Presentation to Hydrocarbon Upgrading Task Force

Duke du Plessis
Alberta Energy Research Institute
and
Alberta Employment Immigration and Industry

McDougall Centre
Calgary, Alberta

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Hydrocarbon Upgrading and Demonstration Program (HUDP)

- Alberta “Vision” – paraphrased
  - Become a world leader in commercializing new technologies to utilize Canadian heavy hydrocarbons with positive economic, social and environmental impact
  - Demonstration Units: Accelerate commercialization of new technologies by closing the gap between pilot plant and commercialization
  - Training of skilled personnel

- HUDP Phase 1 study commissioned by:
  - Alberta Energy Research Institute (AERI), Nova, Husky, Nexen, CNRL, Suncor, Peace River Oil, Shell Canada

- Identify and evaluate “next generation” technologies with “breakthrough potential”
Hydrocarbon Upgrading Demonstration Program (HUDP) – Phase 1

- Contracted Jacobs Consultancy
- Screened 100 technologies and 25 licensors
- Evaluated 17 technology configurations:
  - Conventional 200,000 bpd reference plant for SCO
  - Refined products & petrochemicals
- Selected technologies with best potential
- Technologies ranged from early stage conceptual to more mature, ready for demonstration processes
**HUDP Phase 1 - Representative Process Schemes and Products**

**Product Options**
- SCO
- Refined Products
- Petrochemicals

**Bitumen**
- Mined/SAGD

**Crude Distillation**
- Vacuum Distillation

**Various Primary Upgrading**
- Coke (solid)
- Pitch (liquid)

**Gasifiers**
- Slag

**Various Secondary**
- H₂
- Steam
- Syngas
- CO₂

**Steam Reformer**
- Hydrogen
- Electricity

**In-plant use/export**
- Imported Natural Gas

**In-plant use/SAGD**
- EOR/Sequestration *

**In-plant use/Fischer-Tropsch to ultra-clean fuels**

*not included in Phase 1 of AERI/Industry study*
HUDP Phase 1
General Conclusions

- Overall conversion improves economics to a point
  - Optimum residue make versus capital and operating cost
- Gasification economics attractive especially at high NG prices
  - Challenges - capital cost and reliability
Environmental – Gasification versus SMR

- Upgrader producing finished products
- Gasification reduces
  - non-capturable CO$_2$
  - Coke storage

"Gasification Reduces the Environmental Footprint of Upgrading"


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HUDP Phase 2

- AERI requested expressions of interest for “Next Generation” Carbon/Hydrocarbon Upgrading Technologies – Nov 2006
- Received 23 proposals.
- Identified best for full applications
- Selected 8 for stage-gated funding
  - Residue Upgrading (3)
  - Gasification (3)
  - Bitumen to Petrochemicals (1)
  - CO2 capture (1)
ETX Cross Flow Coking

- Claims:
  - Improved conversion compared to delayed coking
    - Lower coke yields
    - Improved product yield and same qualities
  - Capital savings
- Pilot plant work progressing to validate yield and qualities
- Seeking other participants

Diagram is courtesy of ETX Systems- published in PTQ-Q3-2005
UOP - Residue Upgrading

- Proprietary technology
- Claims:
  - 90+% conversion of bitumen to 525°C and lighter products
  - Optimum Integration with secondary upgrading (hydrotreating/hydrocracking)
NOVA NHC and ARORINCLE

- Proprietary technology based on extensive catalyst development
- High yield of C2, C3 (including olefins) and BTX from bitumen
- Benefits of integration with upgrading & refining

Diagram is courtesy of NOVA Chemicals
PWR Gasification - Claims

- Based on rocket engine technology
- High mass flux
- Advanced materials
- Size and cost reduction

Diagram Courtesy PWR

<table>
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<tr>
<th></th>
<th>GE Gasifier</th>
<th>Shell Gasifier</th>
<th>Conoco Phillips Gasifier</th>
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<th>PWR Gasifier</th>
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<td>Fuel Flexibility</td>
<td>Fair</td>
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90% Size Reduction Provides Significant Advantages

Diagram Courtesy PWR
Great Point Energy (GPE) Catalytic Gasification

- Converts petcoke/coal to methane (SNG) in single stage reactor
- Steam instead of oxygen saves cost of ASU
- Produces SNG at low end of NG market price
- SMR of SNG lower capital cost than gasifier with shift and PSA
Summary

- HUDP is progressing on schedule
- Phase 2 focuses on developing and demonstrating promising “next generation” clean upgrading technologies in partnership with industry
- Technologies selected are at different stages of development
- Government/Industry risk sharing essential to demonstrate commercial readiness
- Opportunity for wider industry participation in selected development and demonstration projects
Contact Information

Eddy Isaacs, Executive Director,
Alberta Energy Research Institute
Suite 2540, 801 – 6 Avenue SW,
Calgary, AB T2P 3W2
eddy.isaacs@gov.ab.ca
Tel. (403)297-5219

Duke du Plessis, Senior Advisor and Research Manager
Alberta Energy Research Institute
Suite 2540, 801 – 6 Avenue SW,
Calgary, AB T2P 3W2
duke.duplessis@gov.ab.ca
Tel. (403)297-3635