UNIVERSITY OF HOHENHEIM

State Institute of Agricultural Engineering and Bioenergy

Coupled biogas and fibre production from biowaste and agricultural residuals

Dr. Benedikt Hülsemann[1], M.Sc. Marian Baumgart[1], M.Sc. Gregor Sailer[1], Dr. Hans Oechsner[1]

[1]State Institute of Agricultural Engineering and Bioenergy, University of Hohenheim, Garbenstrasse 9, 70599 Stuttgart, Germany.

Abstract:

The efficient utilization of biowaste or residues generated in agriculture, forestry, industry or municipalities is of major importance for a circular economy, especially in the global context of increasing energy demands paired with a growing scarcity of resources.

The organic fraction of municipal solid waste (OFMSW) represents one of the most relevant biowaste types while also being a main fraction of the residential waste. In Germany, it is prescribed per law to collect OFMSW in a separate biowaste bin and approx. 5 million tons of OFMSW are currently collected each year. This amount could even be higher due to circumstance that a large share of the population still has no access to a biowaste bin or due to low collection levels of OFMSW in areas with available biowaste bin. Furthermore, recent studies have proven that large amounts of biowaste still remain in the residual waste bin. Additional challenges in the context of OFMSW are the share of impurities (waste sorting at household level) and other problematic substances such as (bio-)plastics that complicate the processing at existing treatment plants and thus limit the re-application potential of products.

OFMSW is mainly utilized via conventional composting and/or anaerobic digestion (AD) for the production of biogas, digestate and compost. In the AD of biowaste, dry digestion systems such as plug-flow- or batch-reactors represent state-of-the-art technologies. The current main objective of waste AD plants is often the hygienic treatment of OFMSW to produce quality digestates and compost products for agriculture. Plant operators usually receive processing fees, which is why the AD plant operates throughput-oriented with relatively low hydraulic retention times. Therefore, the efficient production of biogas is a secondary aspect. In consequence, OFMSW is a complex fibre-rich feedstock with untapped utilization potentials, because of the fact that fibres cannot be degraded by biogas plants. From a sustainability and bio-economy perspective, the inefficient utilization of biowaste has to be avoided.

Therefore, alternative utilization methods that complement or replace the conventional OFMSW treatment approaches could improve the entire value chain of biowaste valorization while contributing to the transformation towards a bio-economy. Within the research project “Biowaste to Products (BW2Pro, 2022-2024)” an innovative concept and the operation of a biorefinery in pilot scale with a treatment capacity of 1000 kg/d of OFMSW is evaluated by also comparing the concept with conventional approaches as mentioned before.

The concept consists out of a pre-treatment (sieving, shredding, sorting) of the feedstock, a steam explosion technology to degrade the fibres, a liquid-solid separation and a two-staged fixed bed reactor consisting of a hydrolysis and a methane reactor for biogas production. Based on this biorefinery the objectives are to separate the fibre in front of the biogas plant and produce natural fibers for different material applications (e.g. flowerpots, fiber composite, bioplastics) as well as

substrate for the production of enzymes. At the same time the liquid will be use as biogas substrate as well as a fertilizer. Within our presentation/poster, we will present the overall biorefinery approach, the feedstock characteristics and preliminary results of the biorefinery operation in pilot- and lab-scale. Further, we will focus on the potential of steam explosion treatment combined with a two-staged anaerobic digestion with high organic loading rates for the future OFMSW utilization.

Furthermore, also German biogas plants which used agricultural substrates are looking for new markets besides electricity and heat production, as the high bonus payments of the first period of the Renewable Energy Sources Act will expire in the next few years.

To ensure economically viable production, it is also necessary to reduce substrate costs. Substrate costs account for around 50% of the costs of a biogas plant. At the same time, German biogas plants have an image problem because they use energy crops such as corn that have no ecological benefit.

One way to reduce costs and get a better reputation is to use agricultural residues and more ecological energy crops. However, both have low methane potential due to their high fiber content.

Therefore, the new concept can be also a solution.