ReGasFerm
Utilization of biogenic residues in a biorefinery concept via entrained flow gasification and gas fermentation for the production of basic chemicals

Philipp Leuter¹, Philipp Johne¹, Sebastian Fendt¹, Hartmut Spliethoff¹,²
¹ Institute for Energy Systems, Technical University Munich, 85748 Garching, Germany, ² ZAE Bayern, 85748 Garching, Germany
philipp.leuter@tum.de

Motivation and Project Approach

- The 3rd Generation Biorefinery
  Leaves and green cut are used as biogenic residues from landscape management. These do not compete with food production and, according to florafuel AG, the annual potential in Germany is almost 100 million tons. The German Advisory Council on the Environment speaks of approx. 65% available for energetic usage. This corresponds to an usable thermal output of ca. 10 GW in Germany. With a plant size for the proposed biorefinery concept of for instance 50 MW, roughly 75,000 tons of sustainable ethanol could be produced per year with only one plant. The project scope includes a pilot scale gasification and synthesis gas cleaning with a downstream liter scale fermentation.

Entrained Flow Gasification

Approach
- Basic studies on the influence of the operating parameters (air / CO₂ / H₂O / CO₂ ratio or addition, flame geometry and turbulence), on gas composition, carbon conversion and efficiencies
- Characterization of gasification performance
- Formation mechanisms analysis of impurities with focus on metabolism harmful substances
- Further development of primary reduction of trace substances

Framework conditions
- Autothermal gasification operation
- Fuel input: 100 kW (+/- 25 %)
- Temperature up to 1500°C
- Pneumatic fuel feeding
- Operation time: ~10 h
- Pressure 0 to 5 barg
- Industry-like design

Gas Cleaning

Approach
- Extended gas analysis for trace substances
- Successfully application of a modular gas cleaning facility for fermentation standards
- Purity requirements for fermentation

<table>
<thead>
<tr>
<th>HCN</th>
<th>NOₓ</th>
<th>HCl</th>
<th>H₂S</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1ppm</td>
<td>&lt; 40ppm</td>
<td>often resistant</td>
<td>often resistant</td>
</tr>
</tbody>
</table>

Framework conditions
- Modular construction
- Cold gas cleaning
- Wet scrubber
- Gas drying
- 4 Adsorber
- Flexible application
- Pressure 0 to 5 barg

Synthesis Gas Fermentation

Approach
- Characterization of critical synthesis gas impurities limits with four bacteria strains
- Production and optimization of fermentative alcohols
- Investigations on gas composition, substrate inhibition and product inhibition
- Products: Ethanol, Acetic acid, 2,3 Butanediol, Butanol, Hexanol, ...

Framework conditions
- Cl: Clostridium ragsdalei
  - Clostridium ljungdahlii
  - Clostridium carboxidivorans
  - Clostridium autoethanogenum
- Artificial syngas optimum
  - CO:CO₂:H₂ = 3:1:1

Bacteria strains
- Syngas
- MFM
- Stirrer
- Burner
- Water cooled pressure vessel
- Gas filter

Contact

Philipp Leuter, M.Sc.
Phone: +49 (0) 89 289 16281
Email: philipp.leuter@tum.de

Philipp Johne, M.Sc.
Phone: +49 (0) 89 289 16296
Email: philipp.johne@tum.de

Sebastian Fendt, Dr.-Ing.
Phone: +49 (0) 89 289 16207
Email: sebastian.fendt@tum.de

The submission is within the RLS Energy Network