The Triple A Process (AmbientAminAbsorption) – Optimization of Biogas Upgrading based on Chemical Scrubbing with Amino Acid Salts for Scalable Expansion of Biomethane Production

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Introduction

The production structure of raw biogas in Germany is closely connected with the agricultural structure. As a result, it is characterized by smaller biogas plants (BGAs), which are in a performance class > 250 m³/h STP methane. There are similar economies of scale for the costs of common processing technologies, which are especially small for large factories. The biomethane processing plants therefore have an average capacity of 630 m³/h STP. Therefore, there is a need for new, low-cost, small-scale gas upgrading technologies that can also be easily integrated into farm effluent and circulation systems, that is the aim of this study.

Fig. 1: The Fermenter of Biogas plant Weitenau

The Triple-A-Concept and the scrubbing agent used result in advantages that have positive impacts on the operational process, the economic efficiency, and the implementation potential of the technology:

- The scrubbing agent should be self-extractable from common biogas substrates such as silages and recycled after consumption in the digester and used for local bioeconomic cycles with short distances.
- The process flow at ambient conditions allows a simple design with low requirements for plant components, safety and professional operation, low energy demand and thus high potential to reduce costs.
- These characteristics allow a well scalable and cost-optimized operation for upgrading capacities smaller 250 m³/h STP.

Experimental Investigation & Results

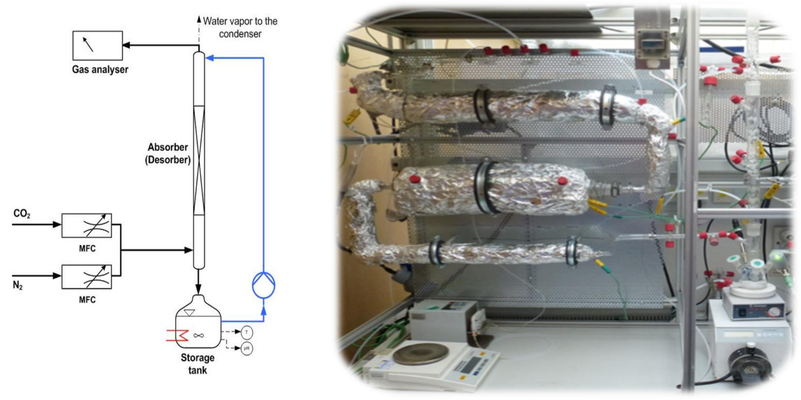

Fig. 2: Lab-scale batch operating plant

Lab-scale: Screening of solutions

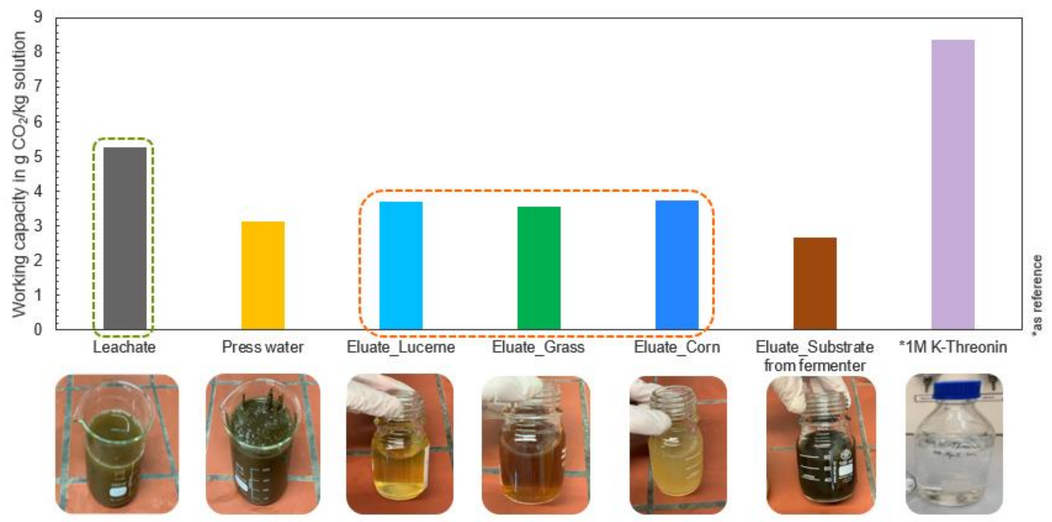

Fig. 3: Working capacity of different solutions from lab-scale batch experiment

- Working capacity of various absorption solutions:
  Leachate > *Eluate_Corn* > *Eluate_Lucerne* > *Eluate _Grass* > *Press water* > *Eluate_Substrate from Fermenter*

Pilot-scale: Construction of reactors

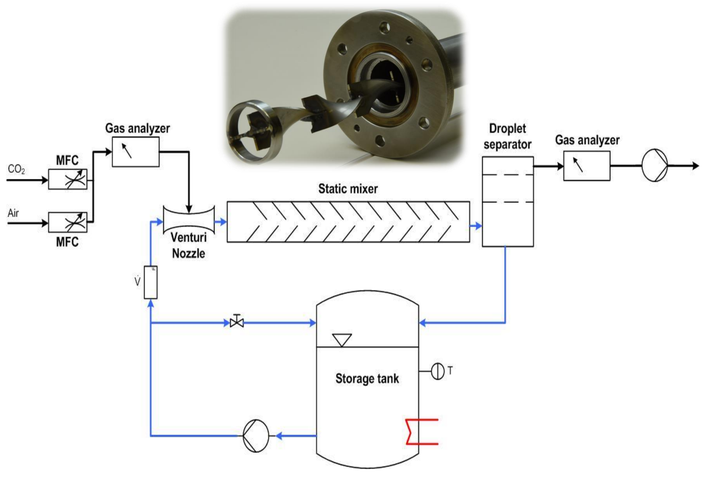

Fig. 4: Experimental set-up for pilot-scale batch operation

Pilot-scale: Continuously operating plant

- Pilot-scale plant: from batch to continuously operating mode
- Construction of reactors:
  - Helix as absorber
  - Empty tube as desorber
- Stripping air preheating through the heat exchanging with solution from absorber
  - Efficient energy use

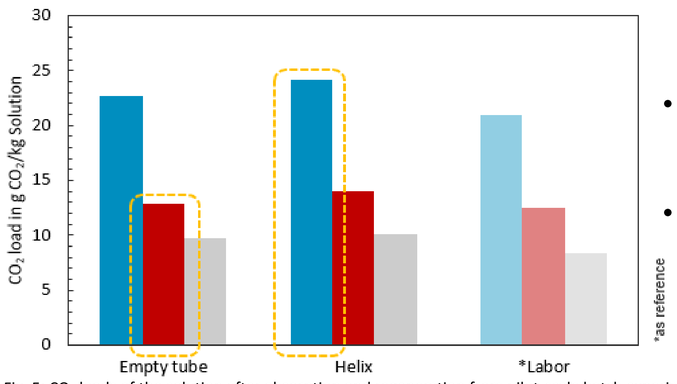

Fig. 5: CO_2 loads of the solution after absorption and regeneration from pilot-scale batch experiment

- In terms of CO_2 Absorption:
  - Helix had a better performance with CO_2 loads of 24.15 g CO_2/kg solution
- Compared with the helix (14 g CO_2/kg solution), Empty tube had a better performance in regeneration

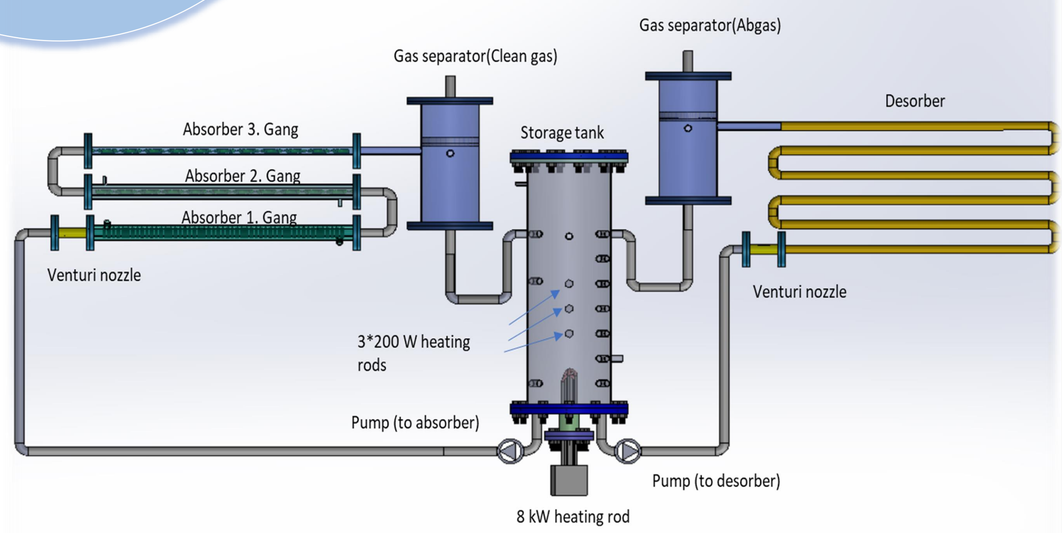

Fig. 6: Construction of pilot-scale continuously operating plant

Conclusions & Outlook

Summary

- In batch laboratory tests, the feasibility of the biogas upgrading by using the absorption solutions which obtained from biomass was investigated
- Two variants of static mixer were used as reactor in pilot-batch working plant and experimentally compared with each other
  - The process principle was proven: Static mixers can be used for CO_2 separation
  - Helix is more prominent in absorption, while empty tube is more prominent in desorption

Outlook

- Investigation of mass transfer and heat transfer with detailed calculation
- Optimization of lab-scale plant and pilot-scale plant
- Pilot-scale plant: from batch to continuously operating mode
- Set up and initial operating of a continuously working pilot plant
- Development of extraction process of organic aicds from residues and wastes of biomass processing industry in lab-scale

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