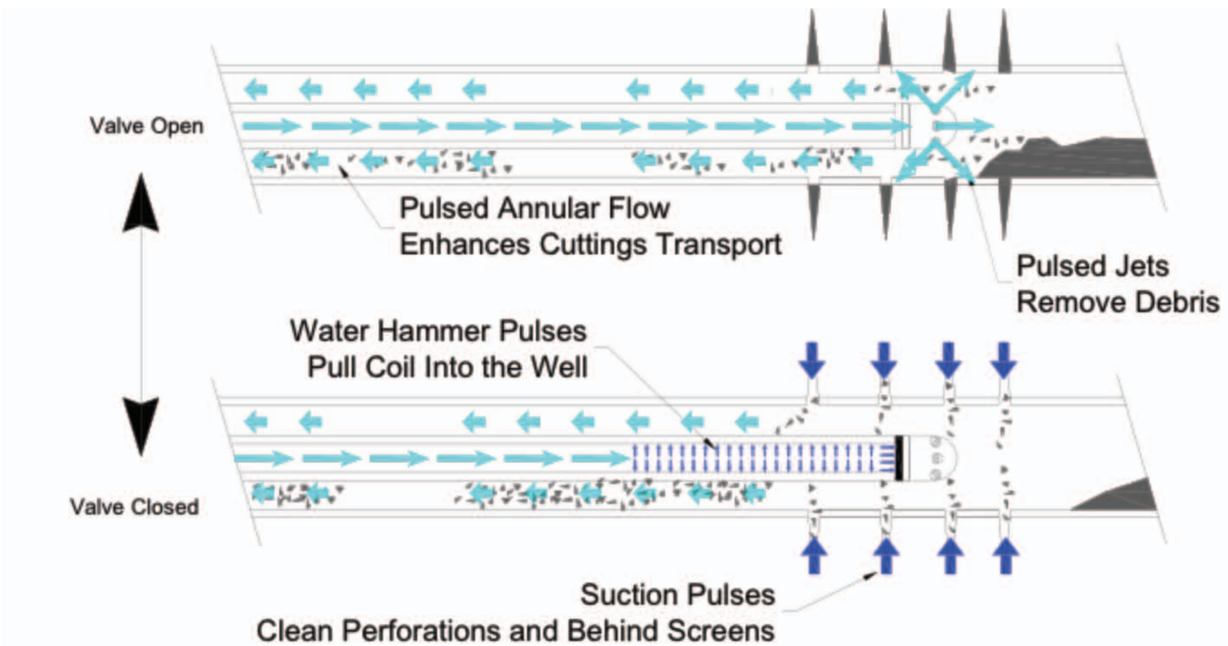
FEATURE	BENEFIT
Intense suction pressure	Removes debris from perforations and behind screens
Flow pulsation	Better sand and cuttings transport at low flow
Low pressure differential	Maximizes flow through long, small coil
Low-flow operation	Starts cycling at low flow to initiate squeeze
Pull action	Pulls tubing into long tortuous wells
Pulsating jets	One-trip cleanout and stimulation Eliminates the need for a motor and mill
High reliability	Multiday extended-reach jobs without tripping
Acid-capable version	One trip cleanout and acid squeeze
Gas compatible	Nitrogen can be run as needed for cleanout or foam diversion



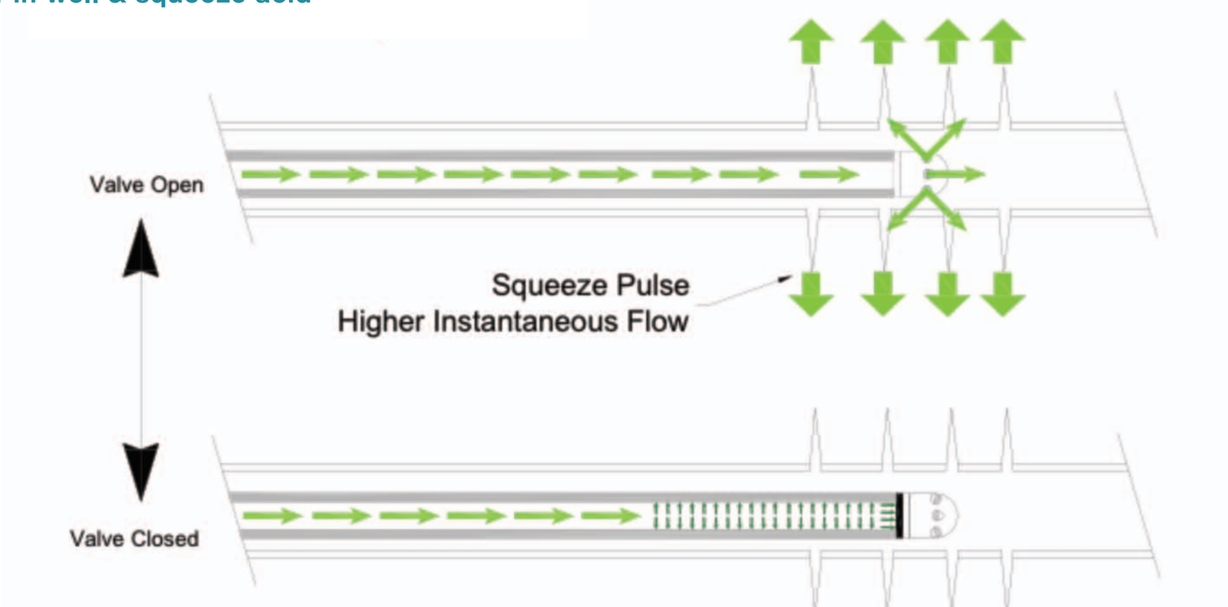
U.S. Patents 6,237,701 and 7,139,219; International and U.S. Patents Pending

One-Trip Cleanout and Stimulation:

run-in hole & circulate with water



shut-in well & squeeze acid



SPECIFICATIONS			
Tool diameter	1.69 in. (43 mm)	2.12 in. (54 mm)	2.88 in. (73 mm)
Connected length (with screen sub)	44.6 in. (1132 mm)	48.7 in. (1237 mm)	66.1 in. (1679 mm)
Design flow rate	1.0–2.0 bpm (160–320 lpm)	1.5–2.5 bpm (240–400 lpm)	1.8–3.0 bpm (300–550 lpm)
Average pressure differential*	400–1500 psid (2.8–10 MPa)	700–2000 psid (4.8–14 MPa)	600–1700 psid (4.1–12 MPa)
Typical annulus pulse amplitude* (proportional to flow rate)	1.5-in. (38 mm) CT / 90–180 psi 4.5-in. (11 mm) casing (0.6–1.3 MPa)	2-in. (51-mm) CT / 160–260 psi 4.5-in. (11 mm) casing (1.1–1.8 MPa)	2-in. (51-mm) CT / 110–180 psi 5.5-in. (140 mm) casing (0.8–1.3 MPa)
Traction force* (proportional to flow rate)	15–25 ft/min (4–8 m/min)	15–30 ft/min (5–9 m/min))	10–20 ft/min (3–6 m/min)
Pulse cycle rate* (proportional to flow rate)	6–12 Hz	8–14 Hz	4–8 Hz
Maximum temperature	400°F (200°C)		
Fluid compatibility	Water, brine, weighted mud, solvents, bleach, polymer gel Acid-capable version can handle 28% HCl and mud acid		
Gas compatibility	Air, carbon dioxide, nitrogen, or multiphase		

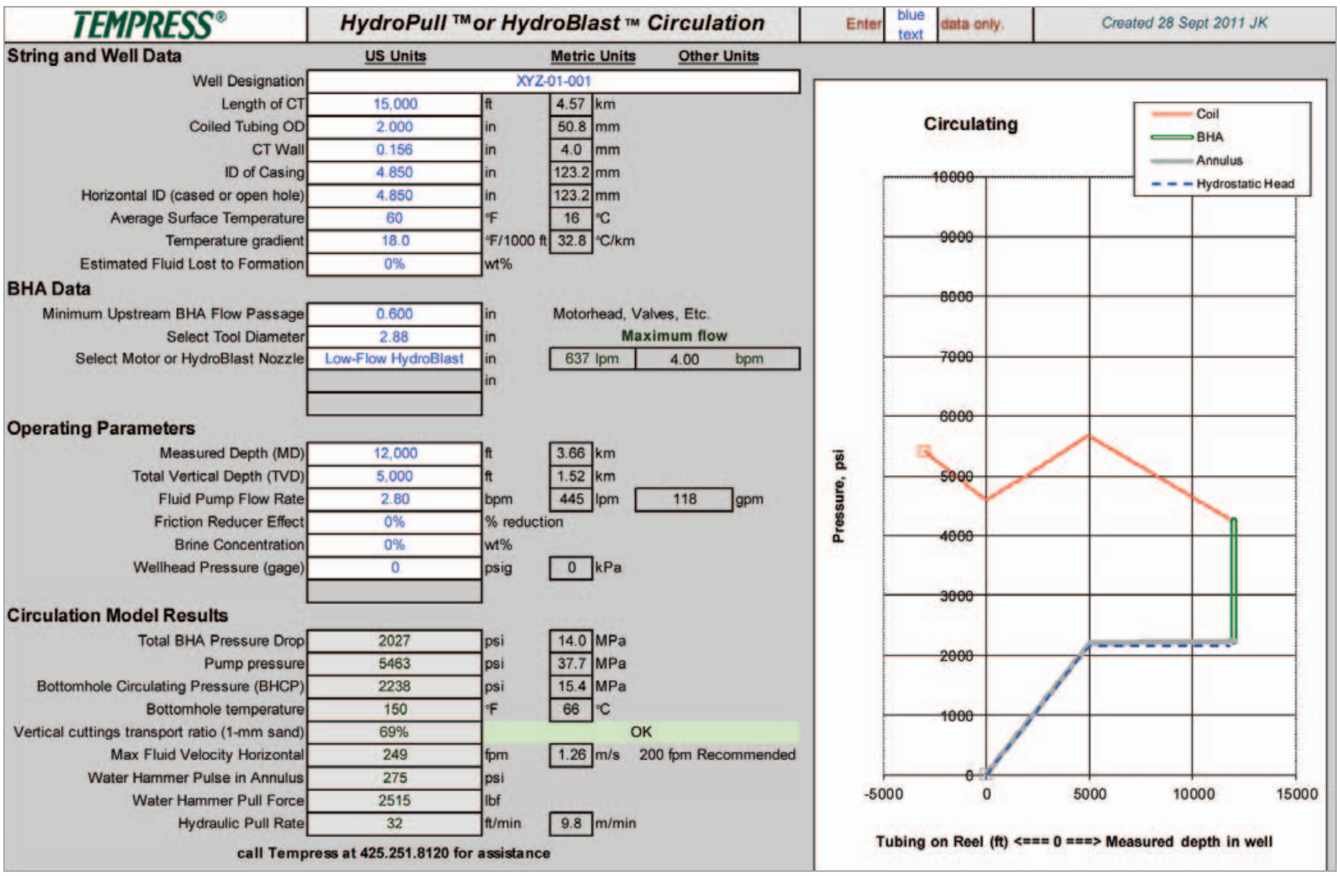
**Values calculated using the Tempress Well Circulation Model.*

HydroBlast™ Operation Guide

An operation guide is included with the HydroBlast™ tool that provides operating instructions and reporting requirements.

HydroBlast™ Application Software

A proprietary software program is available for HydroBlast™ tool job planning. The software evaluates circulating pressures in the well, BHA, and supply tubing based on job parameters. The program calculates pump pressure requirements, the transport of sand and cuttings in the horizontal and vertical sections of the well, the rate at which the tool will pull tubing into the well, and the pressure pulse amplitude in the completion. A screen shot of the software is provided below.



Case Histories

The HydroBlast™ and HydroPull™ tools have been run in over 1500 wells in the U.S. and Canada since their introduction in 2010. Runs range from 1 to 9 days of continuous operation. A few case histories are summarized below.

Heavy Oil Well Stimulation (two wells)

For the first well, a 1.69-in. (43-mm) HydroBlast™ tool with a three-jet nozzle was operated on 1.5-in. (38 mm) coil to enter a 7-in. (18 mm) slotted liner in a heavy oil horizontal completion. Prior attempts to enter this well were prevented because of obstructions between 3100 and 3800 ft (945 and 1158 m). The tool was operated at a flow rate of 1.3 bpm (207 lpm) of produced water plus 15% AS-1 solvent (kerosene and xylene). The tool slowed in the area of the obstructions, but moved through at a feed rate of 8 ft/min (2.4 m/min), then it resumed at a feed rate of 20 ft/min (6 m/min). TD was reached at 4592 ft (1400 m), and the tool was run out of the hole at 33 ft/min (10 m/min). A total of 280 bbl

(44,516 L) of fluid was pumped. ***Well production increased from 44 to 605 bbl (6996 to 96,187 L) per day with low water cut.***

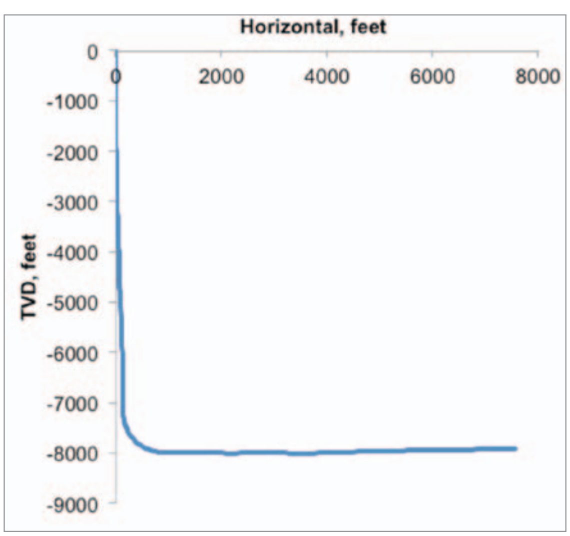
On the second well, a 1.69-in. (43-mm) HydroBlast™ tool with three 0.188-in. (5-mm) forward-facing jet nozzles was used to place 315 bbl (50,081 L) of water with 3% KCl and 2% MudSol. The flow rate was 0.9 to 1.3 bpm (207 lpm) with a surface pump pressure of 1740 psi (12 MPa). The tool was run in at 10 to 20 ft/min (3 to 6 m/min) through the 5.5-in. (140-mm) horizontal slotted liner to TD at 4920 ft (1500 m) MD, with 1970 ft (600 m) TVD. The tool was pulled back every 300 ft (91 m) to sweep sand fill. ***Well production increased from 25 to 44 bbl (3975 to 6996 L) per day with low water cut.***

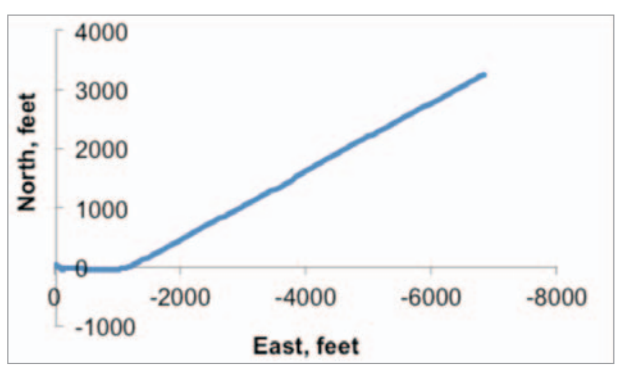
Extended Reach on 1.5-in. (38-mm) Coil

This job required re-entry into a 6.1-in. (155-mm) diameter horizontal openhole from 4760 to 8070 ft (1451 to 2460 m) MD to place solvent. The horizontal section was 3313 ft (1010 m) long. Prior attempts to enter this well with 1-in. (25 mm) continuous rod failed at 6230 ft (1899 m) MD. The casing was 2.44-in. (62-mm) ID, so a 1.69-in. (43-mm) HydroBlast™ tool with a four-jet nozzle pattern was run on 1.5-in. (38-mm) coiled tubing. The tool was operated at 1.3 bpm (207 lpm) and at feed rates of 30 to 65 ft/min (9 to 20 m/min). The final 1000 ft (305 m) to TD was entered at 10 ft/min (3 m/min) with snubbing forces well below the coil limits. The solvent was placed at the toe of the well and allowed to soak for 24 hours. The well was re-entered with the HydroBlast™ tool the following day. Commingled fluid (0.7 bpm [111 lpm] water and 525 scf [14.9 m3] nitrogen) was pumped to lift the solvent from the well. ***The HydroBlast™ tool extended the lateral reach of the coil by 20% or 690 ft (210 m) in this well.***

Extreme-Reach Cleanout

This job involved three wells that required sand cleanout in 5.5-in. (140-mm) casing at an extended reach of 6950, 7170 and 8009 ft (2118, 2185 and 2441 m). A 2.88-in. (73-mm) HydroBlast™ tool with a motor was run in these wells on 2-in. (51-mm) coil at 2.75 bpm (437 lpm). TD was reached on all three wells. A coiled tubing friction lockup model was run for each well trajectory. On the longest well trajectory, shown below, the model predicted coil lockup at a measured depth of 13,060 ft (3981 m), assuming a default value for the coil/casing wall friction coefficient. The HydroBlast™ tool enabled the coil to reach TD at 15,239 ft (4645 m), which is 3179 ft (969 m) beyond the predicted lockup point. ***On the 8009-ft (2441-m) lateral, this represents a minimum 52% increase in lateral reach.***





TEMPRESS®

Motor Gas Separator (MGS™) Tool

This tool incorporates a rotary drum separator that removes the gas from energized flow before it reaches the downhole motor. Bypassing the gas allows operation of the motor at the design flow rate while simultaneously running high gas flow rates. The MGS™ tool incorporates a changeable gas orifice that can be sized as needed.

High-Efficiency Gas Separation

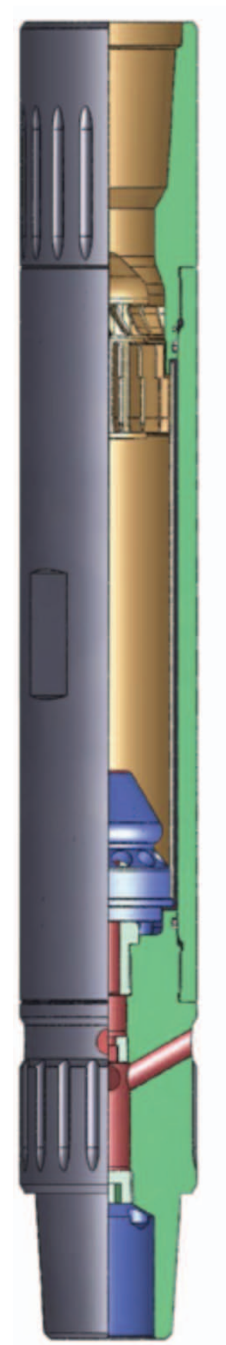
- Removes free nitrogen from the flow through the motor
- Reduces nitrogen damage to stators
- Prevents motor overspeed
- Extends motor life

Rotary Drum Separator

- Compact length simplifies setup of the BHA
- Accommodates severe doglegs and multilateral completions
- Compatible with common well service fluids

SPECIFICATIONS			
Tool diameter	1.69 in. (43 mm)	2.12 in. (54 mm)	2.88 in. (73 mm)
Connected length	16.0 in. (406 mm)	16.6 in. (422 mm)	19.4 in. (493 mm)
Flow capacity (maximum commingled flow equivalent)	2.1 bpm 90 gpm (340 lpm)	2.1 bpm 90 gpm (340 lpm)	1.8–3.0 bpm 260 gpm (1000 lpm)
Maximum pressure loss from tool	< 70 psi (0.5 MPa)		
Max. gas fraction at inlet	80%		
Typical gas cut at outlet Pulse cycle rate*	< 0.5%		
Maximum temperature	400°F (200°C)		
Fluid compatibility (clear fluids)	Water, 1% acid, 3% KCl, scale dissolvers, frac oil		
Gas compatibility	Nitrogen, air, carbon dioxide		

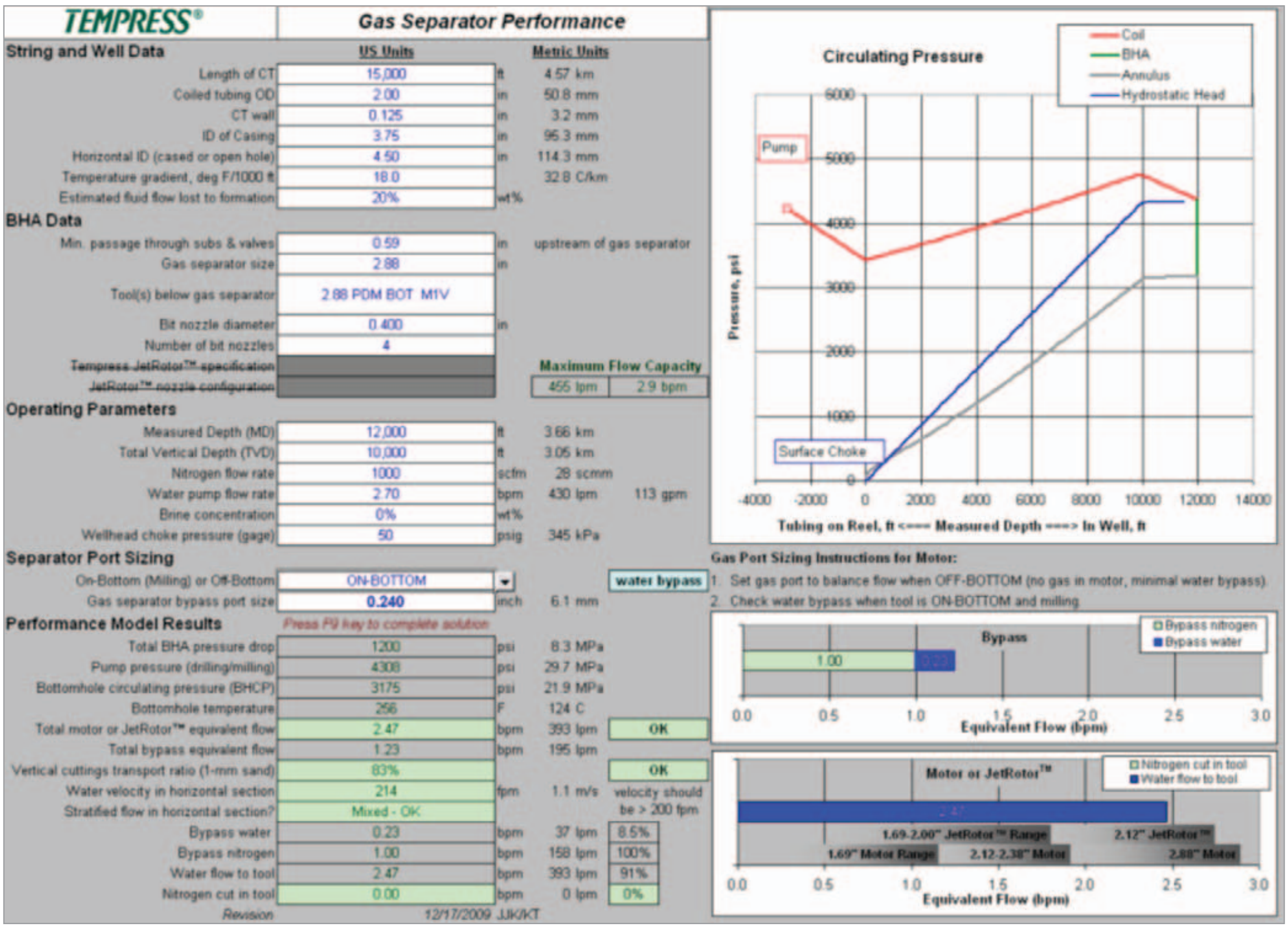
*Values calculated using the Tempress Well Circulation Model.



U.S. Patent 7,677,308; International Patents and Patents Pending

Motor Gas Separator Application Software

A proprietary analysis program supplied with the MGS™ tool allows the operator to select the best separator performance range for the job. All pertinent parameters of the job requirements are entered, and the program outputs the optimum performance and operational ranges, as shown below in a screen shot from the program.



MGS™ Operation Guide

An operation guide is included with the MGS™ tool. This guide explains how to change out the gas orifice and provides cleaning and inspection procedures for multiple runs between redresses.

TEMPRESS®

Water Bypass Sub

This simple sub has two ports that bypass fluid to the side of the BHA. This allows pumping flow rates that are higher than the ratings for motors or other equipment connected below.

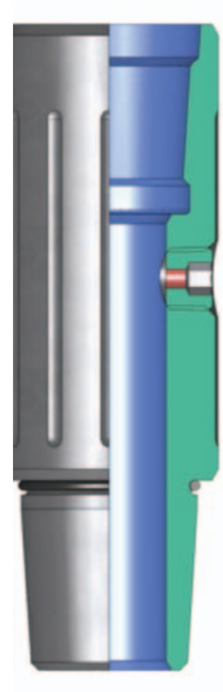
A proprietary analysis program supplied with the Water Bypass Sub allows the operator to select the correct port size for the job. Similar to the MGS™ software, all pertinent parameters of the job are entered, and the program outputs the appropriate orifice size along with key performance characteristics. Standard ports can be resized in the field with a drill. Carbide insert orifices can be made available for particularly long runs with weighted fluids or abrasive additives.

Applications

- Higher flow for better cleaning of large well bores and horizontals
- Used with PDMs, HydroPull™ and JetRotor™ tools

Simple and Reliable

- No moving parts
- No through flow restrictions
- Compact length does not impact setup of the BHA
- Software supported port sizing/setup
- Field adjustable bypass flow
- Compatible with common well service fluids



SPECIFICATIONS			
Tool diameter	1.69 in. (43 mm)	2.12 in. (54 mm)	2.88 in. (73 mm)
Connected length	3.6 in. (90 mm)	5.5 in. (140 mm)	6.0 in. (152 mm)
Maximum Bypass Rate	2 bpm (300 lpm)	4 bpm (600 lpm)	7 bpm (1100 lpm)
Maximum temperature	400°F (200°C)		
Fluid compatibility	Water, nitrogen, polymer gels, solvents, bleach, brine, surfactants, 1% acid, brine, scale dissolvers, frac oil, weighted mud		

TEMPRESS®

JetRotor™ High-Pressure Rotary Jetting Tool

High-pressure rotary jetting offers the ability to remove mineral scale safely and quickly and to stimulate well completions with ***no risk of damage to production tubing or downhole equipment.***

The Tempress JetRotor™ tool is compatible with a broad range of fluids making it applicable in almost all coiled tubing well service jobs. The design is highly compact, which greatly simplifies transport, BHA setup and job execution. The tool is available in several sizes: 1.69 in. (43 mm), 2.06 in. (52 mm) and 2.12 in. (54 mm).

High-Pressure, High-Power, High-Quality Jets

The JetRotor™ tool operates at the highest power and pressure levels available in the industry. The patented open-flow seal design virtually eliminates power losses due to leakage and friction. This seal design ensures that maximum hydraulic power is delivered to the jets.

- Greater range and effectiveness than conventional wash nozzles.
- Flow conditioners in nozzle heads ensure a coherent jet.
- Field-changeable nozzle heads for specific applications.

Hydrokinetic Speed Governor

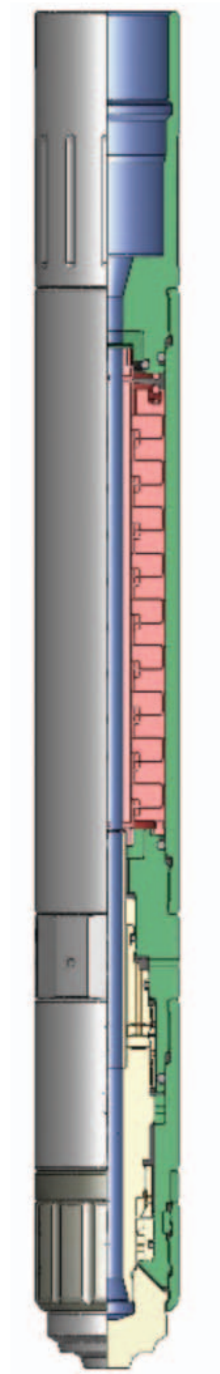
Tempress has conducted extensive testing on the effects of rotary speed on jet effectiveness. JetRotor™ tools incorporate a patented hydrokinetic speed governor that provides the optimum rotation rate with maximum jet effectiveness. The high rotation rates (3000 to 4000 rpm) achieved by the tool allow efficient cleaning at coil feed rates of over 30 ft/min (10 m/min).

- High coil feed rates.
- No special fluids or setup procedures required for speed governor.
- Can be rerun on multiple jobs without redress.

High-Temp, Corrosion-Resistant Alloy Construction

The JetRotor™ tools are fully acid capable and are routinely run in the most severe high-temperature (400°F/200°C) sour gas environments.

- Can run on energized fluids including nitrogen and carbon dioxide.
- Dry gas can be used to complete the job.
- High-concentration HCl is commonly pumped for well stimulation.
- Bleach, solvents, polymers and surfactants can also be jetted to enhance the well service.



U.S. Patents 7,201,238 and 7,524,160; International Patents and Patents Pending

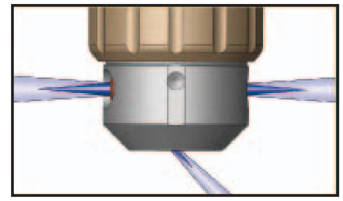
TEMPRESS®

JetRotor™ High-Pressure Rotary Jetting Tool

Nozzle Head Configurations

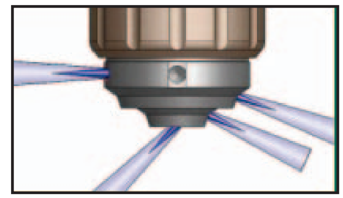
Stimulation and Screen Cleaning
Two large radial jets, one small forward jet.

- Removes drilling damage from openhole completions.
- Cleans screens and perforations.
- Acid blasts for uniform acid delivery during acid squeeze.
- Multistage foam diversion acid squeeze.



Milling
Hydraulic energy is focused forward. The core region of the jets provides 100% coverage of the front of the tool to mill through bridged material.

- Removes soft mineral scale, acid soluble scale, barite sag, paraffin, hard-packed sand and other well obstructions.
- A high-pressure (HP) milling tool is available for hard scales.

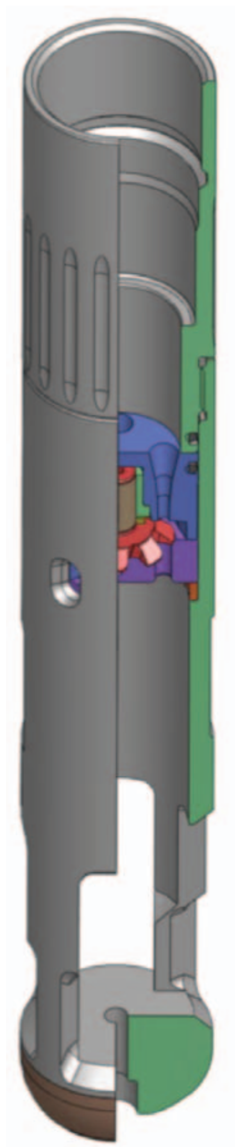


SPECIFICATIONS						
Tool diameter		1.69 in. (43 mm)		2.06 in. (52 mm)		2.12 in. (54 mm)
Tool length		15.9 in. (404 mm)		14.6 in. (371 mm)		21.6 in. (549 mm)
Nozzle head style		Stimulation	Milling	Milling	HP Milling	Universal
Typical coil sizes (in., mm)		1.25, 1.5 (32, 38)	1.25, 1.5 (32, 38)	1.5, 1.75 (38, 44	1.25 HP (32 HP)	1.75, 2 (44, 51)
Fluid compatibility (water)		Water, nitrogen, polymer gels, solvents, bleach, brine, surfactants				
Acid jetting capable		28% acid	28% acid	1% acid	---	28% acid
Maximum temperature		400°F (200°C)				
Design pressure (dP)		3000 psi (20 MPa)	3000 psi (20 MPa)	3000 psi (20 MPa)	5000 psi (35 MPa)	3000 psi (20 MPa)
Max pressure (dP)		5000 psi (35 MPa)	5000 psi (35 MPa)	10000 psi (70 MPa)	10000 psi (70 MPa)	5000 psi (35 MPa)
Fluid flow rates (water) *varies depending on nozzle configuration*	bpm	1.0-1.4	0.7-1.0	0.8-1.9	1.0	1.5-2.1
	gpm	43-59	28-41	35-81	45	64-87
	lpm	160-220	110-160	130-305	165	240-330

TEMPRESS®

VibraFlow™ Turbo-Acoustic Well Stimulation Tool

The VibraFlow™ turbo-acoustic tool converts hydraulic power into a powerful high-frequency acoustic signal. This powerful sonic vibration mobilizes fines in the formation near the wellbore and increases acid reaction rates in low-permeability zones. When run underbalanced, the tool can be used to remove fines and polymers from the formation near the wellbore.* The tool can be operated with a gas separator for underbalanced operations.



Applications

- Acidizing
- Drilling damage removal
- Well stimulation

VibraFlow™ Operation Guide

An operation guide is included with the VibraFlow™ tool.

SPECIFICATIONS	
Tool outside diameter	1.69 (43 mm)
Length	12.2 (309 mm)
Fluid compatibility	Water, solvents, brine, surfactants, and up to 28% HCl acid
Max. operating temperature	400°F (200°C)
Tool connection	1.50-10 Stub Acme
Assembly torque (through tool)	100-120 ft-lb (120-160 N-m)
Maximum assembly torque	150 ft-lb (200 N-m)
Design differential pressure	1670 psi (11.5 MPa)
Design flow rate	40gpm (150 lpm)
Acoustic power at design pressure/flow	2 kW (continuous average) 12 kW (transient peaks)
Dominant acoustic frequency (pitch)	4kHz
Recommended feed rate	6/ft/min. (2m/min.)

*Kolle, J.J., and T. Theimer (2010) "Testing of a fluid-powered turboacoustic source for formation damage remedi-ation," *SPE 128050,* prepared for SPE International Symposium and Exhibition on Formation Damage Control held in Lafayette, Louisiana, USA, 10–12 February.

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NitroBlast™ Gas-Driven Acoustic Well Stimulation Tool

High-frequency sound can mitigate drilling- or production-induced skin damage if the intensity is high enough and the well is underbalanced so that fines loosened by the sound are flushed out of the formation.

The NitroBlast™ tool creates super high-power sound waves (up to 75 kW) at 2 to 20 kHz. Large-diameter acoustic reflectors focus the sound on the formation. The measured sound intensity at the surface of a 6-in. (152-mm) borehole exceeds 190 dB (SPL), which is **300 times loader than the sound level near a military jet on takeoff!**

Applications

- Drilling damage removal from coal bed methane and shale completions
- Tight gas well stimulation
- Depleted well stimulation
- Stimulation during routine well unloading operations

The tool is gas-driven to keep the well underbalanced during treatment.

This tool is developed for shallow well applications [maximum bottomhole circulating pressure of 725 psi (5 MPa)]

FEATURE	BENEFIT
High-intensity, high-frequency acoustic stimulation	Proven to be effective for permeability recovery
Gas-driven	To ensure flushing of fines by formation fluids during stimulation
High power	Allows fast, efficient treatment
Simple with no moving parts	For easy setup and reliable operation
Compact	For easy transport and deployment on 1.5-in. (38-mm) or larger coiled tubing

SPECIFICATIONS	
Tool length	3.75 in. (95.3 mm)
Tool connections	1.50-10 or 2.06-10 Stub Acme
Serviceable well bore pressures	75–725 psi (0.5–5 MPa)
Design differential pressure	600–3800 psi (4.1–26 MPa)
Design flow rate	350–1800 scfm (10–50 scmm)
Acoustic power at design pressures	10–75 kW
Frequency range	2–20 kHz

NitroBlast™ Operation Guide

An operation guide is included with the NitroBlast™ tool.

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TOOL CONNECTIONS AND RATINGS

HydroPull™ and HydroBlast™

		1.69"		2.12"	2.88"
Assembly Number		30249, 30288		30324 & 30326	30283
Connected Length	in	17.5		20.2	29.4
Inlet/Outlet Connections		1.00 AMMT	1.50-10 SA	1.50 AMMT	2.375 PAC-DSI mod
Recommended Connection Makeup Torque	ft-lb	400	300	670	2,700
Housing Thread (Stub-Acme)		1.50-10 SA		1.75-10 SA	2.40-6 SA
Housing Assembly Torque	ft-lb	300		670	2,700
Maximum Operating Pressure [1]	psi	2,000		3,000	3,000
Maximum Over-torque [2]	ft-lb	750		2,100	5,400
Maximum Overpull [2]	lbf	30,000		85,000	150,000
Maximum Setdown [2]	lbf	30,000		85,000	150,000

Screen Sub *(with HydroPull™ & HydroBlast™)*

		1.69"		2.12"	2.88"
Assembly Number		30343		30325	30314
Connected Length	in	22.5		23.4	29.4
Inlet/Outlet Connections		1.00 AMMT	1.50-10 SA	1.50 AMMT	2.375 PAC-DSI mod
Recommended Connection Makeup Torque	ft-lb	400	300	670	2,700
Housing Thread (Stub-Acme)		1.50-10 SA		1.75-10 SA	2.40-6 SA
Housing Assembly Torque	ft-lb	300		670	2,700
Maximum Operating Pressure [1]	psi	2,000		3,000	3,000
Maximum Over-torque [2]	ft-lb	750		2,100	5,400
Maximum Overpull [2]	lbf	30,000		85,000	150,000
Maximum Setdown [2]	lbf	30,000		85,000	150,000

Motor Gas Separator (MGS™)

		1.69"	2.12"	2.88"
Assembly Number		30208	30212	30130
Connected Length	in	18.0	18.3	19.4
Connections (box up, pin down)		1.00 AMMT	1.50 AMMT	2.375 PAC-DSI mod
Recommended Connection Makeup Torque	ft-lb	400	670	2700
Housing Thread (Stub-Acme)		1.437-10 SA	1.437-10 SA	2.375-10 SA
Housing Assembly Torque	ft-lb	300	550	2,000
Maximum Operating Pressure [1]	psi	5,300	10,000	5,000
Maximum Over-torque [2]	ft-lb	560	1,100	3,100
Maximum Overpull [2]	lbf	43,000	43,000	68,000
Maximum Setdown [2]	lbf	43,000	43,000	68,000

1 Maximum Operating Pressure is the maximum inlet pressure at the tool relative to the ambient downhole pressure. It is non-concurrent with other maximum values.

2 Maximum over-torque and maximum overpull ratings are non-concurrent with each other. These values are calculated based on the strength of the tool and connections. Damage may occur if any of these limits is exceeded. Operation at greater than 1/2 of these values must be noted on the job log.

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TOOL CONNECTIONS AND RATINGS

JetRotor™

		1.69"	2.06"	2.12"
Assembly Number		30100, 30160	30106	30224
Connected Length	in	15.9	14.6	20.6
Inlet Box Connection (Stub Acme)		1.50-10 SA	1.50-10 SA	1.50-10 SA
Recommended Connection Makeup Torque	ft-lb	175	175	175
Housing Thread (Stub-Acme)		1.50-10 SA	varies	1.75-10 SA
Housing Assembly Torque	ft-lb	90 - 120	150 - 200	250 - 300
Maximum Operating Pressure [1]	psi	5,000	10,000	5,000
Maximum Over-torque [2]	ft-lb	400	550	800
Maximum Overpull [2]	lbf	15,000	26,000	33,000
Maximum Setdown [2]	lbf	10,000	10,000	15,000

Screen Sub *(with JetRotor™)*

		1.69"	2.12"
Assembly Number		30093	30350
Connected Length	in	22.5	23.4
Inlet Box Connection		1.50-10 SA	1.50 AMMT
Inlet Box Connection (Optional)		1.00 AMMT	-
Outlet Pin Connection		1.50-10 SA	1.50 AMMT
Recommended Connection Makeup Torque	ft-lb	175	670
Housing Thread (Stub-Acme)		1.50-10 SA	1.75-10 SA
Housing Assembly Torque (for JetRotor™)	ft-lb	90 - 120	300 - 670
Maximum Operating Pressure [1]	psi	4,000	5,000
Maximum Over-torque [2]	ft-lb	750	2,100
Maximum Overpull [2]	lbf	30,000	85,000
Maximum Setdown [2]	lbf	30,000	85,000

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Through-Tubing Well Intervention Tools