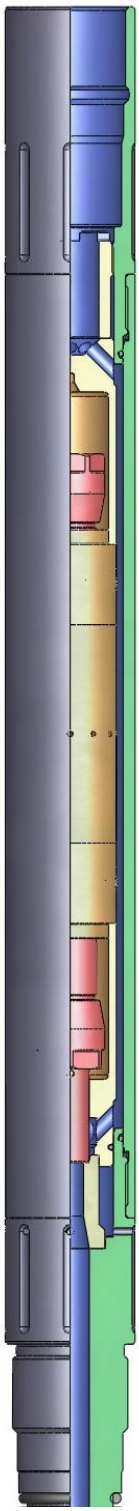
TEMPRESS®

# HydroPull™



*U.S. Patents 6,237,701 and 7,139,219*

## Extended Reach Tool

This tool incorporates a cycling valve that momentarily interrupts the flow to create water-hammer pressure pulses inside the coil and suction pressure pulses in the wellbore. The water hammer generates traction forces of up to 4000 lbf on the end of the coil at a rate of 10 pulses per second. These periodic pulses also vibrate the coil, which reduces friction drag and extends the lateral range of the coil by delaying the onset of helical buckling and lockup.

The valve generates pressure pulses in the wellbore that pull in formation fluids and clean perforations and screens. When the valve opens, the trapped pressure is released as an intense jet pulse when a jetting head is used.

### Coiled Tubing Applications:

- Extended reach milling
- Formation stimulation
- Chemical placement
- Screen and perforation cleaning
- Scale removal
- Acidizing
- Drilling damage removal
- Deployment of logging tools

### Flow Rate Effect

The traction force is linearly proportional to flow rate in the coil. The Standard configuration is recommended for most applications. Lo-Impact and High-Impact versions are available in the 2.88" size for special applications.

### Through-Tubing Motors

The tool is designed to run above a downhole motor for milling applications. The pressure pulsations improve weight transfer in long horizontal wells for more effective milling. ***The need for friction reducing beads or chemicals is eliminated.***

### Nozzles and Jetting Tools

An optional bullhead nozzle is equipped with forward and rear-firing jets is used for well cleanout and stimulation. The jet pulsation is effective in clearing bridged fill. This configuration provides the highest flow rate and traction force. The pressure pulsation produced by the tool increases the effectiveness of high-pressure jetting tools. High-flow nozzles should be specified to maximize pulse amplitude and extended reach. Low flow nozzles should be specified to maximize pressure for hard scale milling.

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## Two-Phase Flow

The HydroPull™ tool is designed to operate on two-phase flow. The presence of nitrogen dampens the impulse amplitude. If a Tempress motor gas separator (MGS™) is run, it should be located downstream of the HydroPull™ tool to ensure maximum effectiveness of the tool. The HydroPull™ should not be operated on straight gas while on surface.

## Logging Tool Deployment

A crossover sub is available for logging tool deployment. The crossover ports the flow to the side of the tool.

## 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 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 1/16" (1600 microns).

## *Specifications*

| Diameter | **1.69"** **(43 mm)** | **2.12"** **(54 mm)** | **2.88"** **(73 mm)** |
|---|---|---|---|
| Connected length (with screen sub) | 40.01" (1016 mm) | 43.55" (1106 mm) | 58.70" (1491 mm) |
| Connections | 1" AMMT | 1-1/2" AMMT | 2-3/8" PAC-DSI (mod) |
| Design flow rate | 1.0 - 1.6 bpm (160 - 250 lpm) | 1.6 - 2.5 bpm (250 - 400 lpm) | 2.5 - 3.5 bpm (400 - 550 lpm) |
| Average pressure differential | 360 – 720 psid (2.5 – 5.0 MPa) | 360 – 1800 psid (2.5 – 12.0 MPa) | 300 - 500 psid (2.2 – 3.5 MPa) |
| Pulse amplitude (Proportional to flow rate) | 1.5" CT 1000 - 1700 psi (7 – 11 MPa) | 1.75" or 2" CT 1000 - 1600 psi (7 – 11 MPa) | 2" CT 900 - 1300 psi (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) | 8 – 12 Hz | 10 – 17 Hz | 6 – 12 Hz |
| Max. temperature | 400°F (200°C) | | |
| Fluid compatibility | Clean, low-solids, fluids: water, 1% acid, 3% KCl, scale dissolvers, *The 1.69" and 2.12" acid capable tools will handle 28% HCl.* | | |
| Gas compatibility | Multiphase with fluid: air, carbon dioxide, nitrogen | | |

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## *Case Histories*

The HydroPull™ tool has been run in over 200 wells in the U.S. and Canada since introduction in 2010. Runs range from 1 to 4 days continuous operation.

1. **Extended Reach Bridge Plug Milling**: This job involved milling 15 bridge plugs from 5" casing in a horizontal well with TVD of 14,430' and MD of 18,510'. The bottom hole temperature was 325°F (163°C). The first 9 plugs were milled without a HydroPull™, but progress stopped at 16,820' MD because of friction lockup of the 1-3/4" coil. A 2.88" HydroPull™ was rigged up and operated at 1.5 to 1.75 bpm above a motor and mill to remove the last 6 plugs. Plug to plug milling and tripping times in the last 6 plugs were the same as the first 9. ***TD was reached at 4080' horizontal – representing an extended horizontal reach of 70%.***

2. **Heavy Oil Well Stimulation (2 well program)**: A 1.69" HydroPull™ was operated on 1-1/2" coil to enter a 7" slotted liner in a heavy oil horizontal completion. Prior attempts to enter this well were prevented because of obstructions at 3100 to 3800 ft. A bullnose nozzle was run. The tool was operated at a flow rate of 1.3 bpm of produced water plus 15% AS-1 solvent (kerosene+xylene). The tool slowed at the obstruction, but moved though at 8 ft/min feed, then resuming a feed rate of 20 ft/min. TD was reached at 4592 ft and the tool run out of hole at 33 ft/min. 280 bbl of fluid was pumped. ***Well production increased from 44 to 605 bbl per day with low water cut.***

   On the second well, a 1.69" HydroPull™ was used to place 315 bbl water with 3% KCl and 2% MudSol. A bullnose with 3 x .188" forward facing jet nozzles was run. Flow rate was 0.9 to 1.3 bpm with surface pump pressure of 1740 psi. The tool was run in at 10 to 20 ft/min though the 5-1/2" horizontal slotted liner to TD at 4920 ft MD, 1970 ft TVD. The tool was pulled back every 300 ft to sweep sand fill. Well production increased from 25 to 44 bbl per day with low water cut.

3. **Extended Reach CO2 Injection Well:** This job required re-entry into a 6.1" diameter horizontal openhole from 4760 to 8070-ft MD to place solvent. The horizontal section was 3313-ft. Prior attempts to enter this well with 1" continuous rod failed at 6230-ft MD. The casing was 2.44" ID so a 1.69" HydroPull™ with a 4-jet nozzle pattern was run on 1.5" coiled tubing. The tool was operated at 1.3 bpm and at feed rates of 30 to 65 ft/min. The final 1000-ft to TD was entered at 10-ft/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 HydroPull™ tool the following day. Commingled fluid (0.7 bpm water and 525 scf nitrogen) was pumped to lift the solvent from the well. ***The HydroPull™ extended the lateral reach of the coil by 20% or 690 ft in this well.***

4. **Milling Bridge Plugs in 5.5" casing (4-Well Program):** A 2.88" HydroPull™ was run with a motor and mill to mill bridge plugs inside 5.5" casing from 7500 to 13,000 ft MD on a horizontal gas well completion (5500 ft horizontal). For the first job, a Tempress gas separator tool was run below the HydroPull™ and above the motor. The tools were operated at 3.25 bpm with 0.5 bpm fluid, or gas equivalent, bypassed by the separator. Eight bridge plugs were milled in an average time of 8 minutes each. At TD the coil shaking on surface was strong. In offset jobs running a competitive vibrating tool instead of the HydroPull, the average milling time was 40 minutes per plug.

For the next two wells, the Tempress gas separator was run above the HydroPull™ and motor to reduce 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.***

5. **Bridge Plug Milling in the Marcellus Shale (5-Well Program)**: These jobs required milling bridge plugs in 5000' to 6000' horizontal 5.5" casing to 11,700' to 12,000' 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™ and thirty-seven were milled without the HydroPull™ using beads and chemicals. The 2.88" HydroPull™ was operated on 2" tapered coil with a motor and mill using produced water at 2.5 bpm. In the toe of the well ***the average plug milling time was reduced from 147 to 36 minutes***, a factor of four. In the heel, the plug milling time was cut in half.

6. **Bridge Plug Milling:** This job involved milling 14 bridge plugs over 4000 ft of horizontal 5.5" casing. The tool was operated on water with friction reducer at 2.5 bpm. The pump pressure while milling with 2" coil was 4900 psi with 1750 psi 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 ability to mill bridge plugs in a pressurized well because of the low-pressure differential though the tool.

7. **Perforating Gun Placement:** The customer required perforating guns to be set in a long horizontal shale well at measured TD of 14,700'. A 2-7/8" HydroPull tool was run on coil above the perforating gun array. The coil was run in hole at a flow rate of 0.5 bpm and locked up at 14,200'. The flow rate was increased to 1 bpm and the array was run to TD without further ado. The perforating guns were actuated by pressurizing the wellbore and fired properly. All tools were recovered in good condition.