Alternative to a pilot hole in horizontal wells

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BACKGROUND

At present, drilling pilot holes is still a common practice in many places. On development fields, in spite of all the information available, it is common to find pay zone at unexpected depths. There are several risks in cases where no pilot holes are drilled.

For example, a formation found too high may require a cement plug while a formation found lower may increase drilling time and "use up section" (more casing needed).

Logging while drilling (LWD) tools allow good interpretation but do not prevent geological surprises that makes "landing" impossible at times. Even in cases where pilot holes are drilled there can be still be surprises as the entry point may be 500 ft away from the pilot hole.

Landing a horizontal well is often unpredictable, frequently requiring the use of a pilot hole. The objective is to drill a usable build section for a production well with minimum lost time while also obtaining localized geological data normally gathered from a pilot hole.

Formation thickness can be different at the entry point thus making landing inadequate.

Pilot holes are usually drilled at drift angles around 60 degrees for various reasons, the main reason being cement placement. Also, the higher angle the more formation needs to be drilled and subsequently abandoned.

It's not unusual to lose 1,000 ft of hole to plug and abandon a pilot hole. Side tracking can be a source of delays and may require losing even more of the interval drilled.

To apply any of the proposed systems, casing shoe placement and the possibility of drilling two different formations must be evaluated.

In the cases of water driven pay zones, isolation must be perfect. Rate of penetration (ROP) anticipated in the pay should be known to optimize final drift angle.

The techniques proposed allow the following:

• A second chance (for the geologist and/or the directional driller);

• A pilot hole for free (minimum 48 hours gained);

• Determining reservoir thickness (formation dips);

• No additional cost incurred when used as a second chance. In other words, the decision to use or not has no cost implications if the well is landed as per prognosis.

The main procedure for all solutions is to drill a similar profile to a drift angle between 75 and 85 degrees, and hold angle and drill ahead until the bit touches the bottom of the pay zone. When the bottom is touched, there will be indications such as resistivity, bit resistivity and ROP.

The next step is to decide the landing point and casing point. The shoe may be set at TVDs as little as 5 ft above the landing point depending on drift angle and the build rate. The time spent to drill the pilot hole is minimal as a small portion will be lost.

In many cases, as little as 160 ft of hole may be abandoned. The drilling time needed may not exceed an hour on some operations. In most cases, the portion of hole to be abandoned is in the pay zone itself.

PILOT HOLE EXAMPLES

The example used for all of the systems described includes:

• Top of pay zone is touched with 85 degree inclination;

• Pay zone is 26 ft thick;

• Order is to land well 17 ft below formation top.

It will take 300 ft of slant section at 85 degrees to cross and touch the bottom of the pay zone.

SYSTEM 1

System 1 has been used successfully in a shallow heavy oil field around 3,000 ft true vertical depth (TVD). ROP is very high and side tracking is easy. In most cases these sands are not water driven.

Following is the sequence with system 1:

• Well is drilled with a final drift angle of 85 degrees;

• 160 ft of hole are abandoned (i.e. 14 ft in TVD);

• Casing shoe is set 160 ft above base of formation.

The cement job takes place the same way. The cement naturally fills the gap between the shoe and the bottom of the well. When exiting the shoe, the BHA is "slid" to land the well (at 85 deg of drift, 4.5 ft of TVD is lost to reach 90 degrees at 5 degrees per 100 ft). Consider pumping tail cement at a higher density or use a cement system compatible with the program but offering high compressive strength. Setting a cement plug in a horizontal hole is a challenge. In this case, several factors are working on our side.

• Contact time is high (several hundreds bls of cement);

•Large difference between formation pore pressure and cement hydrostatic pressure;

• Highly permeable formation.

What takes place during the cement job is a hydrostatic cement squeeze as the pay zone is highly permeable. Cement and friction pressure will eventually displace the mud contained in the rat hole thus providing a solid base and probably an effective seal.

When drilling out the shoe, the remaining pilot hole will be bypassed as with a conventional side track.

SYSTEM 2

The second system uses one or several joints of low hardness steel or other soft material located in the section of the hole to be abandoned. These drillable joints are left full of cement since they are to be placed below one or two standard float collars. Basically a hole is "punched" through a joint of casing. The exit depth is located at the same depth as system 1.

SYSTEM 3

System 3 uses tools that are available for multilateral wells. With the system proposed, a premilled window with a permanent hollow whipstock is used. It would also be possible to run a classic whipstock.

The base of the whipstock or window would be set 160 ft off bottom for a set of conditions similar to system 1.

SYSTEM 4

System 4 is similar to system 1 in the sense that nothing special is required except a rig equipped with a top drive. At the very least a 90 ft high-pressure hose is required in order to perform the cement job, which would be performed the same way as on a regular job. The difference would be the displacement of the tail cement.

In a situation identical to other systems, the procedure would be as follows. The well would be drilled to a final drift angle of 85 degrees and 160 ft of hole would be abandoned (i.e. equivalent to 14 ft in TVD).

The casing shoe would initially be set 70 ft above base of formation. The cement job would be performed. As the tail cement exits the shoe, the casing string would be raised 90 ft in order to leave a solid base for sidetracking.

System 4 is suitable for any scenario. Any problem related to sidetracking or losses could be solved through the use of high compressive strength cement.

As far as fracturing, risks should be minimal as raising casing string could only reduce annular pressure drop. The biggest risk would be to lose the ability to move the casing string while cementing.

SAVINGS

Based on an operational cost of $50,000 per day, eliminating a pilot hole could save 48 hours of operation plus the cost of setting a cement plug.

The drilling time needed to drill the part of the hole to be abandoned is minimal compared to a "regular" pilot hole. In case of hard rock and deep hole, this process could easily save 72 hours of operation.

Outside all obvious savings the biggest gain would be to have better knowledge of the pay thickness and dip ahead of time. If this technique could help reduce or eliminate stratigraphic wells, the gain could be higher.

CONCLUSIONS

The true vertical depth at which horizontal development wells are landed is normally based on data derived from other wells, seismic data and measurements.

These techniques do not allow checking "pay thickness" at the entry point. With the proposed solutions, geologists have extra time to decide the best navigation point and get valuable information at minimum cost.

These techniques are entirely optional almost up to the final landing depth. If the anticipated vertical depths of geological markers are accurate, the well could be landed as originally planned at no additional cost.

However, a well landed at the wrong vertical depth or a pay zone thinner than expected can be solved through the use of systems 1 to 4 and "erase" the part of the hole not needed.

System 4 is probably the best option. One could also imagine ways to hang off casing string in order to minimize WOC but this is another subject. ■