Coal Gasification and Liquefaction - SA Experiences and Opportunities

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forward-looking statements

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Overview

- Background
  - Sasol
  - Direct coal liquefaction
  - Indirect coal liquefaction

- The Sasol Coal to Liquids (CTL) Process
- The Sasol-Fixed Bed Dry Bottom (Sasol®-FBDB™) Gasification Technology & Development
- AECI Coal to Ammonia Plant
- Future Opportunities
- Concluding Remarks
Background

Sasol is an integrated energy and chemicals company converting coal, oil and natural gas into liquid fuels, fuel components and chemicals through the application of proprietary technologies.

Primary strategic focus is to increase shareholder returns by commercialising our technology through our accelerated gas-to-liquids (GTL) growth strategy and focused coal-to-liquids (CTL) opportunities.
Sasol’s Contribution to the SA Economy

Employment
- Direct and indirect employment for over 200,000 people
- Invested R819m in skills development in South Africa in FY12

Taxes
- One of the largest corporate taxpayers - contributing R28,2bn in FY12
- Committed R309,4m to socio-economic development in South Africa in FY12
- FY12 capex spend in South Africa increased by 14% to R18,8bn

Foreign exchange savings
- Foreign exchange savings of billions of rand per annum from locally produced synthetic fuels
Direct Coal Liquefaction

The reaction of coal liquefaction is the conversion of coal into liquid by the thermal decomposition and hydrogenation with catalyst under pressurized condition.

It is more effective to use low rank coal with low energy density and limited utilization as the feedback for liquefaction.

Source: www.powershow.com

LIGNITE / BROWN COAL* 2000 - 4000 kcal/kg

SUB-BITUMINOUS COAL* 4000 - 6000 kcal/kg

BITUMINOUS COAL* 6000 - 7000 kcal/kg

HYDROGENATION

HYDROGEN & CATALYST

HEATING & PRESSURIZING

DISTILLATION

COAL LIQUID 10,000 kcal/kg

GAS OIL

GASOLINE

KEROSENE

*Moisture and ash containing basis
Indirect Coal Liquefaction
The Sasol Coal to Liquids Process

The Sasol complex in Secunda, operated by Sasol Synfuels (Pty) Ltd is the world’s largest commercial Coal to Liquids (CTL) facility to date.

- Facility converts ~40 Mt of coal per annum into ~160 000 bbl/day of liquid fuels
  - ~ 27% of South Africa’s total liquid fuels production
- Other products include *inter alia* pipeline gas, pitch, carbon products, solvents, polymers and other chemicals.
Sasol Synfuels Secunda facility, world’s largest CTL plant
The Sasol Coal to Liquids Process

Coal → Sulphur → Gas Reforming → Cold Separation → Fuels
Water → Gasification → Rectisol → Synthol → Chemical Workup → Chemicals
Air → Ash → Phenosolvan → Tar Distillation → Refinery → Gases
Sasol Fischer-Tropsch Technology Developments

Continuous Improvement, enhancing Sasol’s technologies
The Sasol® FBDB™ Gasification Technology
Typical Sasol® -FBDB™ Syngas Production Block Flow Diagram

Coal
Steam
Oxygen

Sasol® FBDB™
Gasification

Gas
Cooling

Gas
Purification

Sulphur
Recovery

Sulphur

Syngas

Tar & Oil

Sasol® Gas Liquor
Separation™

Effluent to
bio-treatment

Phenols

Sasol® Phenosolvan™

Ammonia

Sasol® CLL™
The Sasol Experience in Gasification

- Syngas production (coal gasification in particular) one of the most critical blocks in a CTL process.

- Eighty (80) MK IV Sasol® FBDB™ gasifiers in Sasol Synfuels, Secunda, operating since early 80’s.

- Four (4) additional gasifiers currently being commissioned in Sasol Synfuels

- Sasol has > 60 years of operating experience
  - 3 MK IV Gasifiers in Sasolburg 1978 – 2004
  - 1 MK V Gasifiers in Sasolburg 1980 – 2004
  - Involved in gasification projects in USA and China
Improvements and Lessons Learned from Operations of the Sasol® FBDB™ Gasifier

Some lessons learned:-
- Understanding of coal properties and coal quality control crucial.

The Gasification plants in Secunda are currently operating at >20% above the original design capacity.
**Highlights of Coal and Gasification R&D Successes at Sasol**

- Demonstration of a Coal Distributor and Stirrer (CSD™) to enable gasification of caking coal in the Sasol®-FBDB™ gasifiers.
- Developed expertise and technology to treat and upgrade condensate resulting from fixed bed gasification.
- Enhancement of the MK V Sasol®-FBDB™ gasifier design.
- Advanced characterisation of coal, ash and tar for Sasol®-FBDB™ gasification technology.
- Developed a statistical on-line gasification plant performance monitoring tool.
Coal and Gasification R&D at Sasol

Test gasifier

- >R80m investment
- Well instrumented, dedicated feeding and sampling systems
- Remains a production asset and only used for tests when required.
- >4000 hours of gasifier performance data obtained
- Information and knowledge contributed to optimisation
Coal and Gasification R&D at Sasol

Coal Stirrer Distributor (CSD™) and Caking Coal
Coal and Gasification R&D at Sasol

Fuel Bed Investigations

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Gasifier top
Gasifier Bottom
Lignite gasifiers
Coal and Gasification R&D at Sasol

MSPEM – Gasifier Performance Monitoring Tool
The Sasol® FBDB™ gasification technology offers various advantages *inter alia*:
- \( \text{H}_2/\text{CO} \) ratio directly suitable for the FT technology
- Low oxidant requirements
- Particularly suited for low grade and lower rank coal
- Gasifiers are robust and have a high availability
- Tar and oils augment liquid fuels production

Given a suitable feedstock, the Sasol® FBDB™ gasification technology offers distinct advantages to both current and future CTL projects.

The technology can also be used for other coal conversion opportunities
Current and Future Coal and Gasification Technology Development Objectives in Sasol

- Improve the viability of CTL ventures utilizing the Sasol® FBDB™ Gasification Technologies
  - Capex & Opex reduction through various initiatives
  - Maximising product revenue
- Ensure Sustainability of existing CTL ventures utilizing the FBDB™ Gasification Technologies
  - Efficiency improvement
  - Opex and total variable cost reduction
  - Environmental footprint reduction
The AECI Coal to Ammonia Plant

- Six Koppers-Totzek gasifiers as part of a 1200 tpd NH₃ plant
- Operated successfully from 1974 to 1999 in Modderfontein, South Africa
The Future Opportunities?

An integrated coal utilization - polygeneration - complex

- Renewables
  - Supplementing
  - Coal

- Other synthesis (future):
  - Methanol
  - DME
  - Surfactants (LAB)
  - Chemicals

- Increased economic activity:
  - Skills development
  - Regional infrastructure development
  - Supporting commerce development

- Fischer - Tropsch based products:
  - Sulphur free fuels
  - Naphtha
  - Jet fuel
  - LPG
  - Base Oils
  - Lubricants

- Co-product industry:
  - Phenolics
  - Anode coke
  - Carburizing coke
  - Low level heat source

- Ash for civil infrastructure:
  - Houses
  - Roads
  - Aggregate
  - Cement additive

- Power from co-generation:
  - Using fines
  - Using Mine Middlings
  - Using gas
  - Integrated steam production
  - UCG / CBM

- Nitrogen industry:
  - NH₃ for chemicals
  - Fertilizers, enabling agriculture
  - Explosives, enabling mining

- Metalics industry:
  - PCI coal
  - Direct Reduction iron
  - COREX

Gasification central to the concept

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Sasol: reaching new frontiers
Concluding Remarks

- Coal will continue to play a significant role in the SA energy economy.
- Integration of various coal utilisation options in one complex (polygeneration) may be an opportunity for SA.
- Coal gasification can be an enabler for the polygeneration concept.
- Direct coal liquefaction is highly coal specific and very costly due to severe process conditions.
- Due to its advantages, particularly the suitability for low grade and low rank coal, the Sasol®-FBDB™ gasification technology will continue to play a significant role in unlocking the value of SA coal.
THANKS

QUESTIONS?