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HYDROFIB, a sustainable technology to improve the biomethane formation from fiber-rich biomass

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Motivation

Fiber-rich biomass as a sustainable source of bioenergy is abundant in Switzerland, such as harvest residues, straw, corn husks and the solids of cattle manure. However, the conversion to biogas is challenging, because of the low hydrolysis rate of these materials. A novel pretreatment method based on the application of low concentrations of oxygen should significantly increase the microbial hydrolysis and consequently, the output of biomethane.

The HYDROFIB micro-aeration

Molecular oxygen promotes specific microbes to produce an enzymatic cocktail for hydrolyzing the cellulosic fiber-biomass. In a second step, the pre-hydrolyzed material is converted to biogas. The two processes have to be separated physically, because higher concentrations of oxygen inhibit the biogas producing microbes.

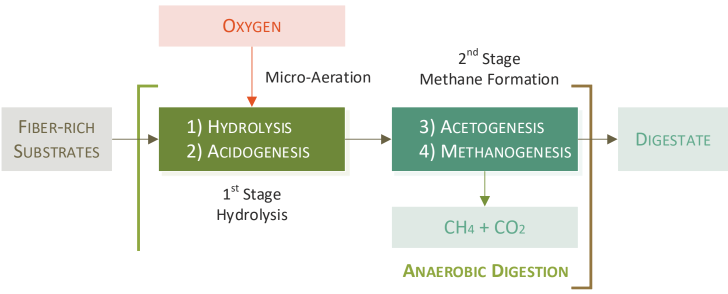

Figure: Block flow diagram of the two stage digestion with micro-aerobic hydrolysis process

In a first stage, fiber substrates are treated with small doses of oxygen, which promotes microbial hydrolysis. In the subsequent fermentation stage, the pretreated substrates are converted into biogas (CH_4 + CO_2)

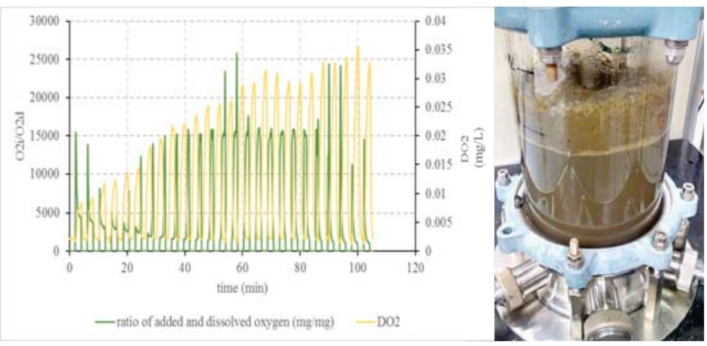

Figure: Measurements of dissolved oxygen (left) inside the hydrolysing lab reactor (right)

Control dissolved oxygen (DO_2) in the hydrolysis step is essential. In a laboratory reactor, we are able to adjust DO_2 in the micromolar range. The mass transfer of O_2 into the solution is calculated.

The HYDROFIB pilot plant

The micro-aeration technology will be demonstrated with fiber-rich substrates at a container-based test facility located at the Allmig AG (Baar, ZG). Container 1 contains the substrate reception and -conditioning. In Container 2 the substrates will be micro-aerated and subsequently fermented to biogas in three continuously operated 330-liter digesters.

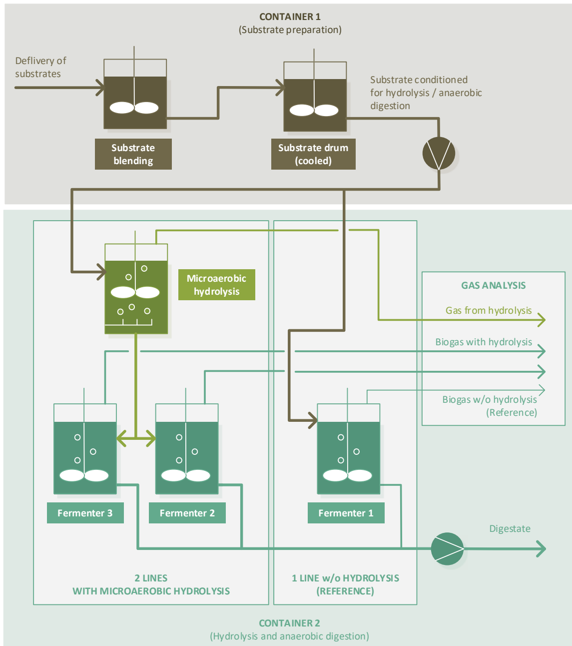

Figure: Flow chart of the HYDROFIB pilot plant

In Container 1 the fiber-rich substrates are conditioned and cooled. In Container 2 the microaerobic hydrolysis takes place by the addition of small amounts of oxygen. The material is digested in 3 fermenters. All produced gases are being analyzed and recorded.

Conclusions

If the HYDROFIB campaign is successful, it will unlock the great potential of Swiss fiber-rich substrates, which will sum up for an additional 1-5 TJ/a of sustainable biogas energy (corresponds to 280-1400 GWh/a).

Figure: Container 2 with hydrolysis reactor and fermenters

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