The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

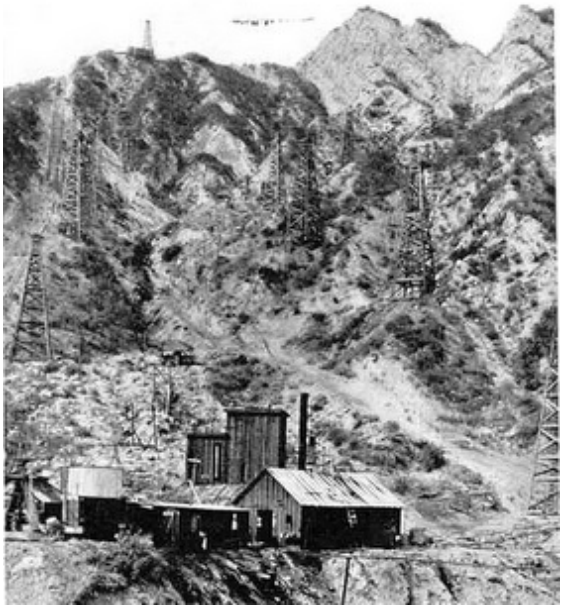
Drilling deviated wells and a couple of legal terms

Posted by Heading Out on October 25, 2009 - 9:44am
Topic: Supply/Production
Tags: autotrak, deviated wells, directional wells, rule of capture, tech talk [list all tags]

This is part of the ongoing series of tech talk posts I make on Sundays about the technology behind some aspects of getting oil, natural gas and coal out of the ground. At the moment, as I noted recently, there are places where it costs more to get the fuel out of the ground than folk are being paid for it, yet they are still pumping it out. There are a number of reasons for this, but I wanted to tie in a comment that goes back to the early days of oil production, when one could find pictures of oil derricks, built one right next to another. That density has been reproduced at Kilgore, TX where at one time they had 1,100 wells producing oil from the Great East Texas Oil field.

Reproduction of well density (from TexasEscapes)

When times got tough each well owner would still produce all the oil possible, why? (Apart, that is from paying the interest on all the money borrowed to drill the well in the first place).



Wells drilled in Ventura County, CA. (US Geological Survey)

Early photos of the oilwells when the first boom first began, showed that they were drilled almost on top of one another and in some difficult country.

There was an interesting ruling that came about at that time, and which has persisted since. It is called "The rule of capture" (which also pertains to water rights, and essentially it says that whatever flows into your oilwell, regardless of where it came from, is yours. (`cos you "captured" it).

So let's say that you live in a nice neighborhood in downtown San Diego, for instance. And under your neighborhood someone discovers there is a rich pool of oil. Well if your next door neighbor is a fast mover, he might drill his well and suck all the oil out of your particular bit of that pool, before you can blink, and yup! It's his (or hers).

So what do you do to counter this and get what's yours before it is half-inched? The obvious answer is to drill your own well, and (rather like two siblings drinking a soda through straws into the same glass) whoever sucks hardest gets the most. Which does all sorts of nasty things to the idea of holding a resource until it's value goes up - but then, that's the oil and gas business.

Well over the last century that obsessive attitude has ameliorated a tad, and now when wells are drilled (particularly since they are a bit more expensive) we try and space them at intervals so that each gets to drain out to the point where it naturally runs out of ability to drain further. There are intricate mathematical equations for this (which I long ago deliberately forgot) but as a first rule of thumb the industry uses a baseline of 40 acres per well. Which means that if you were looking to drill a second well you might **step out** and drill the next well some 440 yds away from the first. (A quarter of a mile, for those of us who think that way).

Which way would you go? Well that depends very much on the information that you managed to get from the well that you just put in. And this will rely on logs that you ran after drilling, and the map that you were given of the underground geology before you drilled the first well. Some of that information will relate to the permeability of the rock, and the quality of the oil. The lighter

the oil and the higher the permeability then the further apart you may want to space the wells (given that they are becoming just a tad expensive these days). Generally in more favorable fields you may space at greater intervals (gas wells tend to be about a mile apart for example).

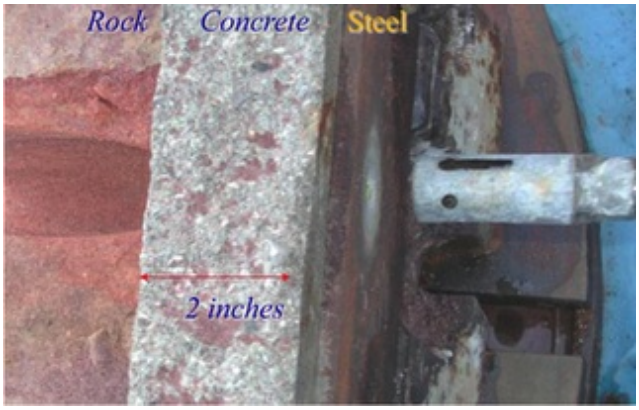
On the other hand, in some cases, having drilled a very well spaced set of wells you may discover that the permeability isn't quite as good as you had thought, and then you might go in and put wells at closer intervals than originally drilled, **infilling** the well pattern.

But there are places where this is not an easy option. One such, of course, is the current spate of discoveries and development in Deep Water. But one of the earlier places where this came about was in Western Siberia. After all, here you are, finally established on a man-made island in the marsh, and producing oil, and to drill the next well you have to drive another road through the swamp, build an island, move the equipment, recreate the drill site, before you can start drilling. As Ivan Ivanovich might have said, "why don't you be a good Comrade and let me drill over to my patch, from your site?"

And thus we get into **directional drilling** (and the entirely "accidental" occasional happening of "subsurface trespass"). **Directional drilling** as a term is quite often used now to refer to techniques for putting pipes under rivers.

Historically wells were drilled, to as great a degree as possible, vertically downwards. There was the occasional meander, and this had to be corrected, after running a borehole survey, to make sure that the drill eventually arrived at the intended target. But in making those corrections, so a technology evolved that allowed wells to be steered at deliberate angles, and then the light dawned, and **deviated wells** could be steered away, at designated angles from the initial well, and out to some additional nearby possible sources.

When directional drilling first was developed, the process occurred in a series of steps. Remember that the wells are usually cased with a steel liner. So the first thing that had to be done was to cut a window in that casing. There are several ways to do this, one of the more efficient of which is to use a high-pressure stream of mud from a jet nozzle, that has had a certain amount of sand added to the mud. This abrasive jet can eat through the steel and cut out a segment or window so that the drill bit can reach and attack the rock.

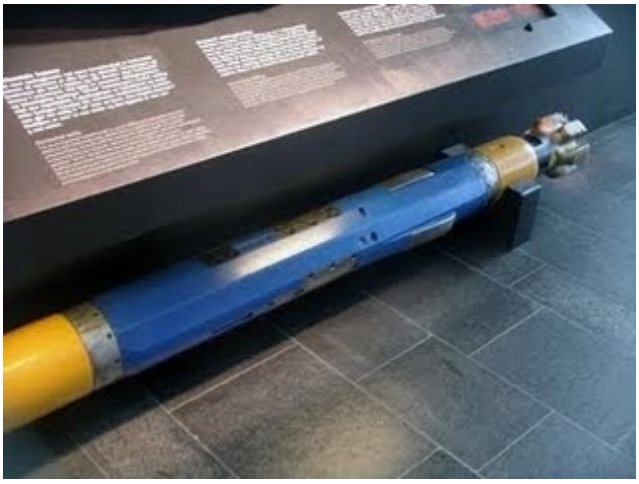


5,000 psi pressurized abrasive waterjet cut through steel, concrete and rock, as could be used to cut a window in a casing

Now we have to make the drill deflect, and the easy way to do this was to slide a wedge into the hole right at the point where the window had been cut. This wedge, known as a **whipstock** was very carefully aligned and set into the borehole with the inclined side set so that as a new drilling bit slid down the hole it would be **kicked off** into the **window**, and began to drill and penetrate the rock in the required direction.

The hole could be started with a smaller bit until the hole is well established (maybe several feet into the new well) and then this **pilot bit** was removed and a full-scale bit put on the bit to allow the drill to continue creating a new hole moving out from, and down from, the new start to reach the new target either by a straight shot, or by drilling over to the vicinity of the new end point, and then kicking back over to the vertical to drill down into the new oil reservoir. The process is not that complicated, and with practice one could then drill a number of different wells out in different directions from that original hole. And from one location, or platform, one can then collectively extract the oil from an increasingly large surrounding area of the reservoir.

More recently there are services available such as the Autotrak system where, just behind the drill bit (which is rotating – as are the main pipe segments – yellow in the picture below) a non-rotating piece of equipment is located (blue) that has three small rams that can push out against the well bore and direct the drilling head over in the direction required.



Autotrak assembly (Oil Museum in Stavanger) – you can see one of the pads pushed out as though it was pushing the head over.

And thus it is now possible, through computer sensing of the position of the head, and control of the rams, to steer the drilling head to where you want it to go.

I said "historically" just before talking about Autotrak because when they tried the older system in Western Siberia they ran into a problem. The quality of Soviet steel was not, at that time, that good at keeping the bit turning down and through the bend it had to follow to deviate the well. And so they had to come up with a different approach. And that I'll leave perhaps for next week's chapter.

This is a series of highly informal posts that are aimed at giving some background to what goes into drilling and production from oilwells. To keep them simple and short I have sometimes simplified a little more than I should to make the description clear, so if it isn't, please ask.