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

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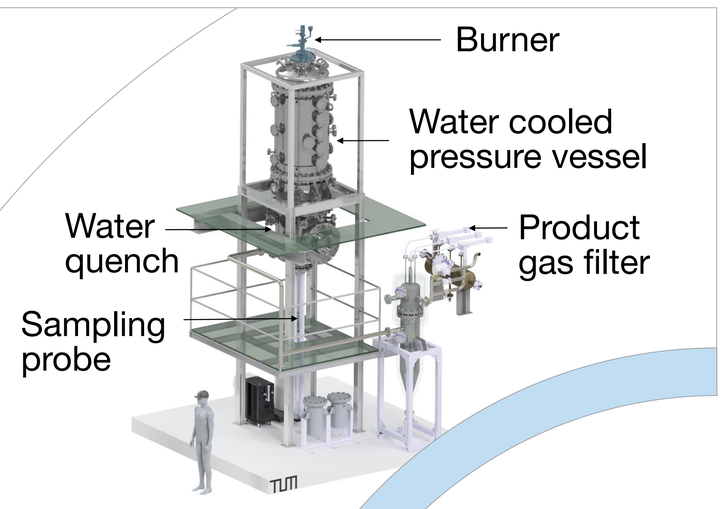
Motivation and Project Approach

- **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 / O_2 / H_2O / CO_2 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

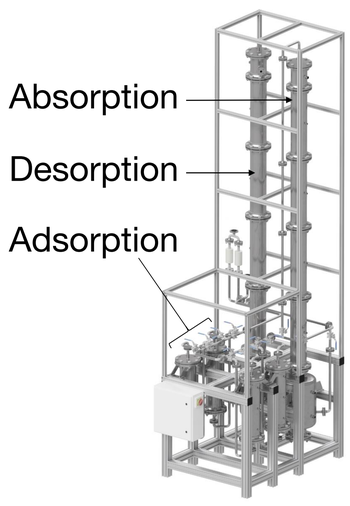


Gas Cleaning

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

HCN	NO_X	HCl	H_2S
< 1ppm	< 40ppm	often resistent	often resistent

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

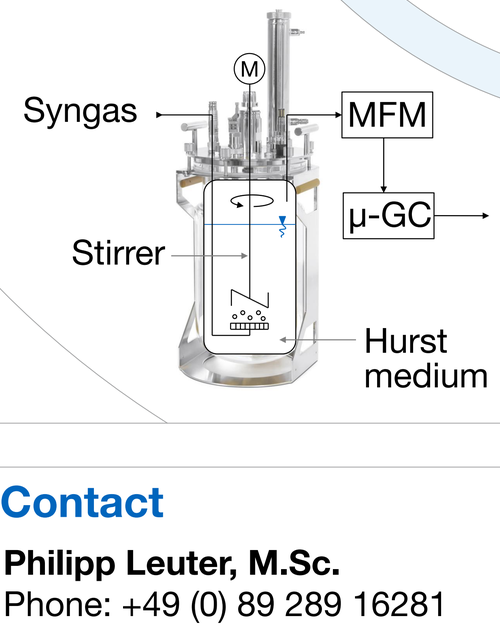


Biomass Residues
Leafs, Green Cut

Basic Chemicals
Ethanol, Butanol…

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, …
- **Bacteria strains**
  - Clostridium ragsdalei
  - Clostridium ljungdahlii
  - Clostridium carboxidivorans
  - Clostridium autoethanogenum
- **Framework conditions**
  - Atm. pressure and T = 37°C
  - Artificial syngas optimum $CO:CO_2:H_2$ = 3:1:1



Goals and Outlook

- Simulation of the complete process chain and sensitivity analysis
- Proof of concept by indirect coupling of all process steps
- Feedback from the fermentation process to the gasification and gas cleaning for optimization
- Techno economic assessment and sustainability analysis
- Process-integrated nutrient recovery

The submission is within the RLS Energy Network

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