MULTILATERAL LEG RE-ENTRY WITH COILED TUBING CASE HISTORIES

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ABSTRACT

Drilling multi-laterals is becoming a preferred method to increase production from a single wellhead. Coiled tubing's role continues to grow as a well intervention system, but is limited in its capacity for selective entry into multi-lateral completions. Without a practical method to selectively enter multi-lateral completions to perform workovers and stimulation operations, these wells are not achieving their full production potential.

A tool has been developed, tested and proven that allows CT to selectively enter each leg of a multi-lateral completion. The tool finds and enters the desired juncture or window and signals the operator at surface that it has done so.

The Lateral Entry Guidance System is being used reliably for conventional CT stimulation or cleanout applications, and it has been adapted to run on the end of other specialized tools. This paper will discuss the tools development/testing and case histories of successful operations in the Permian Basin.

BACKGROUND

Multilateral drilling allows maximum wellbore contact area with the drilled hole. Multilateral wells fall under two categories; laterals off the vertical and laterals, or junctions, off laterals. Re-entry into the different laterals or junctions can be a challenge, making stimulation and or isolation of these laterals a formidable task. Special junction valves and other completion equipment can be installed in cased completions, making re-entry possible. However, this technology can be uneconomical in many fields with marginal production, and does not apply to open hole completions.

A tool was designed, built and tested to accomplish re-entry into multi-laterals. The tool selects alternate legs or laterals and provides a signal at surface that it has done so. The tool uses no electric line or guidance systems. With modifications, the tool can be used in conjunction with other coiled tubing down hole tools.

TOOL OPERATION

The tool works in two modes. The first mode allows circulation through the tool and keeps the tool straight. This mode allows the tool to run into the wellbore in a "natural" manner. In wells with laterals off laterals, running in hole in the straight position delivers the tool into the "natural leg". The "natural leg" is simply the first leg the tool enters. This is usually the last leg drilled.

The second mode is operating the active bent sub to search for the sidetrack. In this mode (mode 2, figure 1) there is no circulation, only internal pressure in the coiled tubing to activate a series of valves in the upper module of the tool. The tool bends an active kick off sub when the coiled tubing internal pressure reaches 2400 psi. The kick off sub then starts to rotate for a full 360 degree "sweep" of the hole in an attempt to get the bent sub tip or "wand" into the sidetrack (see figure 2).

When the wand tip enters a sideleg window, the bent sub is allowed to fully kick over. When the wand is fully kicked over at a 15-degree angle, it develops a slow 4 GPM leak. This slow leak gives feedback at surface that a lateral window has been located. The length of the wand is critical. It must permit entry into the sidetrack, but it must be short enough to fully kick over when the sidetrack is discovered. The slow leak halts the tool rotation, maintaining the tool face angle toward the sidetrack.

With the sidetrack has been located, the tool is ready for directed movement into the sidetrack. By increasing the coiled tubing's internal pressure, the tool's detent valve can be opened to circulation mode (mode 1, figure 3). **A** minimum flow rate must be maintained to keep this valve open. Opening the valve also resets the wand to the straight position and reverses the sweep function to the starting position. The tool can now be run in hole to tag total depth for verification of lateral depth. This process can be repeated as many times as needed with only one trip into the well.

The tool is designed to be "weak", meaning that when in mode 2 and the wand is rotating, the wand is not strong enough to lift the tool body. This prevents lifting the pivot point into a junction resulting in a false "leak" signal and breaking the wand when pushed into the hole (figure *5).*

CASE HISTORY #1

The first field trial was performed in Alberta, Canada in a newly drilled oil well with two 4" open hole legs. The main hole had a measured depth of 10,532' and the sidetrack's measured depth was 9,712'. The sidetrack window was suspected to be at a measured depth of 9,515'. The difference was 820' in measured depth, made depth correlation between the laterals easy.

The tool was run in hole in the straight position (mode 1) to identify the "natural leg". The tool reached a depth of 10,532', indicating that the main wellbore was the "natural" leg. Next the tool was pulled back to the suspected area of the multilateral window. The tool was cycled several times. This process started at the deepest part of the window and continued at 3' stages for a total of 35 settings. Since the leak signal was not seen a secondary location method was attempted. The tool was placed above the window and the coiled tubing was pressured to 2400 psi to start mode 2. Once the pressure was established, the coiled tubing was immediately run into the well, hoping to tag the sidetrack with the wand tip. This was successful on the first attempt and increased "pushing" weight on the coiled tubing, while moving into the hole, indicated at surface that the side track had been located. It was determined that the reason a "leak" signal was not observed during the first attempts, was debris in the hole. A wand length that would provide a 7" kick over was thought to be long enough to enter the sidetrack. Due to the debris in the hole, the wand was too long to achieve a full kick off of 15-degrees.

The tool was put into the straight position (mode 2) and run into the hole. The *tool* tagged bottom at 9,712'. The well was then acid washed one lateral at a time.

CASE HISTORY #2

The first application in the USA for the L.E.G.S. tool was an oil well in Crane, County Texas. The well was drilled in 1940 to a depth of 2,826' with production casing set at 2,533'. The well produced from an open-hole section. In an attempt to expose more pay and increase production, two laterals were drilled from the vertical wellbore.

Lower Lateral
Milled window: 2.351' – 2,359'
Open Hole: 6 1/8"
End of curve: 2,882' MD (2,667' TVD)
Length: 1,074'
Inclination: 89.40"
Azimuth: 188.70"
TD: 3,956' MD (2,699 TVD)

Upper Lateral
Milled Window: 2,322' – 2,330'
Open Hole: 6 1/8"
End of curve: 2,789' MD (2,626' TVD)
Length: 1,204'
Inclination: 90.40°
Azimuth: 181.70°
TD: 3,993' MD (2,640' TVD)

The planned procedure called for an underbalanced wash to TD with nitrified 2% KCL water on each lateral. Each lateral would also be acidized (squeezed) while pulling the coil out of the lateral. Since a single-phase fluid is required to function the tool in the search mode (mode 2), the coil was loaded with 2% KCL water and run in hole below the lower window. The coil was pressurized to function the tool in mode 2. No "leak' detected. The tool was re-set in the straight position (mode 1) and pulled up 3 feet. The tool was cycled again, and no "leak" was detected. On the third cycle, the "leak" was detected while being pulled up hole. The tool was slowly pushed into the lateral for 10 feet and further pressurized to put the tool in the straight position (mode 1) and rotate the wand to its original position. Circulation was established with nitrified 2% KCL water. The open hole was then washed underbalanced while running in hole at 10 ft/min. When TD was tagged at 3,956', the coiled tubing annulus was closed and the lateral was acidized in 5 stages, using

foam for diversion, while the coil was pulled up the hole.

The L.E.G.S. tool was pulled up hole to search for the upper lateral. The upper lateral was found on the second attempt. The underbalanced wash and acid squeeze was repeated on the upper lateral. The tool performed exactly as designed in this well re-entry.

RESULTS AND CONCLUSIONS

It took 25 minutes to find the lower lateral and 19 minutes for the upper lateral. The production results are as follows:

Prior to treatment: **8** BOD & 100 BWD
90 days after treatment: 116 BOD; 156 BWD and 4 MCFD (average)

The operator reported that the Lateral Entry Guidance System saved $12,000.00 in rig cost and ***3*** days production down time.

The Lateral Entry Guidance System is an assured method to re-enter uncontrolled multi-laterals using coiled tubing. The tool uses no electric line or guidance systems and can be modified to run with other coiled tubing downhole tools.

REFERENCES

M. Lambert: "Multilateral Well Leg Re-Entry Made Possible With Unique Coiled Tubing Downhole Tool", paper. SPE 60702 presented at the 2000 SPE/ICoTA Coiled Tubing Roundtable held in Houston, Texas, 5-6 April 2000.

ACKNOWLEDGEMENT

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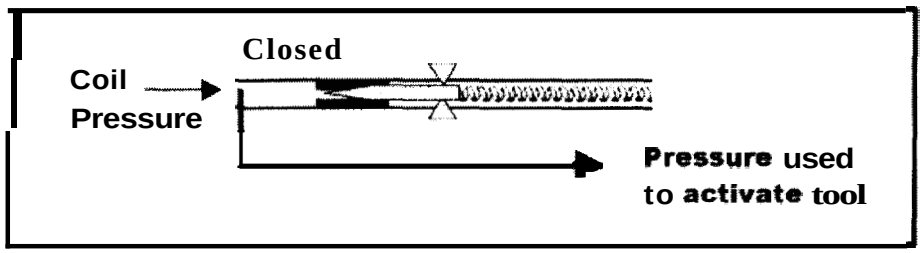

Figure 1 - Tool Set in Mode 2

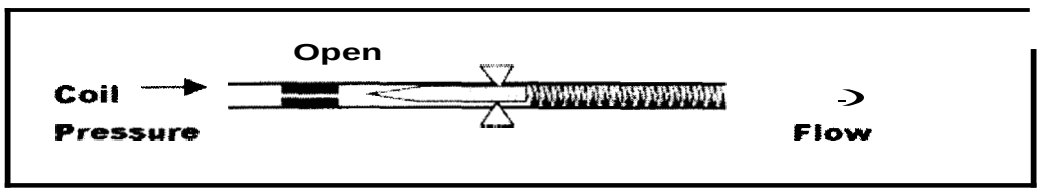

Figure 2 - Tool in Circulating Mode 1

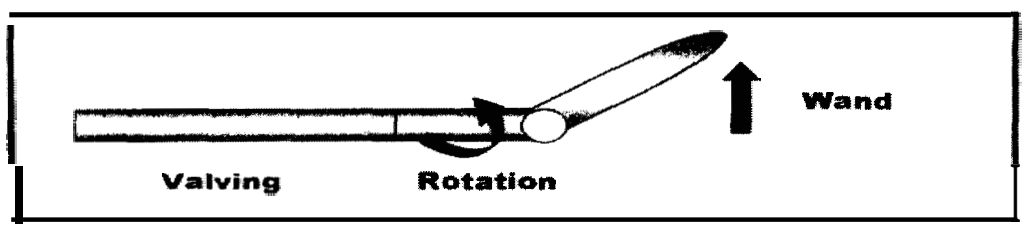

Figure 3 - Tool Set in Mode 2

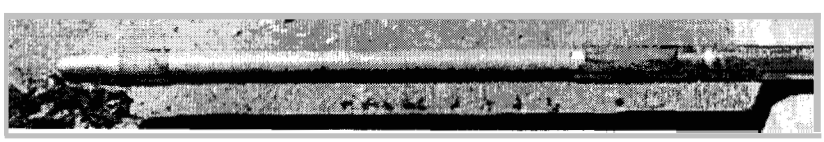

Figure 4 - Wand Showing Bullet-Nose Wash Tip

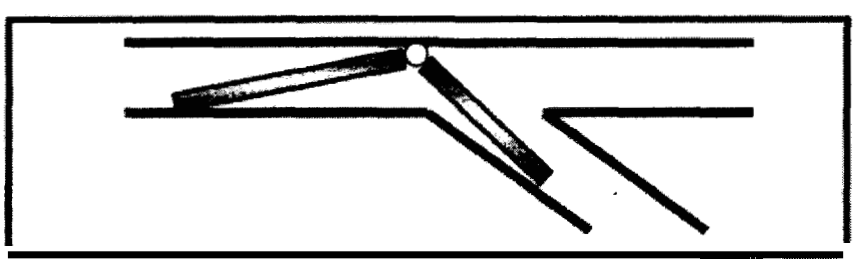

Figure 5