

Thru-tubing intervention benefits a range of wells

John Roberts, Weatherford Intervention Services

WEATHERFORD'S THRU-TUBING operations continue to grow in response to customers needs for less expensive, quicker, better, and safer methods to re-enter and work over wells.

Conventional workovers are very expensive, time consuming and can eat up a lot of the profits increased production might provide. This economic reality could limit the range of wells qualifying for production enhancement work. Weatherford's Thru-Tubing Intervention Services helps decrease that cost and allows a variety of wells to benefit from the procedures.

Thru-tubing in Weatherford's terminology refers to products and services performing functions inside the production tubing as well as in the casing below the end of the tubing. While all of the thru-tubing operations are handled in one group, the products required for each differ dramatically.

In general terms, Weatherford Intervention Services thru-tubing product line is made up of three sub-categories—thru-tubing packers, downhole motors, and fishing products and services.

Beyond the products themselves are the expert technicians operating them in the fields and the engineers who design and develop these systems. Through internal development, acquisitions, and alliances, Weatherford has developed new, patented systems that can perform in extreme downhole conditions with accuracy and reliability.

INTERVENTION PACKERS

In 1998, Weatherford acquired **Tech-Line** to augment the company's line of thru-tubing packers. A critical component in any comprehensive thru-tubing

program, these packers allow for several types of zonal isolation, which in turn allows the operator to perform cement squeezes, acid stimulation, plug and abandonment services, other remedial work and slimhole completions.

Weatherford's Jet Pack Straddle System™ packer system was developed to address a common problem with thru-tubing operations. When operating on coiled tubing, there is no way to accurately manipulate the tubing to actuate the packer.

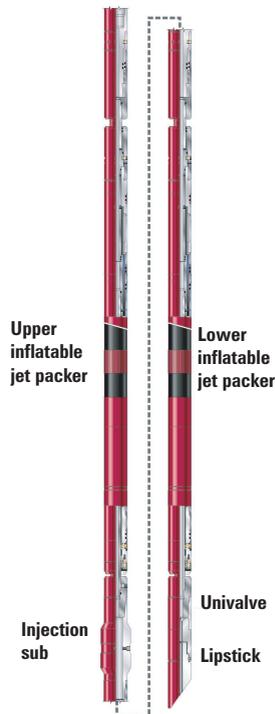
Using Weatherford's new design it is now possible for the packers to be set, isolate the zone of interest, and perform the stimulation all in one operation. Once the stimulation is completed, shutting off the pumps releases the packers so the bottom hole assembly can be positioned to a new depth for additional stimulation.

The development of the Jet Pack Straddle System led to a number of key patents.

While this innovation was helpful in stimulation tool applications, when two packers are being set in a section of the well to isolate treatments, there was still a need for traditional mechanical and inflatable packers that benefit from this technology.

To address these two distinct markets, the packer engineering division was split into two groups, one to develop inflatable products and the other to develop mechanical products.

The mechanical packers produced have a distinctly narrow outer diameter (OD) so not only can they pass cleanly through the production tubing, but they can clear the narrower areas such as safety valves and production nipples. Using these two lines of packers, Weatherford thru-tubing can perform any isolation work that a conventional workover would call for.



System allows packer to be set, zone isolated and stimulation done in a single operation.

DRILLING MOTORS

A vital component to downhole remediation and drilling operations, Weatherford's Positive Displacement Motor (PDM) operates on the Moineau principle; the conversion of hydraulic energy to mechanical energy. But today's standard service equipment cannot withstand the forces generated by emerging applications.

Understanding that, Weatherford set about to develop a world-class motor that was "built for purpose." As advanced metallurgical and engineering principles are employed in the design of small diameter motors Weatherford has substantially increased the amount of horsepower we can safely deliver to the bit. Significant advancements in the motor's bearing and drive train technology have yielded the ability to withstand the rigors of modern applications while delivering that increased horsepower for extended periods.

As versatile and reliable as the PDM is, it has certain limitations. Because the design relies on an elastometric stator it is susceptible to damage working in downhole temperatures greater than 350 degrees Fahrenheit. It is also susceptible to damage from a variety of corrosive fluids.

To overcome the limitations of the PDM, a new motor design was developed with the help of technology licensed from **Rotech Ltd** in Aberdeen, Scotland. The MacDrill is an all-metal design that turns the bit without the use of any elastomer components. This tool can be used for work in wells with a downhole temperature as high as 500 degrees Fahrenheit without damage. The MacDrill can also be used in a variety of corrosive fluid applications.

Work is also progressing on the development of the MacDrill that can be used for directional drilling and there are a number of other changes occurring that will further integrate of the two motor designs.

The bearing assembly for the PDM is being applied to the MacDrill motor. Using a compatible bearing assembly means a standardized attachment for the two lines of motors.

Drill motor, orienter add options

Tom Tilton, Weatherford Drilling and Intervention Services

THE MACDRILL was developed to overcome the high-temperature limitations of the conventional Positive Displacement Motors (PDM). The MacDrill is an all-metal thru-tubing drilling motor design that can operate in environments greater than 300 degrees Fahrenheit.

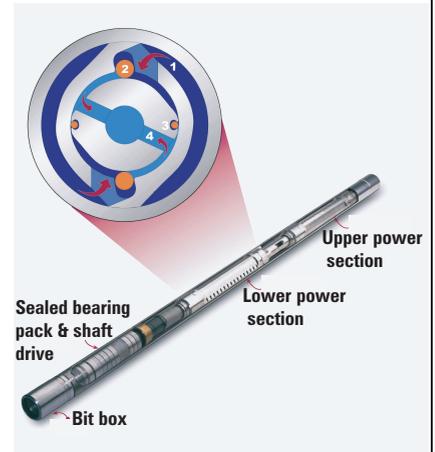
The MacDrill design incorporates a planetary gearbox to reduce operating speed and increase torque output levels comparable to conventional PDMs. The extremely short power section results in tools with the shortest length to torque ratio in the industry. Multiple gear reduction devices can lower speed and increase torque even further. This is of increasing importance for new applications of the tool. In a high-temperature fishing operation, for example, the MacDrill could be used to slowly rotate an overshot onto a fish and then use rotation and torque to aid removal.

While not necessarily performed on

coiled tubing, or thru-tubing, the MacDrill plays a critical role in some Underbalanced Drilling (UBD) activities. In UBD intervention, which may be a thru-tubing activity, a conventional PDM is susceptible to damage from nitrogen or other gases used as compressible drilling fluid. The compressed gas permeates the elastomer stator in the PDM. When the pressure regime downhole changes it can cause explosive decompression of the stator.

This will occur when the pressure drops, allowing trapped gas to form blisters and fractures in the elastomer. This can cause catastrophic damage to the stator and the motor. Because the MacDrill is based on technology that doesn't require elastomers it can easily function in an UBD situation.

Another application of the MacDrill is its use in well clean out operations. With a jet tool attachment, the MacDrill is able to generate high-energy rotating jets that clean away scale and asphaltenes in the wellbore. Additional development is underway to further



The MacDrill is Weatherford's thru-tubing drill motor suited to high-temperature applications.

increase the high-pressure differentials across the jet.

Finally, the hydraulic orienter is a tool Weatherford is very proud of. The savings offered by a coiled tubing solution for reentry work can quickly evaporate if the bottom hole assembly (BHA) is not properly oriented. Over the last year Weatherford has upgraded the reliability and repeatability of the coil-tubing hydraulic BHA orienter. ■

FISHING SERVICES

Of the three components that make up the Thru-Tubing Intervention group, Thru-Tubing Fishing Services is the most critical. These services are relied on to remedy well problems such as collapsed/parted tubing, retrieval of lost tools, removal of cement and other debris, and other operations.

Initially, Thru-tubing Fishing Services evolved from conventional fishing operations run on a drillstring. Rotation was traditionally the preferred method of activating a conventional fishing tool, but rotation of coiled tubing during thru-tubing fishing operations is not possible.

Also, many of the first tool designs were based on wireline fishing equipment. Shortcomings to tool design and services became readily apparent.

To overcome the shortcomings of both conventional and wireline fishing, a series of hydraulically actuated tools were developed. Using these tools, combined in some cases with jars, a variety of tools can be run, set, and activated to retrieve items in a wellbore.

One key to designing a successful fishing tool is to look at the future of the workstring. While coiled tubing is used 70% of the time, a rig or snubbing unit may also be employed. The pulling forces of a rig or snubbing unit and new 110K and 120K yield coiled tubing alloys require stronger fishing tools.

While the base technologies related to Thru-Tubing Fishing Services are about 7-8 years old, those technologies are being improved. Weatherford has developed more robust overshot and spear designs that do not require a specific profile to latch onto. The new design can catch a fish that has a slick OD or ID.

ADDITIONAL SERVICES

Cutting windows on coiled tubing brings together all of the developments in the Thru-Tubing Intervention Services group. Weatherford recently entered into a technology agreement with TIW for the development and commercialization of monobore and Thru-tubing Casing Exit Services.

Operations under this agreement are ongoing on Alaska's North Slope. Expe-

rience gained there will naturally lead to new developments. Our plan is to carry this technology to other markets around the globe.

TIW's confidence in Weatherford's thru-tubing equipment and technology is reflected in this exclusive agreement.

Thru-Tubing Intervention Services offer a wide spectrum of service possibilities. Many of the new products developed are currently in the field-testing phase and will soon be available.

Weatherford is expanding its thru-tubing field offices worldwide and plans to continue working with customers to offer solutions to their needs.

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