The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Taking a turn for the better - or directional drilling again

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Topic: Supply/Production
Tags: tech talk [list all tags]

Normally on Saturdays I post a technical topic on some of the basics of drilling for, and producing, oil. This week it has been delayed a day. Readers are asked to remember that it tries to convey the technology in a relatively simple, and thus easily understood, manner. For those in the oil patch who wince on occasion, feel free to chip with comments, and help convey the ideas. The series is starting to get fairly long, and so the list of earlier posts is attached at the end, and below the fold.

Does the phrase "gunboat diplomacy" ring a bell ? It was an old-fashioned term from the days of the British Empire. And now, apparently, it is making a reappearance in the Far East.

In a post a couple of weeks ago I had mentioned the problem of the "Rule of Capture" wherein the first person to draw oil/gas from a formation was entitled to as much as they could get from their wells, until their neighbors, in turn, sank their own wells.

Well this is not just a historical note - it is now one of the issues between China and Japan. Since the Chinese are tapping into a formation ahead of the Japanese, and thus, potentially "acquiring" some of the Japanese resource.

It was the same concerns that led Iraq into Kuwait back in the term of the first President Bush. Except here there was a concern that the wells in Kuwait had sort of "meandered" into Iraqi territory.

So what is with this meandering business?

Well to develop the idea of directional drilling, we need to return to the Volga-Ural basin in the Soviet Union, back in the 1950's. And I quote from John Grace's "Russian Oil Supply"

> In the Volga-Ural basin, however, particularly after recognition of the enormous potential of the deeper Devonian strata, drilling targets were further below the Earth's surface. Moreover, the older, more lithified rock of the Volga-Ural basin was harder. This required higher drilling torque, which in turn demanded superior strength drill-string steel. The Soviet steel industry was basically unable to provide high-strength drill string in volumes necessary to develop the basin.
>
> Engineers responded with **turbo-drilling**, which does not depend on rotating the drill string. Instead, immediately above the bit, they placed a turbo drilling motor, which itself did the work of turning the bit. This obviated the necessity of twisting the pipe and thereby reduced the required quality of steel.

> Turbo drilling radically increased the productivity, Combined with the growing number of rigs available, the total number of feet of development drilling conducted per year nationwide jumped from 1.9 million feet in 1949 to 7.1 million feet by 1950 and 12.1 million feet by 1960."

(We'll come onto their second innovation - that of waterflood - in a few weeks.).

Putting the motor at the bottom end of the drill string had a couple of other advantages. One is that it allows the hole to **make angle**, i.e. to turn in a tighter radius than if the whole pipe were rotating.

> Motors can accomplish 13°-15° per 100 ft doglegs, while turn radii of rotary steerables are 10° or less.

The Russian idea took a while to catch on in the West and to his credit, a guy in Houston called Bill Maurer , had a fair bit to do with that. (And due to Rita the link is currently down).

Suddenly we did not have to have the complexity of joining 30-ft lengths of drill pipe together to deliver power to the end of the bit. This had always been constrained by the steel strength and joint limitations, now that could be designed out, and the power could be delivered to the bit hydraulically through the mud, since this could be used to drive the motor. Unfortunately because the drilled holes are small, the motors have to be small also, and this means that they started out being quite long. (A case history or two can be found on the web.)

Turbo motors work best at higher speeds, but to create the chips and achieve effective drilling with conventional tri-cones, rotation speeds had, historically been slow. And the problem remained of creating the high thrusts across the bit that were required for this type of drilling, when the motor turned faster.

One answer came in response to a second problem. As the rocks that have to be drilled become harder, so the forces used to cut through them also up, causing a materials problem. The materials used to make the drill bits were breaking under the higher forces. But until now we had tried to break the rock in compression by pushing the tooth into the rock (remember that old miner).

If, instead we dragged the bit across the rock without trying to chip it, in the same way as a metal-cutting bit on a lathe peels off a layer of metal, maybe we could lower the forces on the bit. And if we used a diamond tool to do this, then while each diamond insert would only remove a very small amount of rock, we could impregnate a whole bit face with small diamonds (much cheaper than the single stone you buy for the intended, since they are much smaller, and more common). These diamonds can be dragged over the rock face and slice off very thin layers, but can do so when moved at a very fast speed. Putting the two together meant that a new drilling concept could be developed, and a new drilling bit.

Some pictures of the development of these tools have been given by Schlumberger.
They also show the next development. This came about with the development of larger polycrystalline diamond compacts (PDC's or PCD's depending on your level of technical correctness). By making these larger diamond coated discs and setting them on the drill bit it was easier to circulate the mud so that it kept the diamonds cool. This is important since, if you get the temperature of the inserts above about 3-400 degrees, the diamond starts to soften a bit and

wears faster. In this regard the design of these bits is still not perfect, but it has become better. Some of the earlier work on this was helped along by Sandia Labs, but unfortunately most of the early work was in the days before they posted their work to the internet.

So now we have a tool that can make all sorts of bends and that can drill rock that is harder, and relatively quickly. DoE still considers this an area for further work and is continuing to fund further development. We'll talk about some of those new ideas more in future posts.

This is a series of highly informal posts that are aimed at giving some background to what goes into drilling and production from oilwells. Earlier posts in the series are:

the drill

using mud

the derrick

the casing

pressure control

completing the well

flow to the well

working with carbonates

spacing your well

directional drilling 1

As ever, if this is not clear, or if there is disagreement then please feel free to post, and I will try and respond.