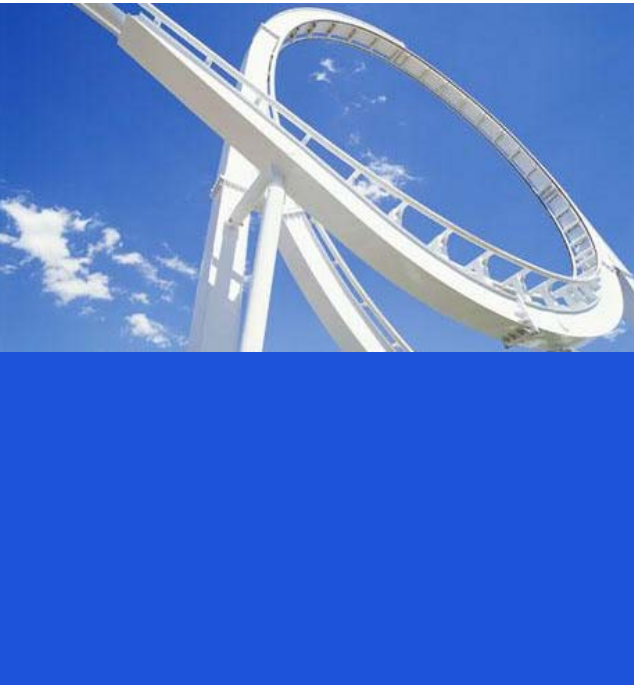
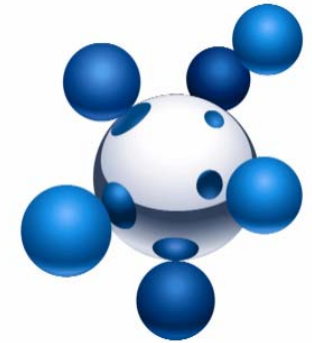


SASOL
reaching new frontiers



***ASPECTS OF THE CLEAN COAL
TECHNOLOGY RESEARCH AND
DEVELOPMENT PROGRAM IN SASOL***

15 to 17 May 2007

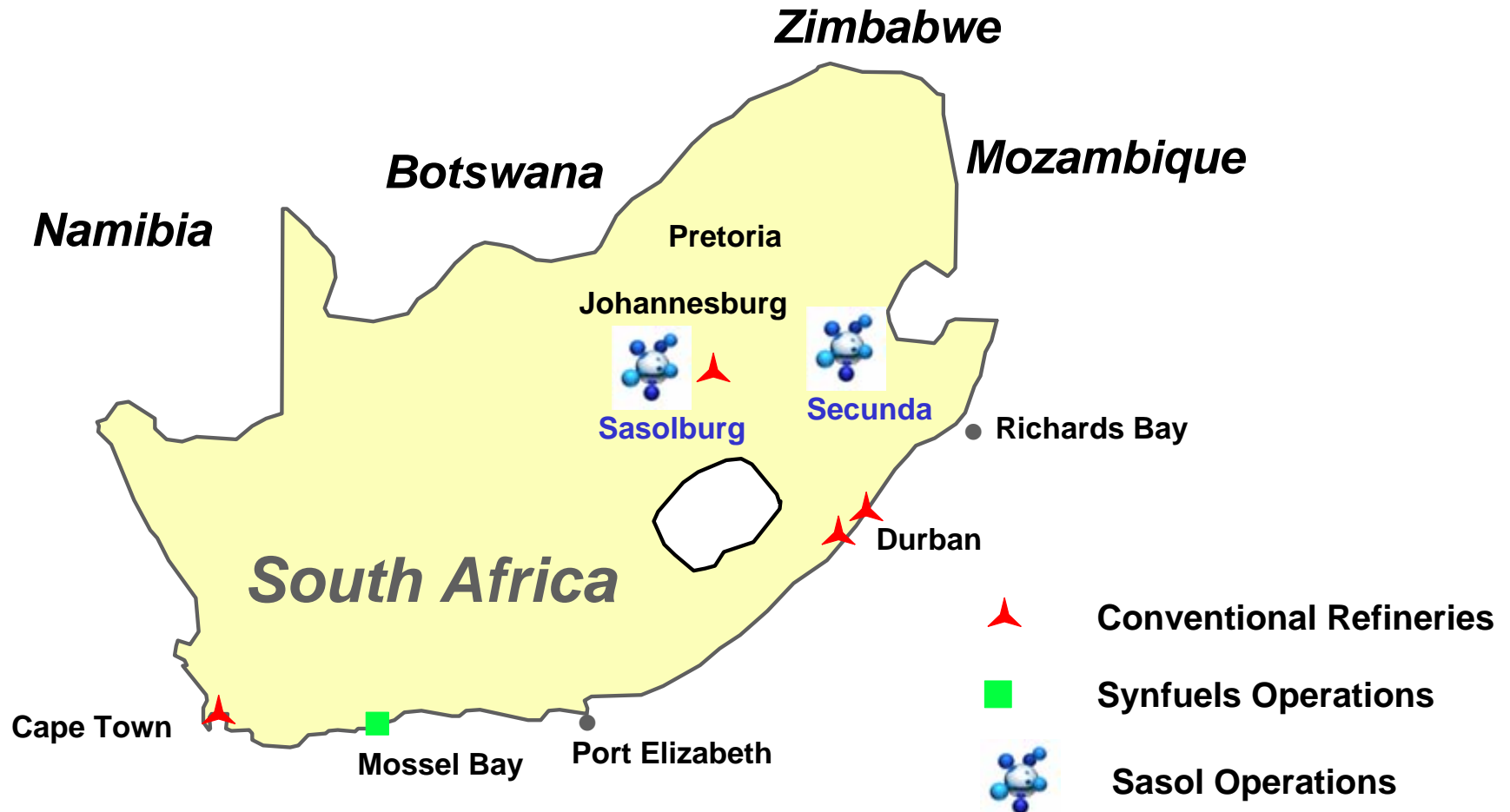


Outline of Presentation

- Background on Sasol
- Focus of this presentation
- Sasol's challenges in broad
- Progress on certain CCT aspects under consideration by the SCT team
- Conclusions



SASOL SOUTHERN AFRICAN OPERATIONS





Secunda Operations





SASOL FACTS (2006)

- ~32 000 employees
- Operating Profit of R20 732 million
- Cash flow for capital investment of R13 billion announced (65% in RSA)
- Annual turn-over of R63 850 million
- Total assets property plant and equipment R62 587 million
- Amongst the top 5 companies in South Africa



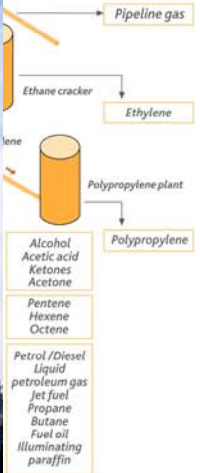
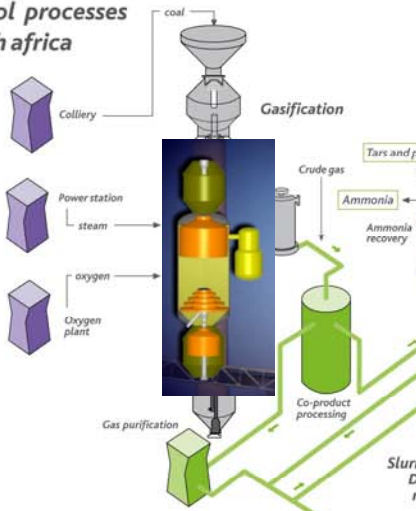
Sasol : Coal to Syngas...background

- Coal used as main feedstock to produce Syngas via Sasol-Lurgi FBDB Gasification
- Since 2004 Sasolburg operations changed to Natural Gas and Secunda feed supplemented by Natural Gas 4% of total production, to be increased in due course
- South African plants gasify ± 30 M tons of coal to Syngas
- 80 Sasol-Lurgi FBDB installed and operated in Secunda

THE SASOL PROCESS (1)



the sasol processes in south africa



Sasol Infrachem
Low-temperature conversion



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The focus of this presentation

- Focus of this presentation:
 - *on syngas production from coal by the Sasol-Lurgi Fixed Bed Dry Bottom gasification process,*
 - *it's CTL CCT challenges (with limited reference beyond this point) e.g.*
 - *Steam generation and FT,*
 - *the successes R&D has had and the current approach to CCT by the R&D and Technical teams within Sasol*

- Excluded to this presentation:
 - *detail pertained per challenge and success story*
 - *detail regarding the incorporation of natural gas in both Secunda and Sasolburg Operations*
 - *the steam generation operations, FT, reforming, refinery etc*



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Some CCT challenges (reflection from 2005)

- Air quality - Specifically CO₂ and H₂S
- Tar processing
- Water consumption and quality
- Fine coal storage/utilization
- Ash storage/utilization
- Trace & heavy metal elements (e.g. Hg, Pb, Se etc)
- Energy efficiency
- Carbon efficiency



WCI 2004 alignment

- **Particulate emissions**
- **Trace elements (particularly Hg, As, Se)**
- **NO_x & SO_x**
- **CO₂ reduction, and CO₂ elimination**
- **Waste (ash & carbon)**



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Progress on certain CCT aspects under consideration by R&D – CO₂

- South Africa in very challenging position
 - *Virtually no in-land sequestration options*
 - *No real deep empty mines*
 - *No saline aquifers*
 - *Very little possibility for sequestration at sea*

- Sasol's approach
 - *Thermodynamically capped by end products produced*
 - *Focus on energy efficiency to reduce CO₂ emissions*
 - *Jointly involved with government and ESCOM in CO₂SLF to identify and work up possible solution*
 - ***Also looking at utilization of CO₂ in innovative manner***
 - ***Looking at non-carbon sources for energy supply***
 - ***ECBM study conducted in coal resources in Neighbouring country - Botswana***



Progress on certain CCT aspects under consideration by R&D – H₂S

- Sasol agreed with government to reduce H₂S emissions against backdrop of earlier more lenient legislative environment
- Appropriate emission measurement and management system agreed with Government
- **Plant cut-back when permit is exceeded**
- Through Conceptual Development studies a number of end of pipe solutions were developed e.g. sulphuric acid plant, sulphur plant etc
- **Innovative R&D conducted by SCT team:**
 - *Reduce sulphur at source investigated e.g. de-stoning of coal*
 - *Another project registered within the R&D project management process with good progress to date*



Progress on certain CCT aspects under consideration by R&D – ultra fine coal

- Fine high ash coal (the less than 6 mm fraction which is normally less than 30 % ROM) utilised in steam and energy generation but excess (if any) is expensive to process and normally stored in slime dam
- Innovativeness required in the meeting of very stringent specs for gasification re:
 - *Biomass incorporated*
 - *Water resistant product*
 - *Thermally and mechanical strong*



Progress on certain CCT aspects under consideration by R&D – coarse ash

- Applications for coarse ash
- Mineralogy of coarse ash generated by process differs somewhat from fly ash generated by steam and power generation
- Predominant factor is in lower glassy fractions, thus less pozzolan
- **Leaching characteristics well within legal limits and stored in acceptable manner**
- Innovative studies resulted in the following options:
 - *Brick making component – implemented with negative growth of ash heap in Sasolburg*
 - *Cement and concrete extender – tested by cement manufacturer*
 - *Land backfilling and ground remediation – successfully tested through Coaltech 2020 initiative*
 - *Chemical products including – $AlSO_4$ patent*



Progress on certain CCT aspects under consideration by R&D - tar

- Tar stream optimization for optimal utilisation in e.g. petrol/diesel
- Sasol's medium temperature tar produced has vast benefits over high temperature tar
 - *Medium temperature tar less carcinogens than high temperature tar*
 - *Pitch from medium temperature tar even more favourable*
 - *Anode and recarburized coke produced*
- Innovative studies into binder pitch and carbon products such as super capacitor etc
- Medium Temperature tar exceptional in road construction especially w.r.t. time for drying
- **Technologies for possible safe and environmentally clean processing of produced tar being evaluated with good progress to date**



Progress on certain CCT aspects under consideration by R&D – trace and heavy elements

- Trace heavy metal elements (e.g. Hg, Pb, Se etc) effectively handled in Rectisol
- Rectisol one of the best solutions for gas clean-up
- Pure gas to FT exceptionally low quantities of undesirable elements e.g. Hg, H₂S
- Innovative studies into speciation of elements – **samples from gasifier turn-out assisted in FactSage model development**
- **Input given into metallurgical aspects of the gasifier internals for improved maintenance and operations**
- **Iso-kinetic sampling for Hg around the Synfuels operations completed**



New aspects around the steam/water requirement for the SLFBDB process

- High steam consumption due to various contributing aspects
- **Developed innovative technology approach to vastly reduce steam consumption by influencing coal's ash fusion temperature**
 - *Benefits include cost reduction and down stream hydraulic de-bottlenecking*
- From water treatment process brines generated
- **Developed innovative approach to in-situ capture brines through the SLFBDB technology**



CTL comparative studies - water requirement focus

- Secunda flow scheme used as bench mark
- Upgraded CTL flow scheme developed for China and USA
- China option resulted in:
 - *least raw water consumption and effluent production considerably*
 - *less salts (brine produced due to technology decisions)*
- USA option resulted in:
 - *less raw water consumption*
 - *less salts (brine produced due to technology decisions)*
- Process optimization very possible to reduce water consumption in new CTL plant configurations



Some clear successes within the FBDB Sasol-Lurgi environment (from 2005)

- 1. Tar carcinogenic properties far below that of high temp tar**
- 2. Carcinogenic properties of pitch derived from tar far below high temp tar derived pitch**
 - ***Pitch - carbon reduction material (coke) and binder pitch***
- 3. Trace element characterization in coal completed**
- 4. Trace and heavy metal components studies:**
 - ***Hg speciation addressed***
 - ***Heavy metal speciation program***
- 5. Fine coal utilization – number of technology solutions**
- 6. Coarse ash utilization in brick making**
- 7. Reduce emissions at source solutions**



Some clear successes within the Sasol-Lurgi FBDB environment - progress

- 1. Clear tar processing technology under evaluation – SHE concerns effectively being addressed**
- 2. Input to operations regarding metallurgy of internals of gasifier from trace element study**
- 3. Iso-kinetic sampling across Synfuels reveals:**
 - *Hg predominantly produced through boilers and not gasification***
- 4. Fine coal utilization – biomass inclusion and successfully tested**
- 5. Coarse ash utilization in cement manufacturing tested by local cement manufacturer**
- 6. Water treatment (brine produced) – option developed to work away in the SLFBDB process**
- 7. Technology improvement study to reduce steam (water consumption) in SLFBDB process**
- 8. Process flow-scheme improvements to reduce water consumption very possible for CTL in general – not SLFBDB only**



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Going forward: Sasol's approach to CCT

- 1. With Sasol's unique process in mind it is important to realize that Sasol has to determine its own standards**
- 2. International and local interest in CTL brings unique challenges to be addressed effectively through innovative approaches**
- 3. The approach set by Sasol comprises the following:**
 - 1. Understand the environmental footprint in detail*
 - 2. Use the Region specific standards, Country specific standards, World Bank standards*
 - 3. Compile a GAP through comparison*



Going forward: Sasol's approach to CCT

- 1. Identify the critical areas, less critical areas and non-critical areas***
- 2. Appropriately address these areas identified through the strengths of it's innovative employees in e.g. Sasol Technology by***
 - 1. Elimination of pollution through process design and prevention***
 - 2. Reduce/Minimize pollution through equipment changes***
 - 3. Recovery and value generation from various waste streams***
 - 4. Treatment of streams, mitigation or abatement***
 - 5. Last resort - disposal***



Concluding remarks

- Sasol's unique processes makes it very difficult to compare environmental footprints with other refineries, chemical plants etc
- Scan environment for possible solutions and implement appropriately else
- Understand the chemistry and process fundamentals if required
- Innovatively work across teams towards solutions from different perspectives and approaches (CD, R&D, OPI, TM)
- Turning by-products into useable/saleable product
- Challenge operational paradigms and utilise in-house technology options



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