UTILIZING LOW GRADE COAL TO PRODUCE METHANOL: A CASE STUDY

Nandkishor Bhongale                    Kakul Singh Sunil Singhal

© 2019 Fluor Corporation. All Rights Reserved.

Gasification India 2019, Nov 28 - 29, 2019, New Delhi, India
AGENDA

- Gasification Overview
- Coal to Methanol : Case Study
  - Methanol
  - Current Methanol Scenario
    - Global
    - India
  - Coal to Methanol-BFD
  - Economics
- Conclusion
- Fluor Gasification Experience
GASIFICATION OVERVIEW

- Reaction of low value fuels such as coal, petroleum residues, biomass, industrial wastes, MSW, etc. with oxygen and steam at high temperature to produce H₂ + CO synthesis gas

- Primary Gasification Reactions:
  - Partial Oxidation: 2 C + O₂ → 2 CO
  - Steam Gasification (Reforming): C + H₂O → CO + H₂
  - Water Gas Shift: CO + H₂O → CO₂ + H₂
  - Methanation: 3 H₂ + CO → CH₄ + H₂O

- Operating Conditions: 900 – 2000°C / 0.3 – 85 barg

- Heteroatoms:
  - N converted primarily to N₂, NH₃, HCN
  - S converted primarily to H₂S, COS, CS₂
  - Many trace components (e.g. formic acid, chlorides, sulphur & nitrogen compounds, cyanides, soot, metal carbonyls and others)

Contd..
GASIFICATION OVERVIEW

◆ Water gas shift to adjust H₂/CO ratio as required for end product
  ➢ CO + H₂O → H₂ + CO₂

◆ Syngas clean up and acid gas removal to condition gas for downstream catalysts and to meet environmental regulations

◆ Sulphur recovery as elemental sulphur or sulphuric acid

◆ Potential for CO₂ capture and use for Coal Bed Methane / Enhanced Oil Recovery or Sequestration

◆ Gasification is a complex and challenging process
  ➢ Project execution requires integration of technologies from several parties
  ➢ Attention to trace components, corrosion, catalyst life and process control
  ➢ Special attention to CAPEX and OPEX from the early stages of project development
  ➢ Requires a highly qualified team with gasification experience
  ➢ Frequent routine maintenance and replacement of specific component which result in downtime
  ➢ Handling of solids
METHANOL

◆ Methanol is a versatile chemical having a wide range of applications

◆ Traditional applications include production of formaldehyde, acetic acid, MTBE, Methyl Methacrylate, Methylamines, Methyl Halides, etc.

◆ Emerging applications are: Methanol to Olefins, Gasoline Blending, Biodiesel, DME, Methanol to Gasoline, Bunker Fuel, etc.

◆ Methanol is a clean burning fuel → produces no particulate matter, no soot, no SOx and NOx emissions
CURRENT METHANOL SCENARIO - GLOBAL

- World has installed capacity of 120 MMTPA of Methanol and will be about 200 MMTPA by 2025
- China alone produces 65% of world Methanol and it uses its coal to produce Methanol.
- Israel and Italy have adopted the M15 blending program with Petrol and fast moving towards M85 & M100
- Japan and Korea have extensive Methanol & DME usage and Australia has adopted GEM fuels (Gasoline, Ethanol & Methanol) and blends almost 56% Methanol

Reference:
- http://vikaspedia.in/energy/energy-basics/methanol-economy-in-india
Coal to Methanol: Case Study

CURRENT METHANOL SCENARIO - INDIAN

- India has an installed Methanol Production Capacity of 2 MMTPA which is currently produced from Natural Gas.
- As per plan by NITI AAYOG → 30 MMTPA of Methanol is required to substitute 10% of crude imports by 2030.
- Presently India’s import bill on account of crude stands at almost 6 lakh crores.
- Government has set a goal to reduce the import bill by 10% by the year 2022.

HOW TO ACHIEVE THESE GOALS:

- India has fifth largest coal reserves in the world.
- Most of these reserves have low rank coal with high ash content.
- Gasification offers an alternate to use domestically available coal reserves to make value added products in an environment friendly manner.

Reference:
- http://vikaspedia.in/energy/energy-basics/methanol-economy-in-india
Coal to Methanol: Case Study

**COAL TO METHANOL - BFD**
ECONOMICS

Basis and Assumptions:

- Methanol Capacity: 2250 KTA
- Coal (35-40 wt% ash) price: 20 - 40 $/MT
- Raw water price: 0.06 $/MT
- Sulphuric acid price: 78 $/MT
- Operations & maintenance cost: 2 to 3% of CAPEX

Cash Cost = Raw material (coal + raw water) cost + Operations & Maintenance (incl. catalyst & chemicals) cost + Capital cost over plant design life – Revenue from other byproducts

This Case Study is based on certain assumptions and results may vary based on feedstock characteristics and type of gasification technology selected

FLUOR
# Coal to Methanol: Case Study

**ECONOMICS**

Results:

<table>
<thead>
<tr>
<th>Coal Cost ($/MT)</th>
<th>Methanol Cash Cost ($/MT)</th>
<th>Methanol Cash Cost (Rs/liter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>180</td>
<td>10.2</td>
</tr>
<tr>
<td>30</td>
<td>200</td>
<td>11.4</td>
</tr>
<tr>
<td>40</td>
<td>220</td>
<td>12.5</td>
</tr>
</tbody>
</table>

Imported Methanol price in India: **290-320 $/MT**

Reference:
Gasification is a complex and challenging process but –

- Offers a cost effective option to convert low rank coal into **high value added products such as Methanol**

- Coal availability in India places gasification in a strategically important position with anticipated **positive downstream product slate demand**

- Gasification offers an alternate to use domestically available vast coal reserves to make value added products in an **environment friendly manner**

- Can **reduce India’s fuel import bill** and help in achieving Government’s plan to **boost Methanol economy**

- While challenging, several gasification projects have been successful. Must employ **best technologies** and employ **gasification experienced** design engineers
## FLUOR GASIFICATION EXPERIENCE

<table>
<thead>
<tr>
<th>Client</th>
<th>Location</th>
<th>Scope</th>
<th>Feed</th>
<th>Products</th>
<th>Technology</th>
<th>Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confidential</td>
<td>Indonesia</td>
<td>Pre-FEED</td>
<td>Coal</td>
<td>Polypropylene, DME and Urea</td>
<td>Confidential</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Lake Charles Methanol</td>
<td>Louisiana</td>
<td>FEED</td>
<td>Pet coke</td>
<td>Methanol</td>
<td>GE</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Celanese / IOCL</td>
<td>India</td>
<td>Pre-FEED</td>
<td>Pet coke, Coal</td>
<td>Ethanol, Power</td>
<td>Confidential</td>
<td>2015</td>
</tr>
<tr>
<td>Reliance Industries</td>
<td>India</td>
<td>E, P and PM Support</td>
<td>Pet coke, Coal</td>
<td>Hydrogen, SNG, Power</td>
<td>MDR E-Gas</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Pertamina</td>
<td>Indonesia</td>
<td>Pre-FEED</td>
<td>MSW</td>
<td>Power</td>
<td>Solena</td>
<td>2014</td>
</tr>
<tr>
<td>Confidential</td>
<td>Indonesia</td>
<td>Pre-FEED</td>
<td>High Moisture Indonesian Coal</td>
<td>SNG, Urea, CO₂</td>
<td>Confidential</td>
<td>2012</td>
</tr>
<tr>
<td>Jindal SynFuels</td>
<td>India</td>
<td>Pre-FEED</td>
<td>High Ash Indian Coal</td>
<td>FT Liquids, Ammonia</td>
<td>Confidential</td>
<td>2012</td>
</tr>
<tr>
<td>Reliance ADAG</td>
<td>India</td>
<td>Pre-FEED</td>
<td>High Moisture Indonesian Coal</td>
<td>SNG, Power</td>
<td>Confidential</td>
<td>2012</td>
</tr>
<tr>
<td>MAK</td>
<td>Mongolia</td>
<td>Pre-FEED</td>
<td>High Moisture Brown Coal</td>
<td>MTG, Power</td>
<td>Confidential</td>
<td>2012</td>
</tr>
<tr>
<td>Fulcrum Sierra BioFuels</td>
<td>Nevada</td>
<td>FEED Refresh, EPC</td>
<td>MSW</td>
<td>Ethanol, Power</td>
<td>InEnTech (IET)</td>
<td>2012</td>
</tr>
<tr>
<td>OPTI Canada Phase II</td>
<td>Alberta</td>
<td>FEED</td>
<td>Residue</td>
<td>Hydrogen, Power, CO₂</td>
<td>Shell</td>
<td>2012</td>
</tr>
<tr>
<td>Rentech</td>
<td>California</td>
<td>FEED</td>
<td>Woody Waste</td>
<td>FT Liquids, Power</td>
<td>Rentech SilvaGas</td>
<td>2011</td>
</tr>
</tbody>
</table>

Contd..
<table>
<thead>
<tr>
<th>Client</th>
<th>Location</th>
<th>Scope</th>
<th>Feed</th>
<th>Products</th>
<th>Technology</th>
<th>Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summit</td>
<td>Texas</td>
<td>FEED</td>
<td>Coal</td>
<td>Urea, Power, CO₂</td>
<td>Siemens</td>
<td>2011</td>
</tr>
<tr>
<td>Swan Hills</td>
<td>Alberta</td>
<td>Pre-FEED, FEED</td>
<td>Deep Unmineable Coal</td>
<td>Power, CO₂</td>
<td>Swan Hills In-situ Coal Gasification</td>
<td>2011</td>
</tr>
<tr>
<td>MSEZL</td>
<td>India</td>
<td>Pre-FEED</td>
<td>Petcoke</td>
<td>Acetic Acid, Hydrogen, Power</td>
<td>Confidential</td>
<td>2010</td>
</tr>
<tr>
<td>Eastman</td>
<td>Montana</td>
<td>Pre-FEED</td>
<td>Petcoke</td>
<td>Hydrogen, Methanol, Ammonia, CO₂</td>
<td>GE</td>
<td>2009</td>
</tr>
<tr>
<td>Confidential</td>
<td>Montana</td>
<td>Pre-FEED</td>
<td>Coal</td>
<td>Urea, Power, CO₂</td>
<td>Siemens</td>
<td>2009</td>
</tr>
<tr>
<td>Valero</td>
<td>Texas</td>
<td>Pre-FEED</td>
<td>Petcoke</td>
<td>Hydrogen, Power, CO₂</td>
<td>ECUST</td>
<td>2009</td>
</tr>
<tr>
<td>Steelhead</td>
<td>Illinois</td>
<td>FEED</td>
<td>Coal</td>
<td>SNG</td>
<td>CoP E-Gas</td>
<td>2006</td>
</tr>
<tr>
<td>Total</td>
<td>France</td>
<td>FEED</td>
<td>Residue</td>
<td>Hydrogen, Power</td>
<td>GE</td>
<td>2004</td>
</tr>
<tr>
<td>ISAB</td>
<td>Italy</td>
<td>Owner's Eng.</td>
<td>Residue</td>
<td>Hydrogen, Power</td>
<td>GE</td>
<td>1999</td>
</tr>
<tr>
<td>Great Plains</td>
<td>North Dakota</td>
<td>Owner's Eng.</td>
<td>Coal</td>
<td>SNG</td>
<td>Lurgi</td>
<td>1988</td>
</tr>
<tr>
<td>Shell</td>
<td>Netherlands</td>
<td>FEED, EPCM</td>
<td>Residue</td>
<td>Hydrogen, Power</td>
<td>Shell</td>
<td>1997</td>
</tr>
<tr>
<td>Motiva</td>
<td>Louisiana</td>
<td>EP</td>
<td>Residue</td>
<td>Hydrogen</td>
<td>GE</td>
<td>1985</td>
</tr>
<tr>
<td>Eastman</td>
<td>Tennessee</td>
<td>C</td>
<td>Coal</td>
<td>Chemicals</td>
<td>GE</td>
<td>1986</td>
</tr>
<tr>
<td>Sasol</td>
<td>South Africa</td>
<td>EPCM</td>
<td>Coal</td>
<td>FT Liquids, Chemicals</td>
<td>Lurgi</td>
<td>1980</td>
</tr>
</tbody>
</table>
STAY CONNECTED..

Nandkishor Bhongale
Nandkishor.V.Bhongale@fluor.com  
+91.124.457.0700 Extn. 3295

Kakul Singh
Kakul.singh@fluor.com  
+91.124.457.0700 Extn. 2294

Sunil Singhal
sunil.singhal@fluor.com  
+91.124.457.0700 Extn. 1649

http://www.fluor.com

http://www.linkedin.com/company/fluor

@FluorCorp

http://www.youtube.com/user/FluorCorporation