Scale-up of the MILENA biomass gasification process for the production of Bio-SNG

Berend Vreugdenhil
ECN: Energy for the Future

Largest Dutch R&D institute in the field of energy; independent and committed (ECN in IPCC)
“Missing link” between fundamental academic research and market application

Ambition: cutting edge R&D that influences the European transition to a sustainable energy system
R&D units

- Solar energy
- Biomass
- Wind energy
- Efficiency & Infrastructure
- Policy Studies
- H₂ & Clean Fossil Fuels
Why Bio-SNG?

• Natural gas is the main primary source of energy in the Netherlands and fossil natural gas reserves are in decline -> renewable alternative required.

• Bio-SNG has many applications: Heat and electricity production, feedstock for chemical industry and recently as a transport fuel.

• Efficiency from biomass (wood) to fuel is significantly higher for Bio-SNG than Bio-FT (70% compared to <50%).

• Beyond CO\(_2\) neutral, including sequestration of CO\(_2\) the process becomes CO\(_2\) negative
PRODUCING BIO-SNG

two ways

BIOGAS

- technology: digestion
- status: commercially available
- scale: small (<1 MW)
- fuel: digestable biomass
- potential: limited (< 60 PJ in NL)

Bio-SNG

- technology: gasification
- status: in development
- scale: large (>100 MW)
- fuel: dry biomass (waste wood)
- potential: large
ECN Bio-SNG production process

- MILENA Gasifier
- OLGA Tar removal
- S and Cl removal
- Hydrocarbons removal
- CO$_2$ removal
- Methanation

Biomass → MILENA Gasifier → OLGA Tar removal → S and Cl removal → Hydrocarbons removal → CO$_2$ removal → Methanation → SNG

CO$_2$ recycle
Calculated overall efficiencies to Bio-SNG

<table>
<thead>
<tr>
<th>Process Type</th>
<th>LHV (gross)</th>
<th>HHV (gross)</th>
<th>LHV (net)</th>
<th>HHV (net)</th>
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<tbody>
<tr>
<td>EF Torrefaction 30 bara</td>
<td>52.7</td>
<td>54.3</td>
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<tr>
<td>CFB oxygen 10 bara</td>
<td>63.5</td>
<td>64.1</td>
<td>58.1</td>
<td>59.2</td>
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<tr>
<td>Allothermal 1 bara</td>
<td>70.3</td>
<td>70.9</td>
<td>66.8</td>
<td>67.8</td>
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BEYOND CO₂ NEUTRAL

*BioSNG with CO₂ storage*

CO₂ emission: 100 → -70
170% CO₂ emission reduction
Lab scale Bio-SNG installation

First integrated tests in 2006

MILENA gasification

OLGA Gas cleaning

Methanation
Experimental lab-scale results (Nov 2008)
Results from lab-scale testing

- Gasifier is running reliable, gas composition according expectations.
- Different biomass fuels are tested. Wood is most promising fuel, but other biomasses can be used as well.
- Gas cleaning is tested.
- Suitable methanation catalysts are selected and tested, with good results.
- Process ready for long duration tests and scale-up.
Construction of MILENA gasifier pilot plant
MILENA pilot plant

- Thermal input 160 kg/h (800 kW HHV)
- Design fuel dry wood
- Gasifier / Riser diameter: 0.2 m
- Combustor diameter: 0.8 m
- Total height: 8 m
First pilot scale results

Bed material = sand

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<tr>
<th>Time [hr:min]</th>
<th>CH4</th>
<th>CO</th>
<th>CO2</th>
<th>H2</th>
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Present Bio-SNG activities

• The lab-scale installation is modified to make automated tests possible.
• Duration tests are prepared to test the selected catalysts.
• Duration test MILENA pilot gasifier connected to OLGA pilot plant at the beginning of 2009
Future plans of the HVC and ECN

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<td>50-100 MWt</td>
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<tr>
<td>2 M€</td>
<td>5 M€</td>
<td>60 M€; 50 MWt</td>
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MORE INFORMATION

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Bio-SNG / Bio-CNG: www.biosng.com