The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Canada's Oil Sands - Part 1

Posted by Gail the Actuary on August 25, 2009 - 10:56am
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This is the first in a two-part series about Canada's oil sands. In this post, I will talk about a recent American Petroleum Institute (API)-sponsored media trip I made to see Canada's oil sands, and give a little background on material being extracted. In the second part of the series, I will talk about future oil sands production and some issues related to future imports, including environmental questions.

I should mention that while I went on the trip with API, the sources I am using in these two posts are broader than just information on the trip. I will link to some of these sources as I go along. Arguably this post is mostly from the point of view of oil companies, but it seems to me our knowledge base regarding oil sands is so poor that we need to start somewhere.

The group that went on the trip was a mixed group of bloggers and a conventional reporter--Elizabeth Brackett from PBS. This is a photo of some of us.

Left to Right: David Skyuta (Illinois Petroleum Council), Elizabeth Brackett (PBS), Gail Tverberg (The Oil Drum), Byron King (Whiskey and Gunpowder), Brian Westenhaus (New Energy and Fuel), Jane Van Ryan (API), Student (Assisting Margot Garritsen from Stanford Univ.), Kate Shirley (Assisting Jane Van Ryan)

Trip information

On our trip, we visited:

• Syncrude's open pit mining and upgrading operation north of Ft. McMurray. This is a joint venture involving several companies.

• ConocoPhillips Surmont's *in situ* project using Steam Assisted Gravity Drainage (SAGD) technology, south of Fort McMurray.

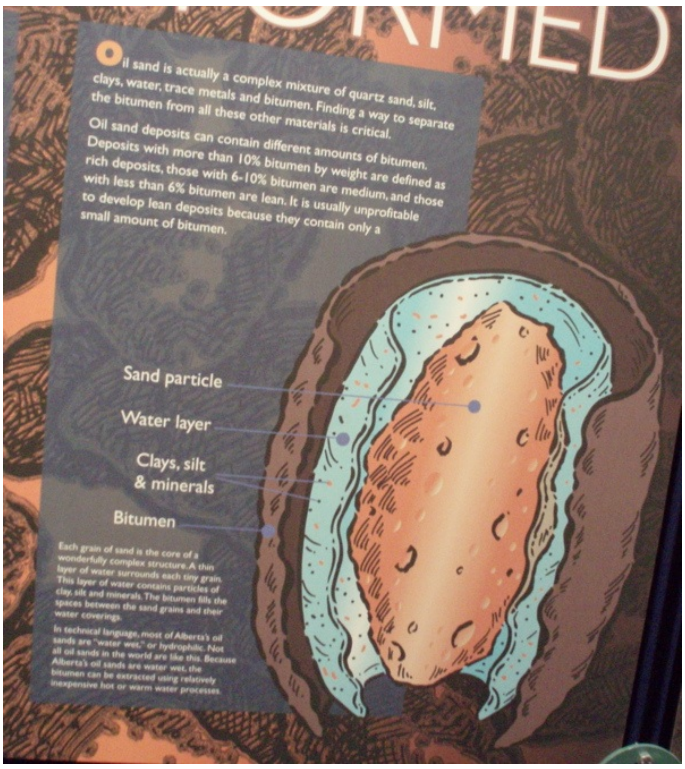
• The Oil Sands Discovery Centre museum in Ft. McMurray.

We also heard a talk by Don Thompson of the Oil Sands Developers Group called Setting the Record Straight.

After we got home, we talked on the phone with Robert Renner, Alberta's Commissioner of the Environment. A transcript and audio recording is available at this link.

Oil Sands--What is It?

Oil sands material is funny stuff. It reminded me of a very dark crumbly brownie, but smelled like asphalt.



Structure of oil sands resource, from display at the Oil Sands Discovery Centre museum in Ft. McMurray, Alberta, Canada.

According to this graphic, oil sands are a complex mixture of quartz sand, silt, clays, water, trace metals, and bitumen. In this mixture, each grain of sand is surrounded by a water mixture. Bitumen fills the space between sand particles and their water coverings.

What makes Canada's Oil Sands different from many other deposits of heavy oil is the water layer surrounding the sand, making them "water wet," or hydrophilic. Because Alberta's oil sands are

water wet, the "bitumen can be extracted using relatively inexpensive hot or warm water processes" according to small print on the poster above.

When the bitumen is separated out from the oil sands mixture, it has somewhat the consistency of cold molasses. I touched some of it in a vial, and couldn't get it off my finger without using a solvent. The API gravity is 8.

Bitumen molecules are much larger than what one finds in conventional oil, containing as many as several thousand atoms. The ratio of hydrogen is similar to that of heavy conventional oil. According to J. G. Speight, hydrogen content of bitumen averages 10.4%, compared to a range of 10.0% to 14.0% for petroleum. Sulfur content averages 5%, making it "sour".

Methods of Producing Oil from Oil Sands

Mining--Illustrated at Syncrude

The oldest and still most widely used method of producing oil from oil sands is mining. This method is gradually being refined, to become more energy efficient, to use less water, and to have less environmental impact in general.

In the mining method Syncrude uses, the various surface layers are first removed and stored so that they will be available when needed for reclamation. Then large equipment is used to scoop the oil sands material out, and load it into large trucks.

Open pit mining operation at Syncrude

Next, the material is transferred by truck to a station where it is mixed with water to form a slurry. Hydrotransport pipelines transport the slurry mixture from the mine to the extraction plant. The slurry is fed into a separation vessel where it separates into three layers--sand, water

and bitumen.

The sand that separates out is trucked to its assigned location, based on a reclamation plan that Syncrude filed earlier with the province. Syncrude says that it plans carefully where each truckload of material goes, so it does not need to move material twice, and thereby increase its costs.

The water (including dissolved minerals, clay, and small amounts of bitumen mixed with the water) that separates out is transferred to tailings ponds. The water from these tailing ponds is then recycled, for use with a new batch of bitumen slurry. With recycling, the amount of water from Athabasca River that Syncrude uses has been decreasing, and now averages 2.03 barrels of water per barrel of finished product. Over 85% of the water used in this process is recycled.

The bitumen that separates out during the separation process is upgraded to form Synthetic Crude Oil (SCO), a light sweet crude oil that sells for about the same price as the benchmark crude, West Texas Intermediate (WTI). This upgrading takes place in a facility that in many ways resembles a refinery (cracks the molecules into shorter ones and separates out sulfur and other pollutants), but does not produce the finished products of a refinery.

Since the upgrading is at the same location where oil sands are mined, Syncrude can make use of the natural gas and other gasses produced in the upgrading process to provide some of the energy required for the energy needs of the facility. I was told that approximately two-thirds of the energy needs of the facility are internally generated, but I have not received written confirmation that this is the case.

Work on reclamation goes on at the same time as mining. Once sufficient sand has been added to reach the planned contours of the reclaimed area, the upper layers are put back and native vegetation planted, according to the plans filed with the province. These plans are updated from time to time to reflect changes in thinking regarding optimal revegetation.

One piece of Syncrude land in an intermediate stage of reclamation--not yet approved by the

province.

Of all of the oil sands operators, Syncrude has the only parcel of land that has been officially been certified as reclaimed. It also has 4,600 hectares that would look to a passer-by as reclaimed, but has not passed the years-long process required by the province to show that reclaimed area fully meets the province's standard in terms of stability, plant growth, water areas, and wildlife.

Another piece of Syncrude land in an intermediate stage of reclamation--wood bison (native species to the area) are being raised here.

I was told that the energy return of this process is 6:1, presumably all of the way from mining to production of Synthetic Crude Oil (SCO).

I was told that many of the processes are gradually being made more efficient, at Syncrude and more generally. For example, Syncrude invented low energy extraction which reduced the temperature required to extract bitumen from 80 C to 40 C. As techniques are refined to become more energy efficient, one would expect the energy return ratio to increase, and the amount of CO_2 generated by the processes to decline.

I was also told that 92% to 94% of the bitumen in the oil sands is extracted in this process--a very high percentage, compared to conventional oil extraction. In some sense, what happens is that the oil sands material is scooped out, nearly all of the bitumen washed out, and the remaining material (mostly white sand) put back. Water to be recycled plus various impurities are put into tailing ponds. The material that cycles through tailing ponds doesn't get to its final location very quickly, and sometimes ends up where it is not wanted, so is a problem the industry and regulators are working on.

I might mention that workers who live in Ft. McMurray ride on company buses to work. The buses pick them up near their homes. Other workers live in a camp on site. I was told by a company employee how much he liked Ft. McMurray because of the cosmopolitan environment,

with workers from around the world. A person I met who used to work in Ft. McMurray commented that drugs are a problem, since the area tends to be young and transient.

In Situ Production

While *mining* is still the largest source of oil sands production, *in situ* production is catching up. According to statistics of Canadian Association of Petroleum Producers (CAPP), a little over 40% of Alberta's Oil Sands production in 2007 was *in situ* or "in place" production.

In situ production has several advantages over mining:

• Less disturbance of the soil -- digging only for pipes, roads, buildings, and equipment;

• Less water use, and water that is used is sometimes from brackish sources;

• Little need for land reclamation. The material just stays where it is. The bitumen is in some way melted and drained out;

• Less (and in some cases no) tailings ponds.

The primary in situ approach in use today is Steam Assisted Gravity Drainage (SAGD) which I will discuss shortly. Cyclic Steam Simulation is also used to a lesser extent. In addition, there are several other in situ approaches under development, including electric induction technologies, in situ combustion, and vapor extraction process (similar to SAGD, but using a solvent other than water). See Oil Sands Story for discussion of some of these methods.

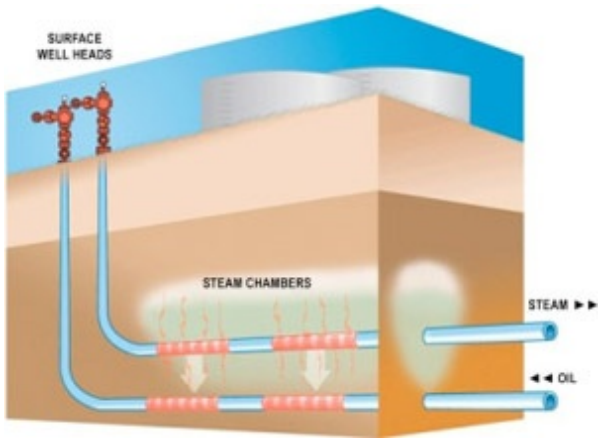


Illustration of Steam Assisted Gravity Drainage (Devon).

In SAGD operations, steam is injected through the upper (injection) well. The steam melts the bitumen, and the melted bitumen plus moisture are collected in the lower (producing) well.

Steam Assisted Gravity Drainage (SAGD) at Surmont

At the Surmont facility, the wells gathering the bitumen mixture are 1,000 feet deep, which is below the groundwater and a limestone cap. Each well is about 3,000 feet long. The surface area is mostly forested, except where equipment is located and where above-ground pipelines run.

Surmont uses brackish (salty) water from deep wells to generate steam. The water is heated to 200C, and piped to the injector wells (see diagram above). The steam escapes from holes in the injector wells and heats the area around the injector well. The bitumen melts, and the melted

bitumen and water from the steam drip down and are collected in the producer wells, found below the injector wells.

Surmont estimates that it collects 60% of the bitumen in place using this process. The steam doesn't actually get everywhere--in the locations it does go, Surmont estimates it extracts 92% to 94% of the bitumen in place. In this process, the vast majority of sand and other materials are left in place, so there is much less material to process, and no need to worry about major land reclamation later.

Samples of source water and water being recycled at Surmont

Surmont recycles its water, so that 90% of the water it uses is recycled. The amount of additional brackish water that needs to be added averages 0.25 barrels per barrel of bitumen--much less than required for mining approaches. Since it uses brackish water, none of this water comes from the Athabasca River.

Before Surmont began producing bitumen in 2007, it drilled delineation wells to determine the extent of the resource and to lay out plans for where extraction would be performed. In drilling the delineation wells, it was necessary to cut down some trees. We were told that Surmont is now in the process of reforesting areas where delineation wells were drilled, under its *faster forests* program.

The bitumen that is produced at Surmont is too stiff to transport by pipeline, once it cools from initial extraction. To overcome this difficulty, Surmont buys SCO (perhaps made at Syncrude) and blends it 50% - 50% with bitumen to produce the petroleum product it sells--Western Canadian Select Blend.

I was told that the energy return of this process is also 6:1. Upon inquiring further, I found that this energy return is only based on the amount of natural gas the process uses--one cubic meter of natural gas to one cubic meter of bitumen. If other fuels were included, the energy return would no doubt be lower. Also, this energy return only relates to making bitumen to blend with SCO, so would seem to be less than the mining energy return.

It is clear to me that there are a lot of indirect energy costs that would be hard to count in any calculation. For example, Surmont is located an hour's drive south of Ft. McMurray, away from any town. All water for drinking is bottled water that is shipped in.

I was told that some of the other in situ sites are "fly in" sites, where the only access is

helicopters. All of the pieces of buildings, pipelines, and processing equipment must be flown in to these sites. Housing and food service is provided at these remote locations, in the same way it would be on a floating oil platform.

More in Part 2 later.

Note: Oil sands vs Tar sands. The province of Alberta and CAPP prefer oil sands, so that is the terminology I have used. Oil sands is also far more commonly used, according to Google.

Some previous oil sands / tar sands posts.

World Oil Exports; US Oil Imports; and a Few Thoughts on Canada - Gail the Actuary - Aug. 2009

EROI Update: Preliminary Results using Toe-to-Heel Air Injection - Dave Murphy – March 2009

Unconventional Oil: Tar Sands and Shale Oil - EROI on the Web, Part 3 of 6- Charles Hall guest post – April 2008

Tar Sands: The Oil Junkie's Last Fix, Part 2 – Guest post by Chris Nelder – September 2007

Tar Sands: The Oil Junkie's Last Fix, Part 1 -
Guest post by Chris Nelder – August 2007

Extracting Heavy Oil: Using Toe to Heel Air Injection (THAI) – Gail the Actuary – August 2007

Canadian Oil Sands Production Update – Sam Foucher – Oct. 2006