Integration of a DME Process System into a Existing CHP Plant

David Pizá
Master Science of Renewable Energy Systems
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Aim

- Study the integration of a biofuel production system in an already existing CHP plant

- Propose a multifunctional system of DME, electricity and heat production, evaluating the energy efficiency.
Contents

• DME
• DME synthesis
• CHP plant
• Results
• Discussion
• Conclusions
• Questions
DME – Dimethylether
A “multi source and multi purpose fuel”
DME – Dimethylether

- Colourless gas at ambient conditions
- Liquefied at –25°C/6 atm.
- Visible flame
- Non toxic
- Cooking range similar to natural gas
- Easy to reform to methanol
DME – Methanol dehydrated

Source. Lennart T, Växjo city
DME – Dimethylether

- Excellent for diesel engines
  - High cetane number
  - High volatility
  - Not corrosive
  - Energy efficient, low cost vehicles fuel
  - LPG handling technology
Environmental concerns

• No concern on ozone layer depletion
• Lower overall emissions of HC, NOx, SOx and CO$_2$
• No particulate matter or soot emissions
DME Plants

- Värnamo pilot plant in, Växjo, Sweden
- Other DME plants built or proposed:
  - China:
    - 3 000 TPD
  - Iran:
    - 5 000 TPD +
    - 2 500 – 4 500 TPD
  - Australia:
    - 5 000 TPD +
    - 2 500 – 4 500 TPD
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DME process

GASIFICATION
Biomass → DRYER → GASIFIER

FILTERING AND CLEANING
HOT GAS CLEANING → CATALITIC REFORMER

SHIFT AND REFORMER
SHIFT REACTOR → HYDROG.

DME SYNTHESIS
DME → SYNTHESIS REACTOR → COMPRESSOR

ACID GAS REMOVAL
ZnO GUARD BED → ACID GAS REMOVAL UNIT

Värnamo pilot plant
Gasifier’s Technology

- **Fixed bed gasifiers**
  - Increased ratio of steam/O₂ to carbon
  - Increased mechanical strength
  - Increased levels of tars and methane
  - Decreased throughput

- **Fluidised bed gasifiers**
  - Increased throughput
  - Increased temperature range
  - Decreased levels of tars
  - Decreased conversion efficiency
  - Decreased overall emissions
DME
Energy and Material Balance

\[ \eta = 67.6\% \]

Source: BIOMETT project
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CHP Plant

400 GWh Bio fuel

100 GWh Electricity

250 GWh Heat

\[ \eta = 87.5\% \]

1 GWh = 3.6 TJ = 85.98 toe
Today’s plant production

- Electricity, 99.3 GWh
- Biofuel KVV, 219 GWh
- FGC, 8.4 GWh
- Pickload, 23.6 GWh
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Results

Polygeneration system

\[ \eta = 83.5\% \]
Modelled Plant Production

DME = 0.7 TWh

- Elect DME, 19 GWh
- Electricity, 26 GWh
- Heat CHP, 101 GWh
- Heat DME, 128 GWh
- FGC, 1 GWh
- Pickload, 21 GWh
Discussion

- $\eta = 83.5\%$
- Elect. production decreases 79%
  - Plus electricity certificates!
- Biomass input decreases
  - 50 % at CHP plant
  - 9 % at the DME process
- Need of 36,700 ha of salix
- District heating demand limits the production of DME from 1,2 TWh to 0,7 TWh
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Conclusions

- Limited DME production
- Lower electricity production

Due to….
- Steam limitation at the CHP plant
- Fixed heat demand along the year
Conclusions

- **Solutions**?
  - Evacuate the extra heat (use of fans and coolers)
  - Increase the district heating demand
  - DME steam free from the CHP plant during the summer
Conclusions

• Reduce biomass input to 16.7%
• Increase 3 times the actual biomass demand
  Impossible to supply by “salix” local fields
• Production of 0.7 TWh of DME
• No extra heat units necessary during the winter
• Possibility of using DME as a feedstock
Questions ??
Thank you for your attention!
DME comparing with…

- Calorific value 1.37 higher than methanol
- Calorific value as a gaseous fuel is 1.65 times higher than methane
- 65% of propane’s calorific value
- Lower limit of explosion than propane, safer in case of leakage