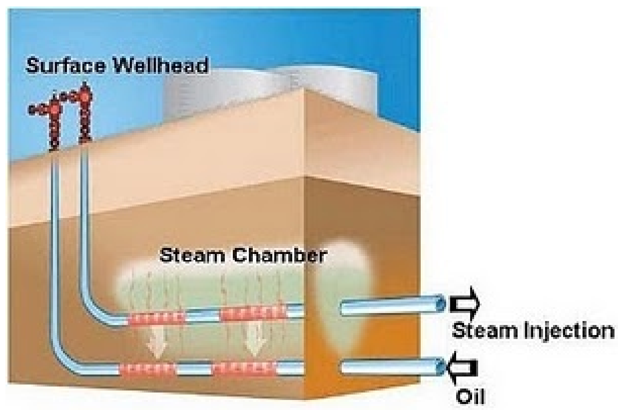
The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Tech Talk: SAGD and Well Production from Oil Sands

Posted by Heading Out on January 24, 2010 - 9:15am
Topic: Supply/Production
Tags: canadian oil sands, oil production, tech talk [list all tags]

This is a technical post relating to the production of oil from heavy sand deposits, such as those in Alberta. It is a part of an ongoing series of tech talks, and should probably be read after the post last week on surface mining of those deposits. It is simplified, and relatively short, and so there are some details that are abbreviated, but longer answers can be provided through comments.



Artist's illustration of the SAGD process (Devon Canada Corp)

Surface mining of oil sand can only progress so far before the gradually deepening seams of the sand become too deep to continue to economically mine them. At the same time the viscosity of the oil is such that it does not flow easily to a conventional type of a well. This is not a new problem for the oil industry, which has had to address issues with the quality of the oil that it finds coming out of a well more than once over the past decades. One of the more easily applicable methods for improving the flow characteristics of the oil is through heating it. (And a quick caveat, the quantities of heat that I am talking about at the moment are significantly different from those that are needed in treating oil shale. I will come to that topic in a couple or three weeks.)

The example of the effect that temperature makes on the ease with which a fluid flows that always first comes to my mind is of a visit to the Nurse's cabin north of Montreal one winter, a long time ago, when after struggling through waist-high snow, we sat and poured whisky from a bottle left there, as we waited for the wood stove to heat the cabin. When we started the Scotch poured as though it was a heavy syrup.

Viscocity of an oil is something that we usually only think about when we buy the engine oil that we put into the car on odd occasion. Buying the right oil means either looking for the little label that has the right description or reading the manual to get the number. But the oil that we buy for the engine is rated in part on how it behaves at different temperatures. We want the oil in the engine to easily circulate around the parts, and lubricate them from the time that we switch the engine on. But if the engine starts cold, and the oil is too thick, then it may not move easily around the parts, which may run dry for a while and wear more rapidly – which is not good. However if the oil becomes too thin once the engine reaches operating temperature then it doesn't act as a good lubricant, and again engine wear is increased. And so manufacturers of the oil will adjust the contents, depending where in the country they plan on selling the oil, and what the temperature variations the oil can expect to operate under there. (And this is why oil is sometimes bought with two numbers – as in 10W-30 – the first number relates to the cold start, and the latter the performance at the engine operating temperature. And the higher the number the more viscose the oil is under those conditions.)

A typical oil found up in the oil sands of Alberta is much thicker, and more difficult to flow under normal operating conditions than that used in a car. For the areas of the province that are too deep for surface mining the temperature is not affected much by the changes in surface temperature, but the ground temperature is still low enough that the oil is very viscose, and production from a normal vertical well is usually too slow to justify the expense of putting in a well.

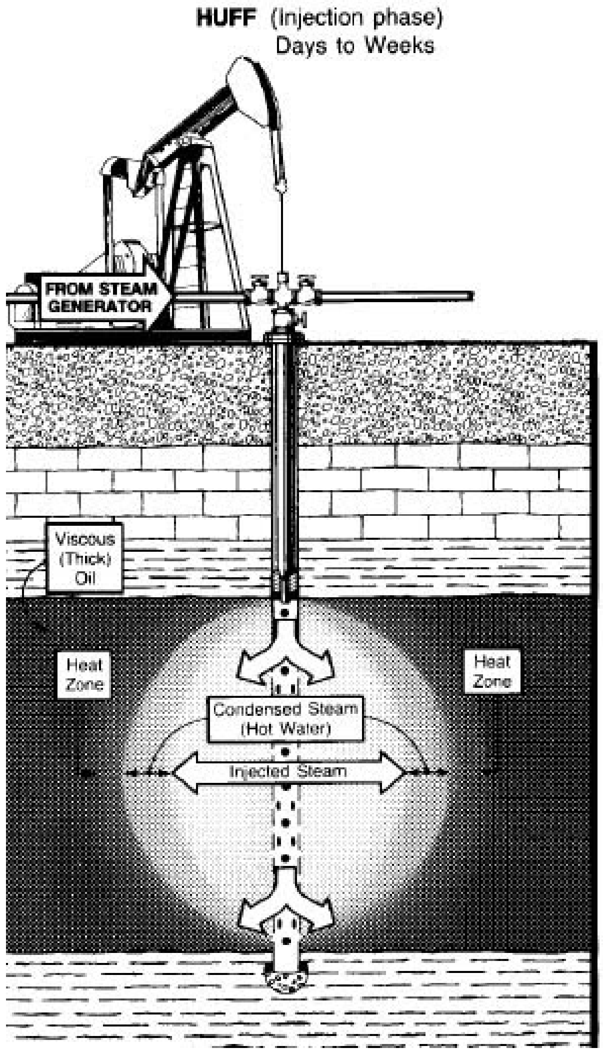
So how can the viscocity be reduced? For a simple example, take an apple, which has fallen in the butter, and you want to clean it off. If you take the apple and put it under a cold stream of water the butter sticks to the apple, but if you raise the water temperature, suddenly the butter melts and runs off the apple. This happens best at about 185 deg F, and if you were to turn a pressure washer onto a greasy surface you would find that it works better if the water is also heated above that temperature. (Some pressure washers are sold that way).

Think now, if you will, of little Johnnie (helped of course by Jessica) having raided the orchard and spread butter onto all the apples, gluing them together and filling the kitchen full, right to the ceiling. How do we clean the butter off and get it back without taking all the apples out and cleaning them one by one (which is sort of what they do with the surface mined oil sand up in Canada).

We could just stand in the hall and stick heaters up against the wall of apples, hoping that the heat would melt the butter and work its way back to the ones further into the kitchen. That sort of works, but burns the local apples and doesn't reach all that far. (They have tried setting fires inside oil wells, and we'll get to that maybe next week). You could fill the kitchen with hot water, but while that washes out some of the butter, a lot of the heat goes into the apples and the water is cold before it reaches the back of the room. And the water doesn't have that much pressure to push the remaining butter off the apples.

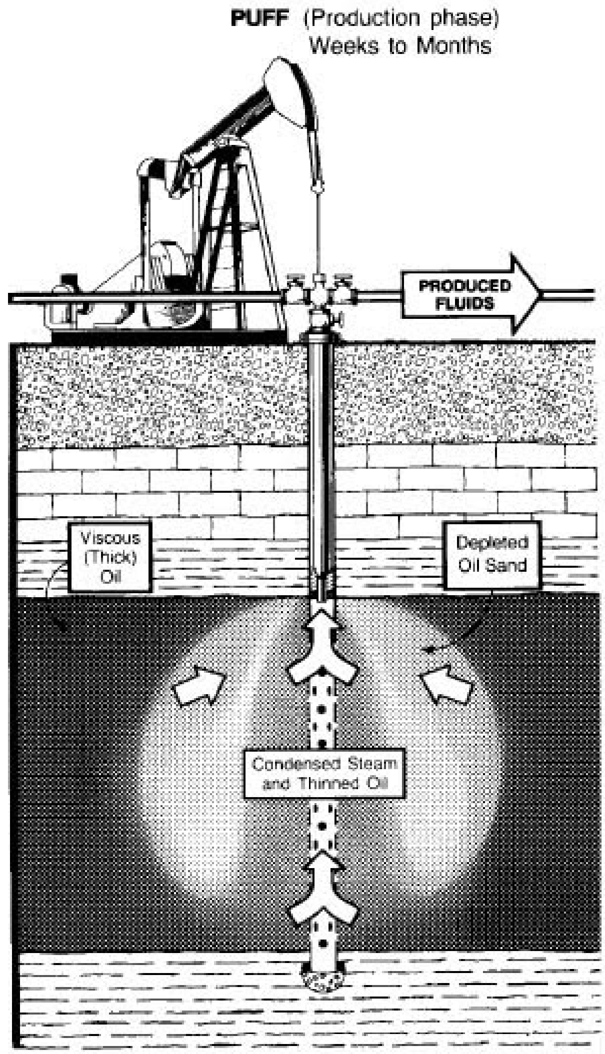
What we need is something that will get through the gaps between the apples and keep its heat. So how about steam? So you go and get a steam cleaner (such as you use for carpet cleaning) and blow the steam into the apples. That works but as the butter starts to flow out it clogs the gaps and starts to re-harden except when the steam is right there. So you start to run the steam for a bit, stop and collect the butter that comes out, run the steam for a bit, etc. You can do this in an oil well and it has the exciting technical name of "Huff and Puff" (would I kid you?). To make the steam more effective it is heated to between 150 and 300 deg C. Where the rock is very permeable and the steam can, in time, work its way back through the particles (apples) this can recover a lot of our butter. But you still lose a lot of heat, which is expensive to generate, just in heating the apples.

The NETL shows how the process works, in three steps:


HUFF (Injection phase)
Days to Weeks
FROM STEAM GENERATOR
Viscous (Thick) Oil
Heat Zone
Heat Zone
Condensed Steam (Hot Water)
Injected Steam

Huff

Soak



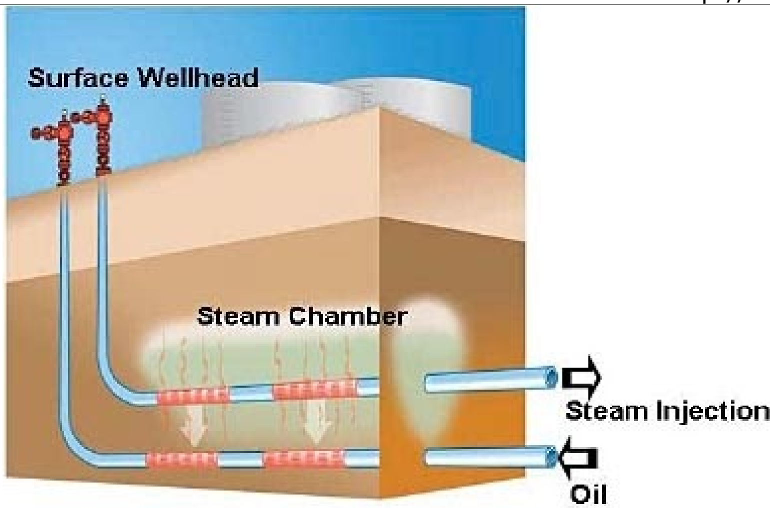
Puff

- The 3 stages of the process as illustrated by NETL.

The problem is that this is still limited by the length of the borehole through the deposit, and because it is an intermittent process, it doesn't give a continuous flow of oil.

However, with the advent of directional and horizontal well drilling, the first part of that problem can be solved, and a longer hole can be drilled into the sand to give a higher exposure to the steam being fed in.

Then, to allow a continuous supply of steam into the sand, a second well can be drilled so that the steam is constantly flowing out of the one (upper) well into the oil sand, and as the steam reduces the viscocity of the oil, so it flows easily into the lower well which can then capture it and carry it to the surface. Because the steam is cooled to water during the process, this is also recovered with the heavy oil, and is then separated from it. In some cases, as I mentioned last time, there is also some natural gas in the formation and this is also recovered and separated. It is often used to heat the water (as much of which as possible will be that reclaimed from the steam) to feed it back into the process.



Artist's illustration of the SAGD process (Devon Canada Corp)

The entire process is called Steam Assisted Gravity Drainage (SAGD – pronounced Sag-D) and over a 30-year period has become the popular method for getting the deeper oil from the oil sand. Just this week, for example, Alberta Oilsands Inc. has filed an application to install a set of 6 paired wells at a site that is a mile from Fort McMurray Airport. The six sets of wells will produce some 4,500 bd. The lower well runs along the base of the formation, while the steam injection well is located above it, and about half way down the formation depth. (It should be noted that the application is also considering a later use of electro-magnetic heating).

Typically several sets of wells are laid out beside each other to provide an interaction between the wells and heat the intervening oil so that it can be recovered. For example, this layout is taken from the application of Devon Canada Corporation for an expansion of their Jackfish project to produce an additional 35,000 bd. Notice, in the layout below, the close pattern of the parallel well sites.

Schematic of a surface layout over the SAGD wells.

There have been a number of different posts at The Oil Drum about SAG-D over the years. Dave Cohen wrote about some of problems as seen in 2006, particularly as they related to the problem of natural gas supply for, among other uses, heating the water to steam.

But I'll return to the issue of adding heat to oil sands, and then get on to oil shales in the weeks ahead.

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