The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

So, if I grow a crack under my neighbors fence, is it still my oil?

Posted by Heading Out on November 5, 2005 - 4:54pm
Topic: Supply/Production
Tags: hydrofrac, oilwell stimulation, polymers, propping sand, tech talk [list all tags]

For those unfamiliar with the site, this is a weekend techie talk session, where I try and explain some of the things that happen with oil production, in a simplified form. At the end of the post there will be a list of earlier topics that I have covered, and questions can be asked through comments.

Speaking of comments, there was one, from Murray earlier in the week about someone who had drilled a series of dry holes, in an area where earlier drilling had been successful. When he tried to find out why, he discovered that his holes had been drilled with mud, while the earlier holes had been drilled without mud. As I mentioned in the mud piece, one of the objects of having mud in the fluid that is circulated through the well during drilling, is to coat the walls of the hole, so that fluid doesn't escape into the surrounding rock. The down-side to that, of course, is that the mud coats the walls of the rock that has the oil in it, so that the oil can't get out.

One of the ways this can be removed, is basically the same as if your house, or car was covered in mud. On the surface you would just take a pressure washer, and wash off the mud. This works better than a scrubbing brush would, down-hole, since the rock has also been crushed a little at the edges by the action of the drilling bit as it passed. The combination of crushed rock and mud gets into the thin cracks that provide the rock permeability, and a simple mechanical scrubbing can't easily reach into those narrow passages. A high pressure jet of water, however, can and will wash all the debris from the walls of the hole, opening the rock up to its original permeability.

However, (aren't you beginning to hate that word) there is a snag.

. (You can try this if you have access to a pool). While a jet in air can soak your neighbor's cat 20 ft away, when the jet is underwater its range is less than a foot. (It is harder to push through denser fluid). As the back pressure in the well increases with depth, so the jet finds it harder and harder to penetrate, so by the time that you get down a couple of thousand feet or so the range of that jet can be less than an inch. And this can come up a little short, if the tool that is being used is not designed properly, or if the completion has, for example, a metal screen in it that holds the bit away from the rock surface.

One way that this can be solved is to add a polymer to the water. There are various different chemicals that can be used, though these are often called long-chain or high molecular weight polymers since it is this feature that helps them to give added viscocity or cohesion to the water to which it has been added. This means, for example, that such a polymer might double the distance that the jet is effective deep in the well, so that it can now reach and clean the well.

It is for another reason, however, that I brought up he subject of polymers. Here we have our well, and the production isn't quite what we had hoped. So one of the common practices is to frac the well. This means sealing off the layer of rock that the oil lies in, and then applying enough pressure to the well section so that eventually the wall of the borehole cracks, and this crack grows out into the surrounding rock. The section is sealed off by lowering packers into the well, and setting them on either side of the zone to be cracked. They are then inflated, to seal off the zone, and fluid is pumped, under pressure, into this isolated zone at higher and higher pressure, until the rock breaks. (The example cited below has a pressure record in the source paper).

Having the crack extend out into the rock, alone, doesn't do much good, since as soon as the pressure is taken off, the crack closes. (Think of partially splitting a log, after you remove the ax, the split in the wood closes back up, and can hardly be seen). What we want to do is to open the crack, and then prop it open so that it stays that way, and the oil along the path can now find a way out to the well. To prop the crack open we mix a special, relatively large grained sand into the water that we are going to pump up to pressure. However, if we just had the sand by itself in the water, it would settle out in the pump, the lines and the bottom of the well, and that would not be good. So we use one of the polymers, mixed with the water, to increase it's viscocity so that it will also hold the sand in suspension.

The choice of polymer for the job can be fairly complicated since what you want is to firstly get the sand into the fracture, to as great a depth as possible, which means a high viscocity, but then you also want the fluid to flow back out easily, leaving the sand in place, so that the oil can get out through the crack. One way of solving the problem is to pump the sand in with the polymer, (perhaps a guar gum) and then to add a second chemical that breaks down the gum so that if will flow more easily back out.

There is one other problem, the pressures that are used to break the rock are quite high, and so the suspension of water sand and polymer ,must be fed through special pumps in order to get a high enough pressure. But the sand is aggressive, and so it will very rapidly wear out the valves of the pump. And in the past this often meant that the pump parts had to be replaced after every frac job - which made the operation quite expensive.

It is often also used to increase the flow in waterwells and can be more simply used, without the sand, as a way of measuring the pressure in the rock. A more detailed description of an example can be found here

> IN2U was a steam injection well drilled to a depth of 1620 ft. and perforated between 1120 and 1450 ft. The hydrofracturing of IN2U lasted 2 days and consisted of a small-volume hydrofracture the minifrac on the first day, followed by a larger volume hydrofracture, the main frac, on the second day. . . . A solution of 2% KCl brine was used as the injection fluid for the early stages of the minifrac. For stage 4, 40 lb cross-linked gel was used. Although no operator notes of the hydrofracture were available, we believe that stages 1 - 3 were performed to initiate the fracture near the wellbore, while stage 4 was performed with higher-viscosity gel in order to find the fracture-reopening pressure and the minimum in-situ stress magnitude. The total volume of injected fluids during the minifrac was 940 bbl. After the minifrac, the well was shut-in for 24 h to allow the injected KCl to percolate into the microfractures created during the minifrac.
>
> The main hydrofracture was created in seven stages over a 4-h period on the second day of pumping. . . . . During stages 1 and 2, KCl followed by 40 lb cross-linked gel was used to reopen the fracture. During stages 3 - 7, a fluid proppant mixture of cross-linked

> gel and 20 - 40 Ottawa sand was pumped into the hydrofracture. The total volume of injected fluids and proppant during the main hydrofracture was 2727 bbl.

(20 - 40 is a mesh size and means that the particles are 0.015 to 0.034 inches in diameter).

Hydrofracing can also be used to create fractures in coal seams to get methane out or to inject carbon dioxide for sequestration.

(Grin and I almost made it through the whole story without mentioning that another use for polymers in water is to make it slippery enough that, when sprayed on the road in front of a group of protesters, it makes the street like ice, so that they can't charge the police line - hence the nickname Banana water).

This is part of an ongoing weekend series on technical aspects of oilwell (and natural gas) drilling. Previous posts can be found at::
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

directional drilling 2

types of offshore drilling rigs

coalbed methane

workover rigs

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