Agenda

- Oil Sands Processing Challenges
- Upgrading Considerations
- Syngas Treating and Processing Solutions
- Incremental Hydrogen Studies
- Integrated Flowscheme Examples
Oil Sands Processing Challenges

- Processing Strategy
  - Targeted product slate
  - Residue conversion approach
  - Hydroprocessing severity

- Project Challenges
  - Total costs
  - Hydrogen requirements and sources
  - Energy demands

- CO₂ Management
  - Current or future considerations
Bitumen Upgrading
Typical Flow-Scheme

- Distillation
  - Naphtha
  - Diluted Bitumen
  - Distillates / Gas Oils
  - Residues
  - Unconverted Residues

- Hydroprocessing
  - Hydrogen
  - Synthetic Crude

- Residue Upgrading
  - Natural Gas
  - Steam Methane Reforming
  - PSA
  - Tail Gas

UOP Technologies
Bitumen Upgrading with Gasification

Flow-Scheme

Distillation

Diluted Bitumen

Residues

Unconverted Residues

Gasification

Distillates / Gas Oils

Hydroprocessing

Synthetic Crude

Hydrogen

Acid Gas

Tail Gas

UOP Technologies
Hydrogen Balance
A Key to Upgrading Success

- Knowing how much and where to put hydrogen
- How to produce low cost Hydrogen
- Integrating both consumers and producers of hydrogen
Knowing how much and where to put Hydrogen Impacts:

- Integration Opportunities
  - Product Quality Selection and Flexibility
  - Capital Costs
  - Operating Costs
UOP Integrated Hydroprocessing Flow-Scheme

Vacuum Gas Oil

Distillates

Deasphalted Oil

Hot Separator

Reactor

Hot Separator with Post-Treat Bed

Cold Separator

Hot Flash Drum

Cold Flash Drum

Hot Flash Drum

Amine Scrubber

Recycle H2

Make-up H2

H2 Recovery

Synthetic Crude or Finished products

Distillates

Deasphalted Oil

Vacuum Gas Oil

Make-up H2
A Typical Gasification Complex Can Produce Steam, Power, and Hydrogen

- **Gasification**
  - Residue Feed Stock
  - Produces H$_2$S, H$_2$, CO, CO$_2$

- **Gas Cooling & CO Shift**
  - CO$_2$

- **Syngas treating & Separation**
  - H$_2$S, H$_2$, CO, CO$_2$
  - O$_2$

- **Air Separation Unit**
  - Produces H$_2$, CO, CO$_2$, N$_2$

- **Claus Sulfur Plant**
  - Produces Sulfur

- **Combined Cycle Unit**
  - Produces Power, Steam
Regions of Use for Acid Gas Technologies

- Benfield™ Process
- Amine Guard™ FS Process
- MOLSIV™ Scavengers
- Polybed™ PSA
- Selexol™ Process
- Separex™ Membrane
Syngas Treating Technologies

Partial pressure of acid gas in feed, psia

Partial pressure of acid gas in product, psia

Amine Guard™ FS Process

Selexol™ Process

0.001 0.01 0.1 1.0 10 100

0.1
What is the Selexol Process?

- Absorption/regeneration process for selective removal of H₂S, COS, & CO₂
  - Physical solvent
  - Typical solvent-extraction flow-scheme
- Product Quality
  - Can be essentially sulfur free
  - Project specific CO₂ slip or capture
  - Project specific acid gas H₂S concentration
Selexol Process
Hydrogen Production Flow-Scheme

CO₂ Absorber

H₂S Absorber

Raw CO₂

Acid Gas Enrichment

Stripper

Export Water

Feed Gas

Raw H₂

Acid Gas
Selexol Process
Commercial Experiences

- **56 operating units**
  - Both Natural Gas and Gasification applications

- **Recent Gasification Applications**
  - Sarlux IGCC - Sardinia, Italy
  - API IGCC – Falconara, Italy
  - Coffeyville Resources NH₃/UAN - USA
  - Syngas treating - Alberta, Canada

- **Coal to Power Applications**
  - US location
  - Presently being designed for multiple Units
Hydrogen Balance
A Key to Upgrading Success

- Knowing how much hydrogen is needed
- How to produce low cost Hydrogen
- Integrating both consumers and producers of hydrogen
For Increased Hydrogen Production Requirements

- CO shift added on syngas:
  - Increased hydrogen
  - Increased CO₂

- CO₂ Absorber included in Selexol
  - CO₂ recovered at high pressure
  - Minimizes CO₂ content of treated gas

- Reduces PSA Size
  - Minimizes tail gas
Gasification for Power and Hydrogen Production

- Gasifier with Quench & Scrubbing
- Air Separation Unit
- Gas Cooling & COS Hydrolysis
- Selexol
- Claus Plant
- Polybed PSA
- Polysep Membrane

Flow:
- Feed → Gasifier with Quench & Scrubbing
- Air to Air Separation Unit
- O₂ to Gas Cooling & COS Hydrolysis
- Purified Syngas to Combined Cycle Power Plant
- High Purity Hydrogen
- Raw Hydrogen
- Electric Power
- Steam for Export
- Tail Gas
- Elemental Sulfur

UOP 4375F-12
Syngas Treating/Separation
Relative Hydrogen Production

% recovery of available $H_2$

Unshifted Gas  Shifted Gas

IGCC Application  H2 + Low Press Fuel  H2 + Med Press Fuel  High H2  Max H2
Syngas Treating/Separation Relative Opex

Unshifted Gas vs. Shifted Gas

- IGCC
- H2 + Low Press Fuel
- H2 + Med Press Fuel
- High H2
- Max H2

Opex levels range from 0 to 3.
# Purification Options Implications

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Hydrogen Balance
A Key to Upgrading Success

- Knowing how much hydrogen is needed
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- Integrating both consumers and producers of hydrogen
Upgrading and Gasification
Conventional Hydrogen Supply Flowscheme

Distillates / Gas Oils

Residues

Residue Upgrading

Unionfining Unicracking

Gasification

CO Shift

Selexol

Syngas Polybed PSA

Plant Polybed PSA

Flash Gas

High Purity H₂

To Plant Fuel System

Synthetic Crude / Refined Fuels

Rich Acid Gas

CO₂ Rich Tail Gas

UOP 4446I-43
# Purification Options Implications

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**Value of Integrated Approach**
Summary

- Integrated solutions provide the best opportunities to maximize margins
- UOP’s Hydroprocessing technologies offer unique and optimal solutions to meet product objectives
- UOP has the complete technology package for syngas treating, hydrogen recovery and purification
- UOP has commercial experience for gasification applications
Technology Integration to Maximize Value of Oil Sands Products

Gasification Technology Conference

October 3, 2006
Washington DC

Thanks for your time and attention