Oil Sands Feedstocks

C Fairbridge, Z Ring, Y Briker, D Hager
National Centre for Upgrading Technology
K Mitchell
Shell Canada Products

12th Diesel Engine-Efficiency and Emissions Research Conference
August 20-24, 2006
Detroit MI
National Energy Board concluded that oil sands production will grow from 1.1 million b/d in 2005 to 3.0 million b/d in 2015.
U.S. and Canadian Markets for Crude Oil

T Wise Purvin & Gertz June 2005
Global Crude Oil Reserves and US Imports (CAPP)

Canada, with 175 billion barrels in oil sands reserves, ranks 2nd only to Saudi Arabia in global oil reserves.

Canada is the largest (#1) supplier of crude oil and of petroleum products to the US.

Sources: Oil & Gas Journal Dec 2005

Source: EIA, 2005
Canadian Oil Sands Potential

- Initial Oil in Place: 1.6 Trillion Barrels
- Potential upside through technological gains
- Recoverable Reserves: 174 Billion Barrels
- Cumulative Production (1967-2003): 4 Billion Barrels
Oil Sands Deposits in Alberta

(Courtesy of Syncrude Canada Ltd.)

Province of Alberta

Athabasca Oil Sand Deposit

Surface mineable

Albian
Syncrude
Suncor
Fort McMurray

Athabasca

Peace River
Cold Lake
Edmonton
Calgary

Lloydminster
Oil Sands Projects

Western Canadian Crude Oil Markets 2005 (000 bpd)

From: CAPP. Canadian Oil and Natural Gas in the North American Market. Washington DC, June 1006. P. 12
Oil Sands Industry Expenditure Forecast

Upgrading Oil Sands  Bitumen to Clean Fuels

Processes and Markets

Product Quality (Chemistry)

<table>
<thead>
<tr>
<th>Bitumen</th>
<th>SCO</th>
<th>Ultra-Clean Fuels</th>
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<td>Hydrogen/carbon = 1:1</td>
<td>Large diesel component</td>
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<td>High sulphur</td>
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- Oil sands
- Extra Heavy Oil
- In situ Production
- Primary Upgrading
- Secondary Upgrading
- Synthetic Crude Oil (SCO)
- North American Refineries
- Gasoline
- Diesel
- Jet
- Pipeline to 'conversion' refineries
- Pipeline to refineries and niche markets
- Pipeline to To 'conversion' refineries
- Pipeline to (partially upgraded oil)
Upgrading, Transportation & Refining are Needed for the Clean Fuels Market to Utilize Alberta Bitumen

T Wise Purvin & Gertz June 2005
National Centre for Upgrading Technology Secondary Upgrading

Fuel Quality & Process Modeling

FCC Process ACE Testing

Knowledge of Industry

Catalytic Hydroprocess Development

Hydroprocessing Pilot Plant Testing

Analytical Method Development
### NCUT Product Modeling

- Aniline point
- Cetane Number
- Ignition Quotient (IQT)
- Cloud Point
- Density (15.6°C)
- Flash Point
- Molecular Weight
- RI
- Pour Point
- Viscosity (40/80°C)

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**Market Demand**

- **GASOLINE**
  - Octane 87-91

- **JET FUEL**
  - Smoke pt. > 22

- **DIESEL**
  - Cetane 43

**50/50 WTI-Midale (Conv. Light-Heavy mix)**

- **GASOLINE**: 24
- **JET FUEL**: 50
- **DIESEL**: 11.9

**SCO**

- **GASOLINE**: 13
- **JET FUEL**: 40
- **DIESEL**: 11.3

**% vol**

- 100
- 80
- 60
- 40
- 20

**UOP-k = 11.8+**

**RESIDUE**
Where to attack the problem? @ Upgrading/Refining Interface

Upgrader

Refinery

- **EXTRACTION & FROTH TREATMENT PLANT**
- **DILUENT RECOVERY UNIT (2 UNITS)**
- **FLUID COKER (2 UNITS)**
- **LC-FINING (1 UNIT)**
- **NAPHTHA HYDROTREATER (2 UNITS)**
- **LIGHT GAS OIL HYDROTREATER (1 UNIT)**
- **HEAVY GAS OIL HYDROTREATER (2 UNITS)**
- **HYDROGEN PLANT (3 UNITS)**
- **AMINE AND SULFUR PLANT**
- **FLUID COKER (2 UNITS)**
- **NAPHTHA HYDROTREATER (2 UNITS)**
- **LIGHT GAS OIL HYDROTREATER (1 UNIT)**
- **HEAVY GAS OIL HYDROTREATER (2 UNITS)**
- **HYDROGEN PLANT (3 UNITS)**

- **CAT-FEED HYDROTREATER**
- **DISTILLATION UNIT**

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- **HYDROGEN PLANT (3 UNITS)**

- **CAT-FEED HYDROTREATER**
- **DISTILLATION UNIT**
GC-FIMS Chromatograms of ULSD Blend Streams

Oil sands based

Conventional petroleum based

Simulated Distillation

0 25 50 75 100

Mass%
### Tabular GC-FIMS Data (200°C+)

**Boiling Range**: 210 - 220°C

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<th>HC Type</th>
<th>Z No</th>
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<th>Conventional petroleum based</th>
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GC-FIMS Distribution by Boiling Point

Oil sands based

Conventional petroleum based
2D-GC Comparison (FID)

Oil sands based

Conventional petroleum based
Two Dimensional Gas Chromatography – FID Signal
Oil Sands Development

• Transportation fuel production from Alberta’s oil sands is growing at a rapid pace
• Oil sands could be the single largest petroleum supply to the U.S.A.
• The value chain in oil sands is technology intensive
• A number of technology challenges and opportunities to ensure responsible growth have been mapped out
• Capital investment in oil sands production and upgrading is substantial
• Security and Prosperity Partnership of North America – Oil Sands Initiative
Knowledge Gaps

- Effect of diesel fuel chemistry on combustion, engine emissions, lubricity, and after treatment technologies for future engines
- Effect of diesel fuel chemistry and blends (conventional crude derived diesel fuel, oil sands, bio-fuels and Fischer Tropsch fuels) on tomorrow’s engines
- Could low temperature combustion engine technology change fuel requirements?
- Oil Sands Chemistry and Engine Emissions Roadmap Workshop, June 2005, Edmonton, Alberta, Canada
Where do we go from here?

• Chemistry models and combustion models need to work together (i.e. chemical descriptors used to characterize diesel fuel for processing research need to be useful for combustion models and engine research)

• Standard fuels, including oil sands components, need to be evaluated in several engine R&D programs to better correlate fuel chemistry to engine emissions (both today’s and tomorrow’s engines)

• National Centre for Upgrading Technology has established working relationships with US researchers (PNNL and ORNL) to understand how future engine technologies may affect oil sands processing and vice versa

• NCUT also has working relationship with combustion researchers at National Research Council Canada
Future Fuels for Future Engines

**Processing**
- ongoing research, development and demonstration activity
- Producer - upgrader - refiner interface
- new production, upgrading and refining technologies that deliver higher quality products
- variety of bitumen-derived products but Heavy Gas Oil is critical
- FCC – conversion capacity
- process models provide guidance and detailed analysis would help

**Engines and Emissions**
- passenger vehicle and on-road and off-road diesel engines
- government policy and vehicle/engine regulations and harmonization
- new vehicle/engine technology standards
- current/future fuels in current/future engines
- analytical research and composition - emissions models

**Hydrocarbon and Fuel Quality**
- hydrocarbon stream and diesel fuel on-going activity
- government policy, fuel regulations and harmonization
- fuel standards (CGSB & ASTM, EPA & CEPA)
- stability, compatibility, cetane number, lubricity, additives
- analytical research & product quality models
Additional Sources

- There is some useful information on oil sands in the web sites below:

  - [http://www.energy.gov.ab.ca](http://www.energy.gov.ab.ca)
  - [www.ptac.org](http://www.ptac.org)
  - [http://www.choa.ab.ca/](http://www.choa.ab.ca/)
  - [http://www.capp.ca/](http://www.capp.ca/)
  - [http://www.neb.gc.ca/whatsnew/index_e.htm](http://www.neb.gc.ca/whatsnew/index_e.htm)