Oil Sands/Tar Sands Overview: Resource Development

Randy Mikula
Introduction:

- The oil sands geology
- The resource and reserve: Surface mining and in-situ
- Environmental Issues associated with oil sands development
- Oil sands impact on the Canadian economy/products and markets
Natural Outcrops along the Athabasca River just North of Fort McMurray
Natural Outcrop along the Athabasca River, Tar Island, Just Upstream of the Suncor Mine
Canadian Reserves on the world stage: since 2002 Canada has been the biggest exporter of oil to the United States.
### Reserves and Production Summary 2005 (billions of barrels)

<table>
<thead>
<tr>
<th>Bitumen Resource</th>
<th>Total</th>
<th>Mineable</th>
<th>in situ</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,694</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>179</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remaining Reserve</td>
<td>174</td>
<td>35</td>
<td>144</td>
</tr>
<tr>
<td>Annual production</td>
<td>0.388</td>
<td>0.252</td>
<td>0.189</td>
</tr>
<tr>
<td>Years of production</td>
<td>448</td>
<td>140</td>
<td>760</td>
</tr>
</tbody>
</table>

**Athabasca Reserves and Production Summary 2005 (billions of barrels)**

<table>
<thead>
<tr>
<th>Peace River</th>
<th>Cold Lake</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.388</td>
<td>0.252</td>
</tr>
<tr>
<td>0.189</td>
<td></td>
</tr>
</tbody>
</table>

**Fort McMurray**

- Total: 179
- Mineable: 35
- Remaining: 174
- Annual: 0.388
- Years: 448

**Edmonton**

- Total: 144
- Mineable: 140
- Remaining: 0
- Annual: 0.189
- Years: 760

**Calgary**

- Total: 174
- Mineable: 35
- Remaining: 174
- Annual: 0.388
- Years: 448
<table>
<thead>
<tr>
<th>Bitumen</th>
<th>Total</th>
<th>Mineable</th>
<th>in situ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource</td>
<td>1,805</td>
<td>131</td>
<td>1,674</td>
</tr>
<tr>
<td>Reserve</td>
<td>176</td>
<td>38</td>
<td>138</td>
</tr>
<tr>
<td>Remaining Reserve</td>
<td>170</td>
<td>34</td>
<td>135</td>
</tr>
<tr>
<td>Annual Production</td>
<td>.544</td>
<td>.302</td>
<td>.246</td>
</tr>
<tr>
<td>Years of Production</td>
<td>312</td>
<td>113</td>
<td>553</td>
</tr>
</tbody>
</table>

Approximately a 20% production increase in 2 years; 27 fewer years to reclaim
• First Nations people used bitumen to treat their canoes;
• 18th century: oil sands first seen by European explorers;
• 1906 to 1917: tried to drill for oil;
• 1913 Sydney Ells (from our original department) conducted first work on extracting using hot water; continued in 20’s by Karl Clark who develops the Clark Hot Water Process;
• 1920’s to 1948 hot water extraction used to produce bitumen for roofing and roads (Fitzsimmons: Bitumount);
• 1936 to ’40’s Abasands (Max Ball) plant produces diesel from oil sands but plant burned and interest lost after end of 2nd world war;
• 1967 GCOS starts operations (now Suncor): world’s first oil sand’s operation;
• 1978 Syncrude starts production.
• 1974 AOSTRA underground test facility built for in situ production testing; Cold Lake in situ starts up in 1985.
Oil Sand Composition

• Oil sand consists of sand, fines (clays), bitumen, and water (with soluble salts). Composition ranges from (wt%):
  Sand 55 – 80 %
  Fines 5 – 34%
  Bitumen 4 – 18%
  Water 2 – 15%

• There are 3 main classes of ore based on bitumen content:
  High Grade: > 12% bitumen
  Average Grade: 9 – 12 % bitumen
  Low Grade: < 9 % bitumen

• A typical ore = 73% sand, 12% bitumen, 10% fines, 5% water
A lot of water is required to produce a barrel of bitumen!
MINING  →  EXTRACTION

tree clearing

overburden

truck & shovel

slurry

crusher & cyclofeeder

bitumen froth to treatment

MFT & CT containment

tailings

sand storage

tailings settling basin

water recycling

tailings oil recovery

TAILINGS MANAGEMENT

Courtesy Syncrude
1 m³OE ~ 40 GJ
So 10 GJ/m³OE ~
Is about 25% of the input energy in the product
1 GJ/m³OE ~ 2.5%

Source: Clearstone et al - An Air Quality Impact Study of Canada’s Oil and Natural Gas Industry – October, 2008
The area occupied by the circle is approximately 400,000km², and the area of the oil sands resource (in white) is approximately 141,000km². Currently land disturbance due to oil sands development is about 600km², with tailings containment about 180km².
No nation can long be secure in this atomic age unless it be amply supplied with petroleum . . . It is the considered opinion of our group that if the North American continent is to produce the oil to meet its requirements in the years ahead, oil from the Athabasca area must of necessity play an important role.

J. Howard Pew (GCOS 1960’s)
Oil Sand

Water

Bitumen product

Leftover water and mineral

Recycled Water

Fluid fine tails

Sand Tails

- Water
- Bitumen
- Mineral
- Sand
- Fines

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The sand tailings are used to build the containment for the fine tailings.

- **Extraction**
  - **Ore**: 100%
  - **Tailings**: 86.5%
  - **Oversize**: 13.5%

- **Recycle Water**
  - **Transition Zone**: MFT

- **Recycle Water**

**Wet Ore 100%**

**Fine Tailings**
- **32%**

**Sand Beach**
- **47%**

**Sand Dyke**
- **7.5%**

**Entrapment**
This much water must be added

This much water is used for extraction

0.8

0.6

0.4

0.2

0.0

Oil Sand Water Sand Water

Relative Volumes

This much water is lost

0.2

Rel

0.0

0.4

0.6

0.8

1.0

Oil Sand Water Sand MFT/TFT CT/NST Recycle Water

Process Streams

Water used for extraction: Approximately 12 barrels per barrel of bitumen

Water Recycled: Approximately 70%

Water lost to tailings: Approximately 4 barrels per barrel of bitumen

(this is for a typical ore)
The tailings containment structures are some of the largest man made features on the planet.

Dry stackable tailings technology is one way to reduce the volume of the accumulated fluid fine tailings. Dry stackable tailings implementation will allow for reclamation of the boreal forest, and reduce the water requirement from the Athabasca river.
Aerial photo from approximately 1987 when the “best available technology” was water capping of the accumulated fluid fine tailings or sludge.

CT/NST technology promised to increase water re-use from 75% to over 80%, but now even this improvement on the “best available technology” proposes to have an end pit lake containing leftover fluid fine tailings or MFT.
Suncor Pond 1 Reclamation
Suncor Pond 1 September 2010 (Wapisiw Lookout)
Tailings research at CETC-Devon: Minimizing the Environmental Impact of Oil Sands Development
Storage volume limitations will drive new tailings technologies as much as water availability. Without the implementation of some other dry stackable tailings technology, long term storage volumes could become unsustainable.
THE CT PROCESS
With the correct recipe, CT or NST is pumpable, but rapidly releases recycle water, leaving a trafficable surface for reclamation of the boreal forest. Without the correct recipe, the mixture will segregate, leaving a fluid material unsuitable for reclamation.
The circled area represents the commercial version of the swimming pool experiment in the previous slide, and the photographs show the trafficable surface created. Water released from this pond was returned to the extraction process, reducing storage volumes and reducing withdrawal from the Athabasca river.
MFT DEWATERING
aka Thin Lift
aka TRO
aka AFD
Thin lift dewatering
Centrifuged fluid fine tailings

- Increased water recycle
- Reduced volume
- No fluid storage requirement
- Reclamation behind the mining operation

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October issue of Alberta Oil Magazine

A new standard in fluid fine tailings dewatering: Syncrude Centrifuge Pilot cell #3
Bitumen
Water
Sand
Fines

The CT/NST Process
The Centrifuge Process

Historical Tailings Management
The CT/NST Process

President Obama, you'll never guess who's standing between us and our new energy economy...

Canada's Tar Sands: the dirtiest oil on earth.

Canadians, please stand up for our children. This is the best path forward.

Stop the Tar Sands

The most destructive project on Earth

February 2008

Canada [Not just mounties and ice hockey anymore]

Canada's governments are allowing the boreal forest to be dug up to bring America the world's dirtiest oil. Producing tar sands oil releases three times the global warming pollution of conventional oil and creates giant toxic lakes you can see from space.

And that's not all. Coming soon is a multimillion-dollar public relations campaign to tell you everything's fine.

KALIUM Research

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Pond Construction: MORDOR?

Seepage and runoff collection
The arrow marks Mildred Lake, adjacent to Syncrude’s tailings pond; the Mildred Lake Settling Basin.

The Department of Fisheries and Oceans routinely harvests game fish from this lake to restock a sport fishing lake south of Fort McMurray (Lac La Biche).
Progress is slow but measurable

AFTER: South Bison Hills

BEFORE: The Syncrude Base mine
SUMMARY

Several tailings management options are commercialized or have been demonstrated at close to commercial scale. Although progress has been slower than anyone would like, mined out areas are becoming available and are being utilized to implement a variety of stackable tailings technologies.

Water conservation by the use of “dry stackable tailings” management options will have significant implications for the recycle water chemistry, possibly offering the opportunity to improve water quality from an environmental perspective.
Any Questions?