Coal Gasification

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Gasification is not new, practiced in various forms since 1792....
What is Coal

- Carbon
- Hydrogen
- Sulfur
- Oxygen
- Nitrogen
- Ash
- Water
Coal Gasification

...how it differs from combustion...

Combustion - excess air

- CO$_2$
- H$_2$O
- NO$_x$
- H$_2$S
- O$_2$
- flyash

Gasification - excess fuel

- C
- H
- N
- S
- O
- Ash

- CO
- H$_2$
- N$_2$
- SO$_x$
- Mostly slag

Mostly slag
Coal Gasification

.....a means for co-production of power, fuels and chemicals....

Note: energy in the C in coal is used to generate H\(_2\) from water, and coal Co-production of power and H\(_2\) – base for subsequent chemicals production
Gasification – *summary of environmental impacts*

- CO₂ in a concentrated and pressurized form – more amenable to capture
- No Soₓ, S is in the form of H₂S, can be captured as a S-byproduct
- Little NOₓ compared to combustion, below acceptable limits
- Particulate emission within permissible limits
- Heavy organics within acceptable limits
- Coal ash mostly glassy, trace elements confined into slag into a non-leachable form
- Mercury, if present in coal, can be captured using activated carbon bed
- Gasifier temperature destroys Furans and Dioxins, if formed
- Up to 25% less water usage than supercritical *pf* power plants
Types of Coal Gasifiers

- **Dry ash**
- **Sintered ash**
- **Slag**

**Air or O₂ blown**
**Steam –may or may not be required**

Christiansen, 1996; IEACCC report
Coal Gasification – Current Status

Early large plants .. 250 MW class – mainly for power

Puertollano – Spain; Shell (Prenflo)

Buggenum – Netherlands; Shell

Wabash – USA; ConocoPhilips (E-Gas)

Polk – USA; GE (Texaco)

Both Dry and Slurry feeding.............
Coal Gasification – Current Status

Early large plants ..... mainly for chemicals production

Great Plains Synfuel Plant North dakota
http://www.dakotagas.com/Companyinfo/index.html

Weyburn pipeline
http://www.ptrc.ca/access/DesktopDefault.aspx

Sasol – since 1955

Uses Lignite
- Fertilizers
- NH₃ for chemicals
- Pesticides
- Solvent
- Resins
- Naphtha
- Liquid N₂
- CO₂

2.7 MT per year
For EOR

Uses variety of coals
- Olefins
- Polymers
- Solvent
- Wax
- Auto fuels
- Degreasers
- Grease
- Lubricant
- Fuel oil
- Phenol
Coal Gasification – Current Status

Several key players active in coal gasification ..... 

General Electric – a major player in gas and steam turbines

- 3 plants start-up in China in 2005-06 – coal-to-ammonia and methanol
- 4 license agreements in China to work on coal-to-ammonia projects

- American Electric Power IGCC, Ohio – Commercial start-up in 2012
- American Electric Power IGCC, West Virginia – Commercial start-up in 2011
- Duke Energy IGCC, Indiana - Commercial start-up in 2011

- GE – BP, BP-Rio Tinto Joint Venture in Hydrogen Energy, GE-Bechtel tie-up for turnkey gasification offering

- Last week’s acquisition of Stamet Pumps – a significant boost for their offering now into the sub-bituminous to low-moisture lignites
Coal Gasification – Current Status

- **Siemens** – a major player in gas and steam turbines
  - Acquired Future Energy gasification – suitable for bituminous and lignites
  - Confirmed contracts for six 200-500 MW projects in China – coal-to-methanol and coal-to-ammonia
  - Siemens-Fluor tie-up for turnkey gasification offering

- **Shell** – a major player in coal and petro-chemicals
  - 15 coal gasification projects in China - coal-to-methanol and coal-to-ammonia
  - JV agreements in Australian gasification projects
  - Tie-up with Krupp UHDE, and Black & Veatch for turnkey IGCC offering

- **Conoco Phillips**
  - 606 MW IGCC for Excelsior Energy in Minnesota
  - Tie-up with Fluor for turnkey gasification offering
Southern Company

- 285 MW proprietary transport reactor based IGCC in Orlando
- Supported by the US Government under its CCPI Round 2 funding
- Tie-up with KBR for design services

*Formation of these tie-ups – reduce front end engineering and development costs - Reduce the IGCC risks*
Coal Gasification – Current Status

...other major players...

- **Sasol, South Africa**
  - contracts signed for feasibility studies for coal-to-liquids projects in China and India

- **Mitsubishi, Japan** - a major player in turbines
  - developing gasifier of its own
  - building a 250 MW IGCC plant in Japan

- **Hitachi**
- **J-Power**

*Significantly improved IGCC potential due to the involvement of the top power industry vendors + some with state-of-the art GT + strong financial muscle*
R&D requirements for Brazilian Coal

- Indigenous R&D capacity building – for Brazilian conditions and Brazilian coal properties – technology developed for coals elsewhere may not be directly applicable without tweaking

- Proper estimation of coal resource and coal/ash characterization

- Reducing ash content is key to utilization via gasification
  - Washability characteristics – yield, and yield improvement
  - Characterization of washery rejects
  - Use in CFBC for maximum energy extraction

- Gasification characteristics of parent coal and washed coal
  - Entrained flow vs. fluidized bed gasification
  - C-conversion, gas composition
  - Extent of pollutant emission – gaseous and solids
  - Characterization of solid wastes
  - Any ash related problems?

...by no means complete.....
R&D requirements for Brazilian Coal

- Indigenous research centre – coordinated closely with the coal industry and the government – not working in isolation on academic research only

- Focusing on practical issues – coordinated with the users of the entire fuel chain – geological sector, coal mining industry and coal utilities

- In the process develop the skill base in R&D in the country – to cater for the need of the industry

- Development of Skill base in experimental area, modeling and analytical support

- Networking with other research centres and universities elsewhere in the world
Does Coal Have a Role in Security of Supply?

Key to Risk Management
Diversification
Diversification
Diversification

Coal provides a much needed Diversity in the energy-mix

Coal’s saving grace

- Abundant and well dispersed unlike natural gas or oil
- Secure
- Relatively affordable