The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Logging a well, does not mean a two by four between the eyes

Posted by Heading Out on November 20, 2005 - 8:20pm
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Tags: tech talk, well logging [list all tags]

So what is a reserve? Can we wander into a meeting with one of them Eastern banker types wave a fistful of geological maps under his/her nose and get them to cough up $100 million so that we can go drill a hole in the back 40? Well not exactly. There is a fundamental definition that says that a proven reserve can only be counted where there is no "reasonable doubt of uncertainty" in the estimate of the oil/gas in place. And how do you overcome that doubt, why by drilling a hole down into the reservoir and starting to produce the oil.

But here's the thing, let's say I buried a container of soda in a sandbox and just left a straw sticking out of the sand. How do you know, short of digging it up, or fully draining it, whether I buried a soda can, a liter bottle or a full barrel's worth? That is the problem that you face when you finally drill to the bottom of an oil well and find that the cuttings that come to the surface are all nice and oily. And the answer is that you can place a special coring bit on the end of the drill string and take out a cored cylinder of rock all the way down through the pay zone, or you must log the well, and often you will do both.

This is one of the techie talks that turn up on this site on intermittent weekends. It tries to provide some basic information on topics that relate to oil and gas production and you are asked to bear in mind that it is a very simplified explanation, so that you can grasp the basics. A full list of previous posts is given at the end of the piece.

Taking the core of rock is useful. It allows a visual inspection and real measurement of porosity and permeability. But it is expensive, and does not give a lot of information on what conditions are really like at the bottom of the well. Logging the well is usually carried out by an oilwell service company Schlumberger was one of the earliest in the business, and has a fairly good site that explains a lot of the terms with illustrations, so I may pinch some of their materials in what follows.

What do we need to know? Basically how much oil is there, and how fast can we get it out. To calculate the former number we need to know how porous the rock is, as an initial number. If a rock has a porosity of 20% and it is 200 ft thick and the area to be extracted in 1000 ft long and 1000 ft wide then the total volume of the rock is 200 x 1000 x 1000 = 200 million cubic feet. The total available space for oil to be in is 20% of that or 40 million cubic feet. Were this all oil it would be equivalent to about 6.8 million barrels of oil. Unfortunately it likely won't be and this is, in part, why we have the hole logged.

The operation is carried out after the well is drilled, but before you spend the money to put in a proper completion and wellhead connection. (There is after all no point in spending that money if it is not going to be worth it. Plus it is easier to measure the rock properties while the hole is still open and before it is cased). The company will bring out a logging truck that will run a wireline

down the well, at the bottom of this line is a pod, called a sonde, that contains the various logging tools that will be used to take measurements. Typically it can be anywhere from 30 to 90 ft long and will contain a number of instruments. Each will give a different number that will collectively help with the estimate of the amount of oil that is there, and the condition of the hole itself. Generally the sonde is lowered to the bottom of the hole and then drawn back up the hole recording the information as it goes. The sonde will probably measure the density of the rock, and indirectly measure the porosity and the resistivity of the rock using electrical acoustic and the trace levels of radioactivity that can be found in some rocks. The signals are continuously sent back to the logging truck, and continuously recorded against the depth of the hole, on thin strips of paper that form the well log. The borehole diameter can also be measured up the hole at the same time using a caliper tool.
Along the way cores can also be drilled into the side of the well

The first thing to know is the porosity, since this will tell if there is enough space for an economic amount of oil. A reservoir rock will have a porosity somewhere between 6 and 30%. This can be calculated from the measurement of the rock density, or by using a neutron porosity tool that is calibrated to give a trace of porosity percentage as the sonde travels up. The porosity can also be found using a sonic log that measures the speed of sound through the rock. By correlating the value against known standards the type of rock, and its porosity can be found.

Apart from the oil in the rock, there is likely to be some water. Some of this can be bound to the rock, particularly if has some shale in it, and this has to be deducted from the porosity so that we are left with the effective porosity - which is the combined volume of water and oil that there. A Gamma Ray (GR) trace will give an indication of how much shale there is in the rock,

So we then need to know how much water and how much oil are present. It is a little difficult to measure the oil directly, but one can measure water content, since this controls the reistance of the rock to the passage of an electric current. And so by measuring resistivity one can see how much water is there, and where the interface between an oil layer, and the underlying water can be found.

There is an additional tool that measures the immediate resistivity between electrodes on a pad that pushes against the rock as the sonde moves up, and this can give an additional measure of the rock permeability. This also has found a use in tracking conditions as the bit is still drilling.

Running a measurement of the well diameter can also tell a number of things. Many oil bearing rocks are weak, and can be crushed around the edge of the hole, after it is made, by the surrounding rock pressure. On the other hand very permeable rocks will have soaked up some of the water from the drilling mud, leaving a thicker cake on the wall, reducing the diameter. Finding these zones ahead of time can make it easier to plan to deal with them when the well is completed. Provided, of course, that when these logs are run, that they show that there is enough oil in that rock to justify the investment. After all if the resistivity log shows that the layer has about 80% water in those pores, that will only leave 20% of the space filled with oil - or, in this case, perhaps only 1 million barrels or so. And life being the way it is, we may only be able to produce about 35% of that oil, or 350,000 bbl. So how much did you say that completion was going to cost ?

Incidentally, by comparing the logs run in your well, with those nearby it is possible to get a much better picture of the rock structure in the whole area and this helps in deciding if it would be worth drilling infield wells between the existing ones.

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

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