



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

RESEARCH | TECHNOLOGY | CATALYSTS



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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



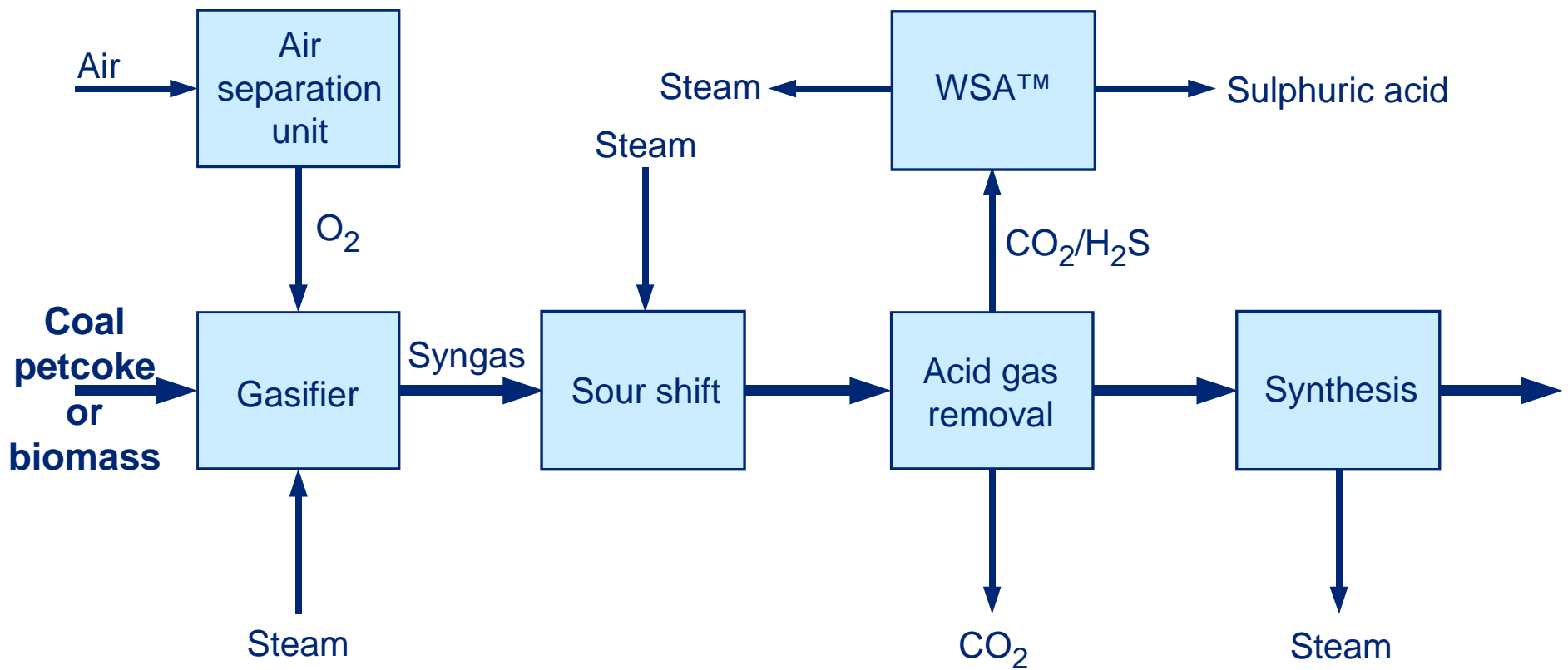
- For synthesis gas utilisation downstream of gasification this at least means
 - Low environmental impact – locally and globally
 - Products useable today and tomorrow
 - High efficiency in production (low energy waste)
 - Long-term solutions to feed supply – and renewable

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



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



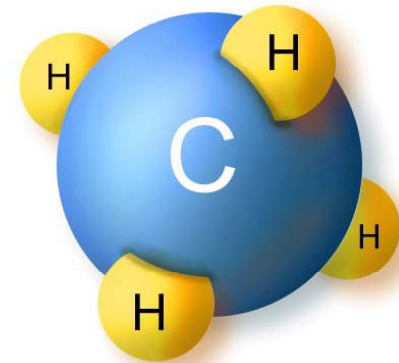
A few Topsøe projects in the renewable area

- 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



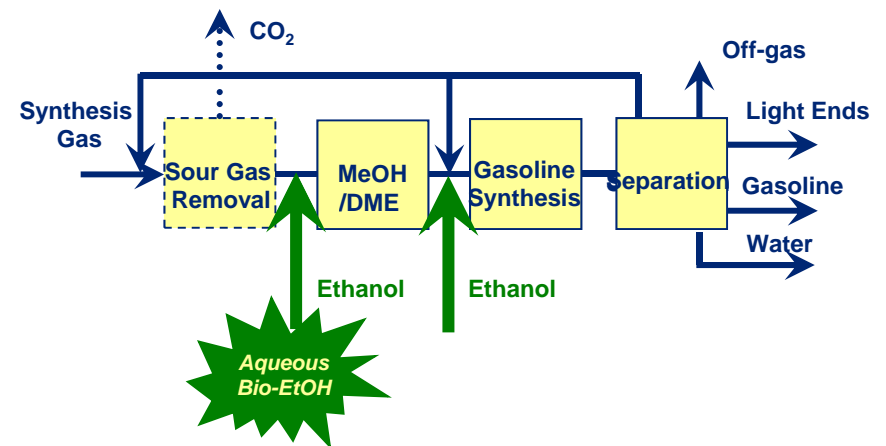
Coal can be used in chemicals and petrochemicals production

- Coal and biomass (eg 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



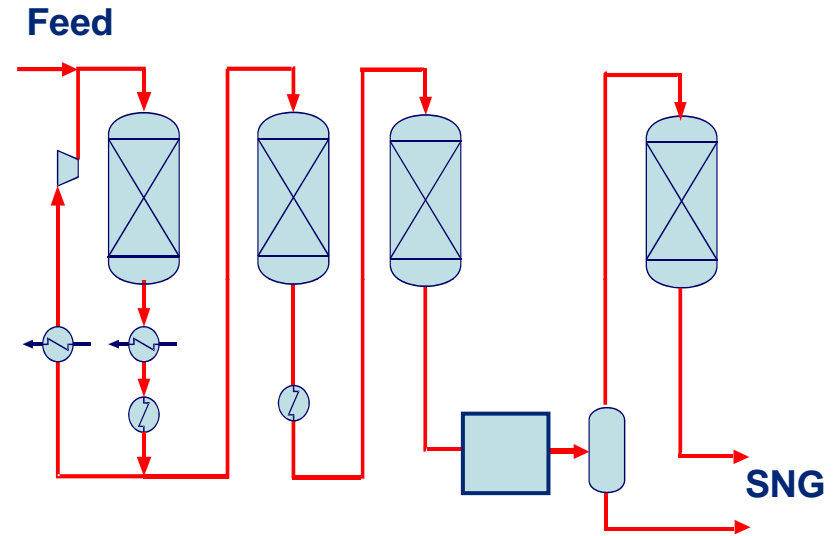
The process for synthesis of gasoline: TIGAS is a very flexible process

- 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



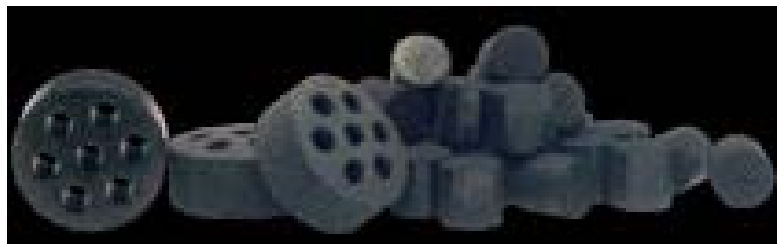
The TREMP™ process is based on well-proven technology and concepts

- 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

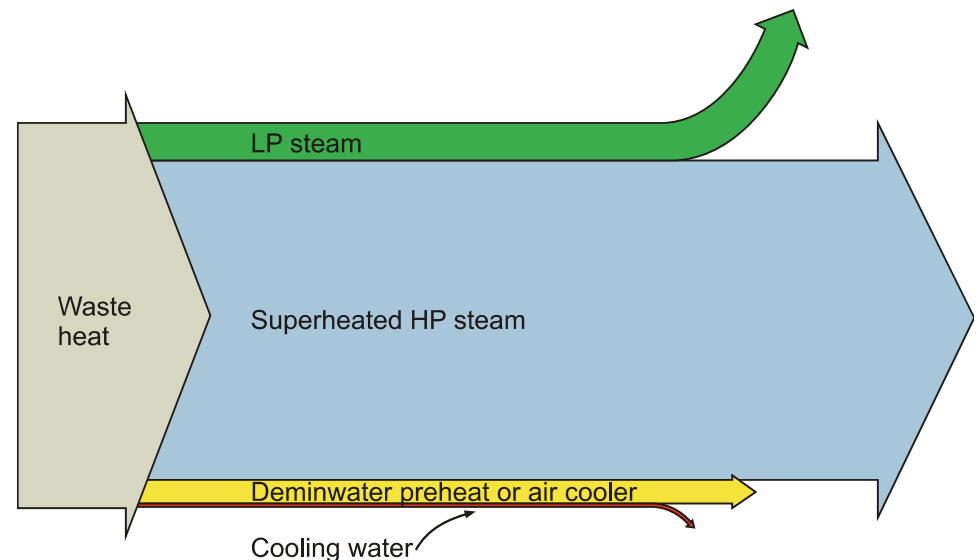
- Qinghua SNG project
 - Large SNG capacity – 180,000 Nm³/h
 - Importance of energy efficiency
 - Unique catalyst
 - Industrially proven final methanation



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



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