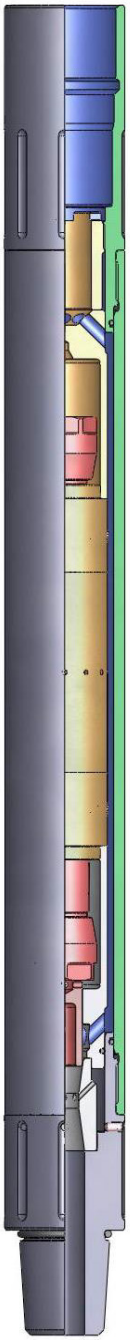
Extended-Reach Tool



U.S. Patents 8,528,649 & 8,939,217, International Patents Pending

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 periodic 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 typically 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 ***Routine entry of 10,000 foot horizontals***
Flow pulsation	Better hole cleaning Fewer short trips ***Mill 24+ 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

Specifications

Tool diameter	1.69 in. (43 mm)	2.13 in. (54 mm)	2.38 in. (60 mm)	2.88 in. (73 mm)	
Connect length	18.25 in. (464 mm)	20.15 in. (512 mm)	21.40 in. (544 mm)	SA 29.35 in. (745 mm)	DIN 32.32 in. (821 mm)
Connected length (with screen sub)	36.50 in. (927 mm)	43.55 in. (1106 mm)	44.80 in. (1138 mm	SA 58.70 in. (1491 mm)	DIN 64.60 in. (1642 mm)
Connections	1 in. AMT	1-1/2 in. AMT	1-1/2 in. AMT	2-3/8 in. PAC-DSI (mod)	
Design flow rate	0.9–1.8 bpm (140–290 lpm)	1.2–2.2 bpm (190–350 lpm)	1.2–2.2 bpm (190–350 lpm)	1.8–4.1 bpm (300–650 lpm)	
Average pressure differential*	440-850 psid (3.0–5.9 MPa)	420–1,250 psid (2.9–8.6 MPa)	420–1,250 psid (2.9–8.6 MPa)	280–620 psid (1.9–4.3 MPa)	
Traction rate* (proportional to flow rate)	15-25 ft/min (4-8 m/min)	15-30 ft/min (5-9 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	8–14 Hz	3–7 Hz	
Maximum temperature	400°F (200°C)				
Fluid compatibility	Water, brine, weighted mud, bleach, solvents, 1% acid, 3% KCl, polymer gel and scale dissolvers. *Acid-capable tools (1.69 and 2.13 in.) can handle 28% HCl and mud acid.*				
Gas compatibility	Air, carbon dioxide, nitrogen, or multiphase				

* Values calculated using Tempress Performance Software.

Specifications

Tool diameter	3.13 in. (79 mm)	3.38 in. (86 mm)	3.50 in. (89 mm)
Connected length (with screen sub)	69.60 in. (1768 mm)		
Connections	2-3/8 in. API REG		
Design flow rate	2.5-4.3 bpm (400-680 lpm)		
Average pressure differential*	330-880 psid (2.3-6.1 MPa)		
Traction rate* (proportional to flow rate)	10-20 ft/min (3-6 m/min)		
Pulse cycle rate (proportional to flow rate)	3-6 Hz		
Maximum temperature	400°F (200°C)		
Fluid compatibility	Water, brine, weighted mud, bleach, solvents, 1% acid, 3% KCl, polymer gel and scale dissolvers		
Gas compatibility	Air, carbon dioxide, nitrogen, or multiphase		

* Values calculated using Tempress Performance Software.

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.

Coiled Tubing Connection

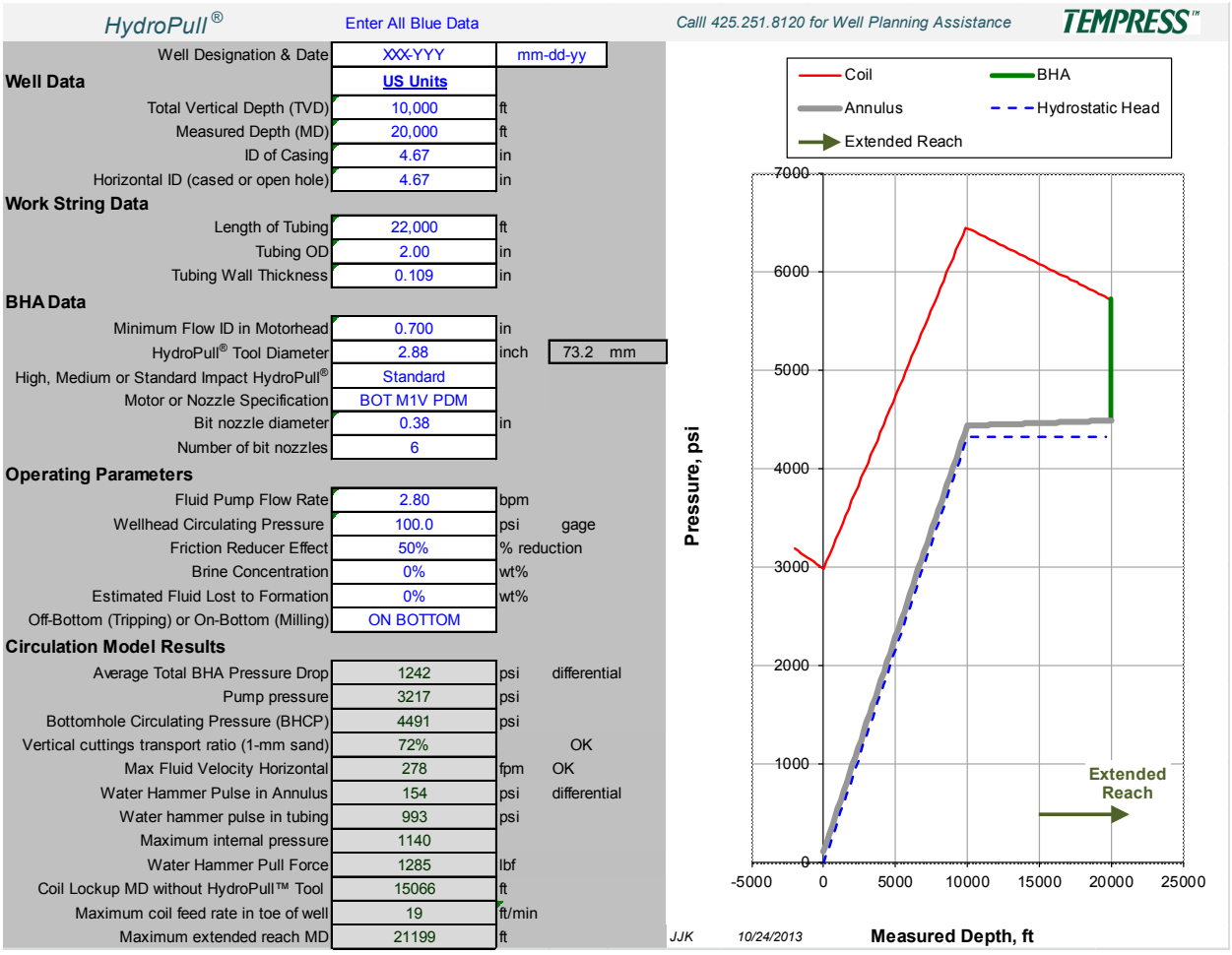
A high-quality coiled tubing connection is required to prevent leakage and failure when the HydroPull® tool is operated at the high end of its design flow rate range. Refer to the HydroPull® Operation Guide for pressure test and pull test recommendations.

Last Chance Screen

Clean fluid with no sand should be run. 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® Performance 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® Enter All Blue Data Calll 425.251.8120 for Well Planning Assistance TEMPRESS™

Well Designation & Date	XXX-YYY	mm-dd-yy	
Well Data	US Units		
Total Vertical Depth (TVD)	10,000	ft	
Measured Depth (MD)	20,000	ft	
ID of Casing	4.67	in	
Horizontal ID (cased or open hole)	4.67	in	
Work String Data			
Length of Tubing	22,000	ft	
Tubing OD	2.00	in	
Tubing Wall Thickness	0.109	in	
BHA Data			
Minimum Flow ID in Motorhead	0.700	in	
HydroPull® Tool Diameter	2.88	inch	73.2 mm
High, Medium or Standard Impact HydroPull®	Standard		
Motor or Nozzle Specification	BOT M1V PDM		
Bit nozzle diameter	0.38	in	
Number of bit nozzles	6		
Operating Parameters			
Fluid Pump Flow Rate	2.80	bpm	
Wellhead Circulating Pressure	100.0	psi	gage
Friction Reducer Effect	50%	% reduction	
Brine Concentration	0%	wt%	
Estimated Fluid Lost to Formation	0%	wt%	
Off-Bottom (Tripping) or On-Bottom (Milling)	ON BOTTOM		
Circulation Model Results			
Average Total BHA Pressure Drop	1242	psi	differential
Pump pressure	3217	psi	
Bottomhole Circulating Pressure (BHCP)	4491	psi	
Vertical cuttings transport ratio (1-mm sand)	72%		OK
Max Fluid Velocity Horizontal	278	fpm	OK
Water Hammer Pulse in Annulus	154	psi	differential
Water hammer pulse in tubing	993	psi	
Maximum internal pressure	1140		
Water Hammer Pull Force	1285	lbf	
Coil Lockup MD without HydroPull™ Tool	15066	ft	
Maximum coil feed rate in toe of well	19	ft/min	
Maximum extended reach MD	21199	ft	

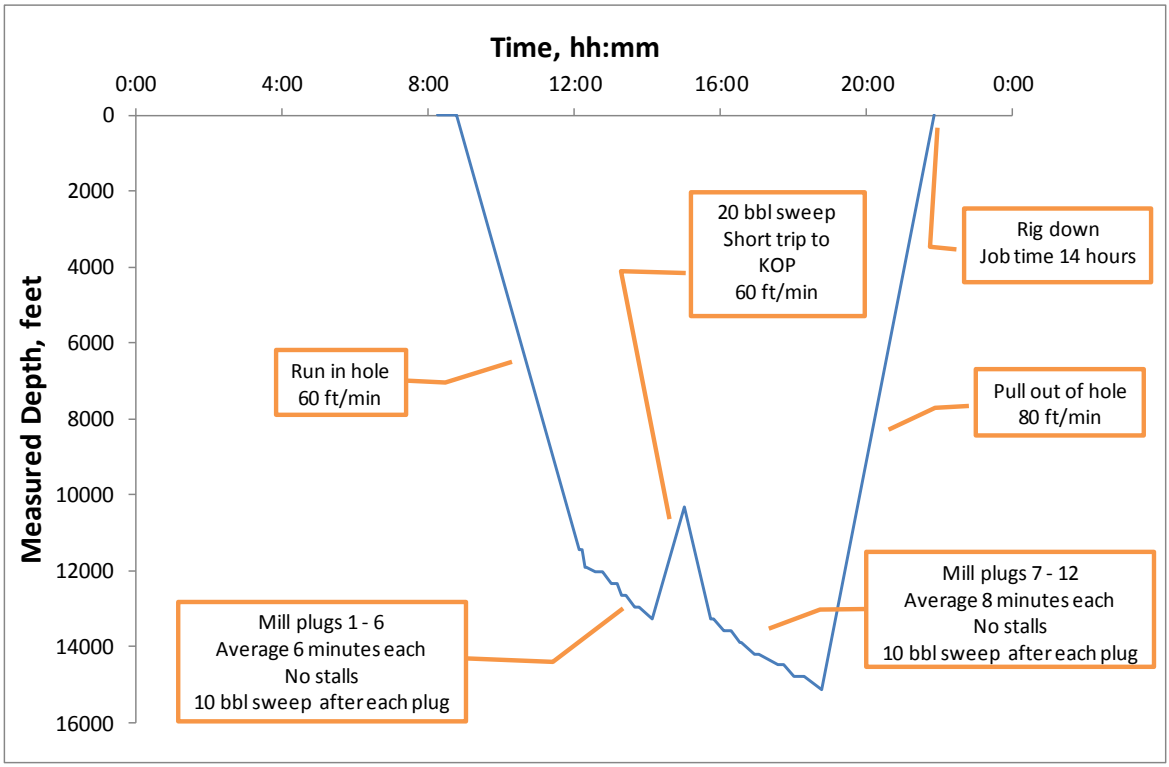
HydroPull® Operation Guide

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 thousands of 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%.***

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 gas separator 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.***