Gasoline and Power via Air Blown Gasification of Biomass

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Haldor Topsøe A/S – www.topsoe.com

- Founded by Dr. Haldor Topsøe in 1940
  - selling high quality catalyst since 1944
  - selling high quality processes since 1957

- Business areas:
  - Syngas
    - Hydrogen
    - Ammonia
    - Methanol/ DME
  - Refinery
  - Environmental / gas cleaning

*My vision still is that Topsoe is a good place to work - and to have worked*

Dr. Haldor Topsøe
Presentation Outline

- Introduction
- Energy situation and outlook
- Co-production of gasoline and power
- Description of the TIGAS Processes
- Pilot plants
- Conclusions
Energy Situation and Outlook
Wind Power Production in Denmark

Source: IEA Wind Task 26, Denmark
Suggested Future Energy Mix in Denmark

More than 60% is from fluctuating sources!

Source: Danish Energy
Wind Power – a Fluctuating Energy Source

Who will be the supplier when there is no wind?!

1 week, where the total wind production was only between 0-350 MW. For up to 24 hours in a row the production was less than 50 MW, sometimes even 0 MW was produced.

Source: energinet.dk
Blackout …

This is one big future Challenge in a Power grid dominated by energy from fluctuating Producers
The energy balance is today maintained through import/export.

But what if the surrounding countries also heavily expand their wind power capacity?

Intelligent grid/management of heat pumps/electric cars can only move some hundreds MW for minutes or hours...

Thermal plants on standby?
Challenges in The Future

- How to balance the grid at windy days?
- How to balance the grid at zero wind?
- How to make money in such scenarios?
Co-Production of Gasoline & Power

Air

Gasification → Tar Reforming → Gas Cleaning

0-70% Fuel

Max. Min.

Steam

Gas Turbine → Steam Turbine

Power District Heat

Off-gas Steam

Gasoline Synthesis

Light Ends Gasoline Water

CO2, H2S, NH3, HCl

100% operating time for the majority of the investment

HALDOR TOPSØE
Skive District Heating/Power
Air-Blown TIGAS

Biomass

Once-Through TIGAS

Gasoline

~ 100 bbl/d

2 atm

(15.8 MWth)

7.7 MWth

N₂, CO₂, H₂, CO

CO₂

Coal

600--1500°C

600--70 bar

70 bar

189--3030
Skive: 20700 Inhabitants

- 6000 households
- 6000 pass. cars
- 30 km/d (180,000 km/d)
- 11.3 km/l
- 15,900 l Gasoline/d
- 100 bbl/d
Description of Process

hmm...what's going on inside there?

TIGAS
TIGAS
Topsøe Integrated Gasoline Synthesis

- Simple process layout
- No methanol condensation / re-evaporation
- Low recycle rates
- Moderate pressure


- C₃-C₄
- Gasoline
- Water
- Off-gas
MeOH/DME Synthesis

\[ 2H_2 + CO \rightarrow CH_3\text{OH} \]

\[ 2CH_3\text{OH} = CH_3OCH_3 + H_2O \]

\[ CO + H_2O = CO_2 + H_2 \]

\[ 3H_2 + 3CO = CH_3OCH_3 + CO_2 \]
Syngas Eq. Conversion vs. Pressure (M=1)

- $T = 250^\circ C$
- **Feed Gas (mol%)**: 
  - $H_2 = 51$
  - $CO = 48$
  - $CO_2 = 1$

Enabling Air-Blown Gasification

MeOH / DME

HALDOR TOPSØE
TIGAS Demonstration Plant

- Synthesis gas from steam reforming of NG
- 8 bpd of gasoline
Wood to Gasoline

DOE Project

Green Gasoline from Wood Using Carbona Gasification and Topsoe TIGAS Processes
Ample Wood Sources

- Forest residue
- Paper- & Sawmill residue
- Urban wood waste
Wood to Gasoline DOE Project

Green Gasoline From Wood Using Carbona Gasification and Topsoe TIGAS Processes

Conclusions

- Higher share of renewable energy will cause energy balance problems in the power grid
- Co-production of power and chemicals is a feasible solution to accommodate the fluctuations
- Topsøe’s TIGAS process is suitable for co-generation of gasoline and power through integration with an IGCC plant
Thank you