Improving Re-entry in Multilateral Horizontal Wells

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Abstract

Multilateral horizontal wells have been used as an approach to further improve production and injection volumes. As a result, very often the steep hyperbolic decline seen in a single lateral well is reduced. The first approach used was with a milled casing section in which several laterals are drilled off a cement plug. Subsequent laterals are then sidetracked off the main laterals drilled. These laterals are 4 3/4 inch openhole with no liners. Re-entering these laterals is costly when doing initial stimulation work for completion. Considering the future need to clean out fill or other precipitants with a bit and also to re-stimulate, a lower risk well design was desirable. With the help of Weatherford Enterra, a system designed using a permanent packer and retrievable whipstocks was used to address the problems and costs of finding multiple laterals. The system has considerably reduced the amount of time it takes to locate each lateral and greatly improved the likelihood of doing so at a later date.

Introduction

In the Four Corners area, multilateral horizontal drilling has proved to be advantageous. This optimizes the use of existing wellbores and locations. While Mobil has drilled numerous single lateral short-radius wells and some new medium radius wells, multilaterals have been a recent emergence. Mobil has wisely built on previously used techniques for the single lateral re-entries and built on those used by offset operators for multilaterals. This paper will briefly review the previous technique and compare it with the current technique, the focus of this paper.

Casing Sections

A cast iron bridge plug (CIBP) is set below the anticipated depth of the bottom of the interval to be milled. The casing section is then milled with a section mill. When using a steering tool for directional information, that section can be anywhere from 20-40 ft long. Once that section has been cut, a kick-off plug is spotted from the CIBP to a depth approximately 50-100 ft above the top of the sectioned interval. The motive behind this is to have enough cement still above the kick-off point, in the event the top of the cement is contaminated. The cement can be dressed off to the kick-off point, usually 5-10 ft below the top of the section interval. When using an MWD, the section interval must be longer to minimize interference from the casing with the MWD. A gyro can be used to get kicked off, until the MWD can pick up a reliable signal.

The first lateral, most often the upper one, is drilled and then all subsequent laterals whether opposing or stacked (in the same azimuth at a differing TVD) are openhole sidetracked from it. A junction area is created made of cement and rock that is susceptible to erosion and enlargement from drilling operations as well as stimulation fluids. This creates a difficult situation when attempting to re-enter the laterals for stimulation purposes. Many operational days can be spent requiring a steering tool and/or a motor in an attempt to find a 4 3/4" hole, even at a known azimuth. All of this is done in a hole of unknown diameter. Often entries into laterals are clogged with drilled solids. This approach requires a great deal of accuracy, along with good fortune, to get back into a lateral the first time. Generally, the last lateral drilled is the easiest to get back into. To minimize these costs, an operator may choose to forego individual lateral stimulation and stimulate everything at once. Even if the laterals can be re-entered initially, after stimulation is it very unlikely that they can be entered again.

These difficulties with completions as well as future operations led to a search for a better approach. The solution was an application of existing technology in a different way. The desire was to have an isolated entry point for each lateral that could be found not just during completion but at any time during the life of the well.

Whipstocks

These difficulties with completions led us to consider whipstocks as an option which would offer easily accessible entries to each of the laterals. We wanted to have the ability to use retrievable whipstocks for numerous laterals. Weatherford Enterra was approached about this idea. Weatherford assisted with the idea of using retrievable whipstocks and a permanent packer. The packer is a TIW big bore permanent packer. The hinged back retrievable whipstocks are available with a 1.5° or 3° face. The 3° face was chosen to get away from the casing faster and minimize the risk of drilling down the mudline. The whipstocks are retrieved with a hook.

To outline the application, a TIW packer is set at a point below the lowest window to be milled. The bottom of that window will be the kickoff point for the curve of the lateral to be drilled. Once the packer has been set, an orientation of the keyway is obtained using a gyro. The keyway orientation is then used to orient the whipstock on the surface which is then run and latched into the packer. The milling operation then proceeds with shearing the shear bolt and milling with the starter mill. A window mill and watermelon mill are run on the next trip and if necessary a third mill run is made to clean up the window area. One and a half to two feet of open hole is made before finishing the milling process.

The curve assembly is then used to drill the curve with the guidance of a gyro above the motor. Once the gyro reaches its limit of inclination a steering tool is then run with a wet connect to finish the curve. The curve assembly is tripped out and the lateral assembly tripped back in to drill the lateral.

Once TD is reached for the lateral and all directional tools have been pulled, a retrieving hook is run in to retrieve the whipstock. The latch mechanism is set to shear with 30,000 overpull. The next whipstock is oriented with an extension in the assembly to get the kickoff point (the bottom of the concave) up to the desired depth. The extension lengths have varied from 8 feet to over 50 ft. For whipstock assemblies too long to lay on the catwalk and orient, TIW has developed a double spline (box X pin) sub to orient the whipstock itself to a scribed line on the assembly from the latch key. (See Figure 1.)

The extensions mentioned are made from drill collar stock with IF connections to minimize play inside the casing while milling and drilling. These extensions can be used in the future and for completion or for other wells provided they are the correct OD and connection size. The extensions can have stabilizer fins added to them for added stability with increasing lengths of whipstock assemblies.

Once all of the laterals are drilled, the completion can either utilize whipstocks for re-entry or a re-entry guide which Weatherford has developed. The re-entry guide has an opening that can be pumped through while running the tool in order to wash any debris which may be on or around the packer. The re-entry guide is designed to be above the bottom of the window 6" protecting the bottom of the window milled. It is retrieved with an overshot to protect the top of the window. It is made up with the same extensions used to drill the laterals and oriented at the surface to the orientation of the original whipstock. This allows each lateral to be treated individually.

Comparison

While the casing section appears less expensive, there is an average of seven days spent in the process of milling the section and spotting the kickoff plug. This is the best case scenario, many operators have found difficulties obtaining quality kickoff plugs the first time they are spotted. Worn mills, casing collars, centralizers, and scratchers have also been found to be obstacles that can increase the cost and time of the sectioning operation. Sectioning also produces a larger amount of metal cuttings that can get into the pump system and cause mechanical problems.

The completion phase of a well with a casing section has already been mentioned. More money can be spent on trying to get back into the laterals than on the stimulation itself. Provided that all the laterals are entered, the well can be effectively stimulated.

Although the whipstock system moves additional cost to the drilling phase of the operation, the completion cost has been cut drastically. It takes one third of the time spent on a sectioned well to complete (Fig. 2). This amounts to approximately 3 days per lateral. Therefore more of the funds can be used for additional stimulation volumes if desired. Along with the simplification of the completion, at any time during the life of the well, a lateral can be re-entered with greatly reduced risk.

Summary

This is a new application of existing equipment and technology applied first for Mobil E&P US. In cases where casing integrity is good, whipstocks can be used with a permanent packer and extensions to drill multilateral wells. The cost is higher than section milling in most cases, however, the expense reduction during the completion phase can offset the added cost. An additional benefit is that laterals can be spaced out to allow testing of one lateral at a time. The utility of the well is then higher in the future than that of a multilateral well drilled from a casing section.

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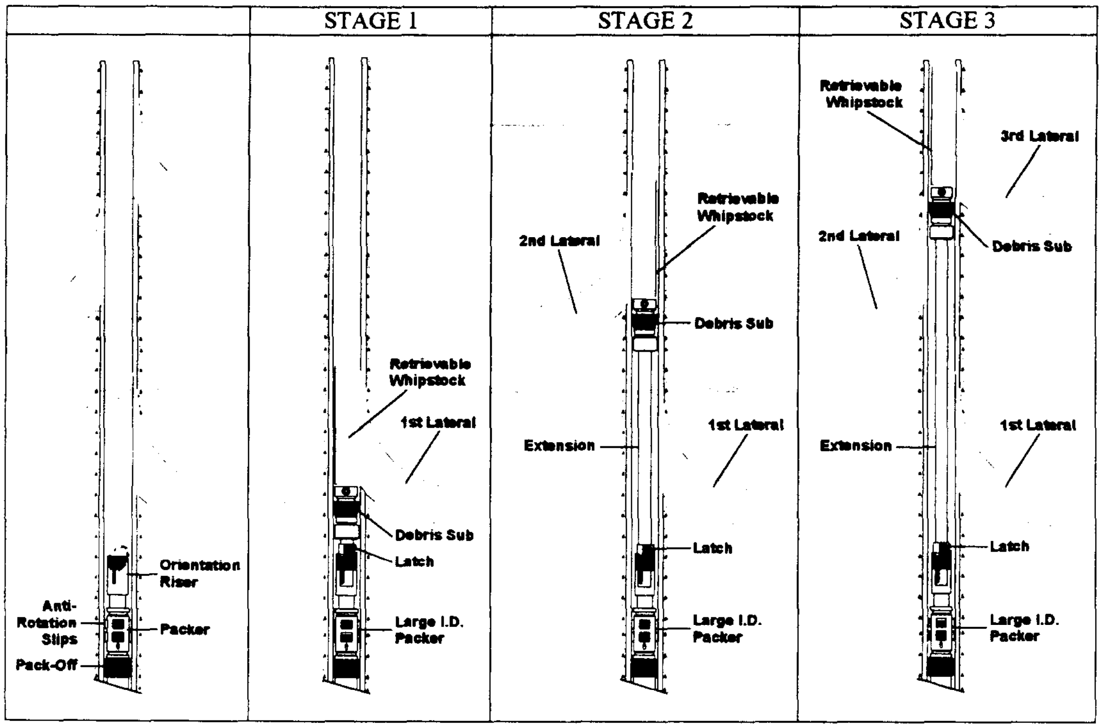

Figure 1- Multi-Lateral/Selective Reentry Type Whipstock

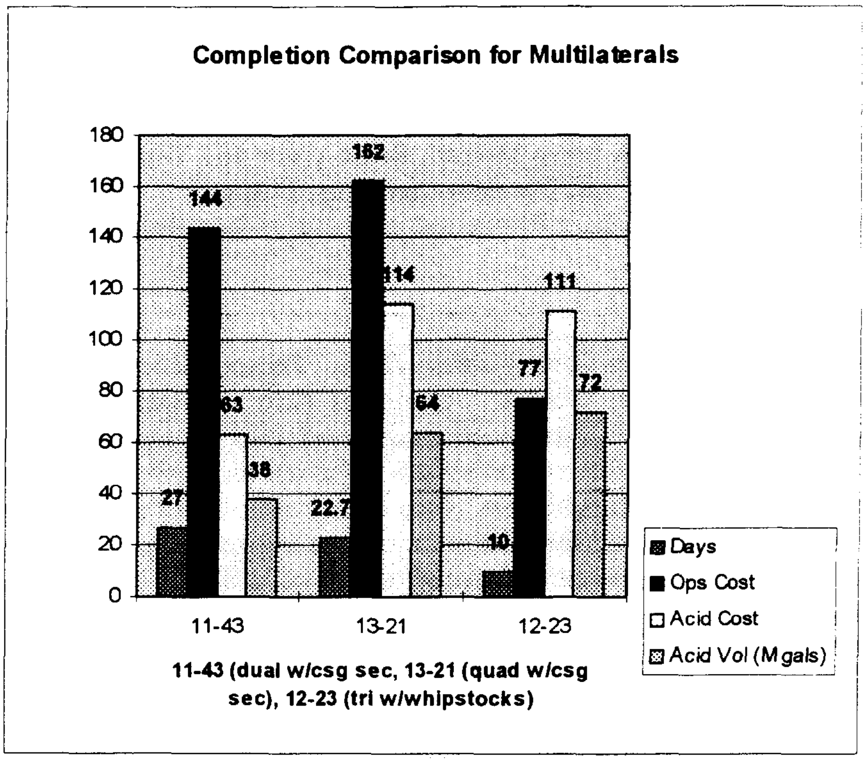
Completion Comparison for Multilaterals
180
160
140
120
100
80
60
40
20
0
144
162
27
63
38
22.7
114
64
10
77
111
72
11-43
13-21
12-23
11-43 (dual w/csg sec, 13-21 (quad w/csg sec), 12-23 (tri w/whipstocks)
Days
Ops Cost
Acid Cost
Acid Vol (M gals)

Figure 2