New technologies & projects based on Topsøe's knowledge of downstream gasification technologies

Jens Perregaard,
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Catalysis is a key driver for efficient technologies

- The company Haldor Topsøe A/S
- Key technology components
- Projects
  - Biomass based
  - Coal based
- Conclusion
Efficient technologies

One definition of Sustainable technologies:
Meet the needs of the present generation without compromising the ability of future generations to meet their own needs

- For synthesis gas utilisation downstream of gasification this at least means
  - Low environmental impact – locally and globally
  - Products useable today and tomorrow
  - High efficiency in production (low energy waste)
  - Long-term solutions to feed supply – and renewable
We have been committed to catalytic process technology for more than 70 years

- Founded in 1940 by Dr. Haldor Topsøe
- Revenue: 600 million Euros
- 2100 employees
- Headquarters in Denmark
- Catalyst manufacture in Denmark and the US
Overview of building blocks

Air separation unit

Gasifier

Sour shift

WSA™

Acid gas removal

Synthesis

Air

O₂

Coal or biomass

Syngas

Steam

Sulphuric acid

CO₂/H₂S

CO₂

Pet coke or biomass

Steam
Already today Topsøe serves industries with efficient technologies

- Synthesis gas conditioning and adjustment
  - CO and COS conversion
- Sulphur management
- Synthesis
  - Methanol
  - DME
  - Ammonia
  - Gasoline
  - SNG
  - Hydrogen
Key technology components

- Understanding and using the interaction of catalyst know-how and process technology

Examples

- Sour Shift and the steam balance
  - Benefit is OPEX saving with lower steam consumption
  - Boundaries for excessive methane formation on the catalyst

- Sulphur management via WSA
  - Task is to remove the sulphur
  - Benefits are CAPEX and OPEX improvements
  - A further benefit is a significant positive contribution to the steam/energy balance

- Tar reforming in a bio application
  - Task is to remove tar
  - Benefit is a significantly increased amount of product with the same amount of wood/biomass
Biomass can be an additional source for products (chemicals and fuel)

- **Via gasification**
  - Existing downstream technologies can be used
  - Tar issue needs to be addressed

- **Via integration with bio-refineries**
  - Example: ethanol produced via fermentation and used as a platform for production of other chemicals

- **Key points**
  - Efficient collection of the feedstock
  - Robust technologies
  - The commercial conditions need to be right
A few Topsøe projects in the renewable area

- Wood to gasoline project in the US
  - 25 bbl/d demonstration
  - Gasification by Carbona/GTI

- Wood to SNG
  - Two projects in Sweden
    - Gobigas
    - Different gasification technologies

- Black liquor to methanol/DME
  - Gasification by Chemrec
  - Pulp mill
  - New methanol technology
Coal can be used in chemicals and petrochemicals production

- Coal and biomass (e.g., pulp and paper waste) can be used for manufacture of fuels
  - SNG (substitute natural gas) by Topsøe’s TREMP process
  - Gasoline by Topsøe’s TIGAS process

- Major petrochemical products can be manufactured
  - Higher alcohols (HA)
  - DME
  - MeOH and ammonia
  - by Topsøe processes
The process for synthesis of gasoline: TIGAS is a very flexible process

- Output can be increased by adding
  - Methanol
  - Ethanol and other higher alcohols

- The process has been demonstrated on a large scale for 4 years

- US DOE supports the technology

- The process has “breakeven” at an oil price significantly below the current level

- The product has 88-92 octane

- The TIGAS product can be used directly in the gasoline pool
The TREMP™ process is based on well-proven technology and concepts

- TREMP™ has been chosen for 10 plants with a capacity of more than 20 million cubic metres of SNG per day.
- Catalyst used in TREMP™ is in operation in a large number of industrial plants.
A few Topsøe projects in the Coal area

- Qinghua SNG project
  - Large SNG capacity – 180,000 Nm³/h
  - Importance of energy efficiency
  - Unique catalyst
  - Industrially proven final methanation
A few Topsøe projects in the Coal area

- **POSCO SNG project**
  - Integration of Sour Shift, Rectisol and TREMP in collaboration with Linde
  - Significant savings on OPEX
  - First SNG project in South Korea
  - COP gasification
Topsøe Technologies are ready to tackle the production challenge

- Environmental technologies with high efficiency and features suitable for the gasification concept are ready to tackle the environmental challenge
- Efficient synthesis technologies for numerous products tackle the energy challenge
  - Methanol, Ammonia, Sulphuric acid, DME, Gasoline (TIGAS)
- Topsøe is contributing to the renewable area and aim at servicing this new market with efficient and unique solutions
- Topsøe is proud to take part in the new and growing industry of producing SNG
  - In China
  - In South Korea
  - In Sweden
  - In the US
- And we are ready to offer TREMP and other technologies throughout the world
We look forward to future discussions – thank you for your attention

jep@topsoe.dk