

HTC-Innovation Campus in Switzerland - hydrochar for our common future!

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Motivation

The HTC-Innovation Campus Rheinmühle project aims to optimize a pilot plant employing hydrothermal carbonization (HTC) for the production of char briquettes and liquid by-product (process water) from bio-wastes. Each year approximately 1000 m³ cow manure of a livestock farm and 100 t sewage sludge from a close-by water treatment plant (ARA Chur) will be processed. HTC products will be further used as alternative fuel and substrate for biogas production.

The HTC hydrochar briquettes are converted to a storable feed fuel for gasification and combustion systems. The separated process water is used as a co-substrate in an anaerobic fixed bed reactor. The pilot plant is intended to show a power- and heat-generating processing pathway for manure and sewage sludge in Switzerland, leading to its industrial development.

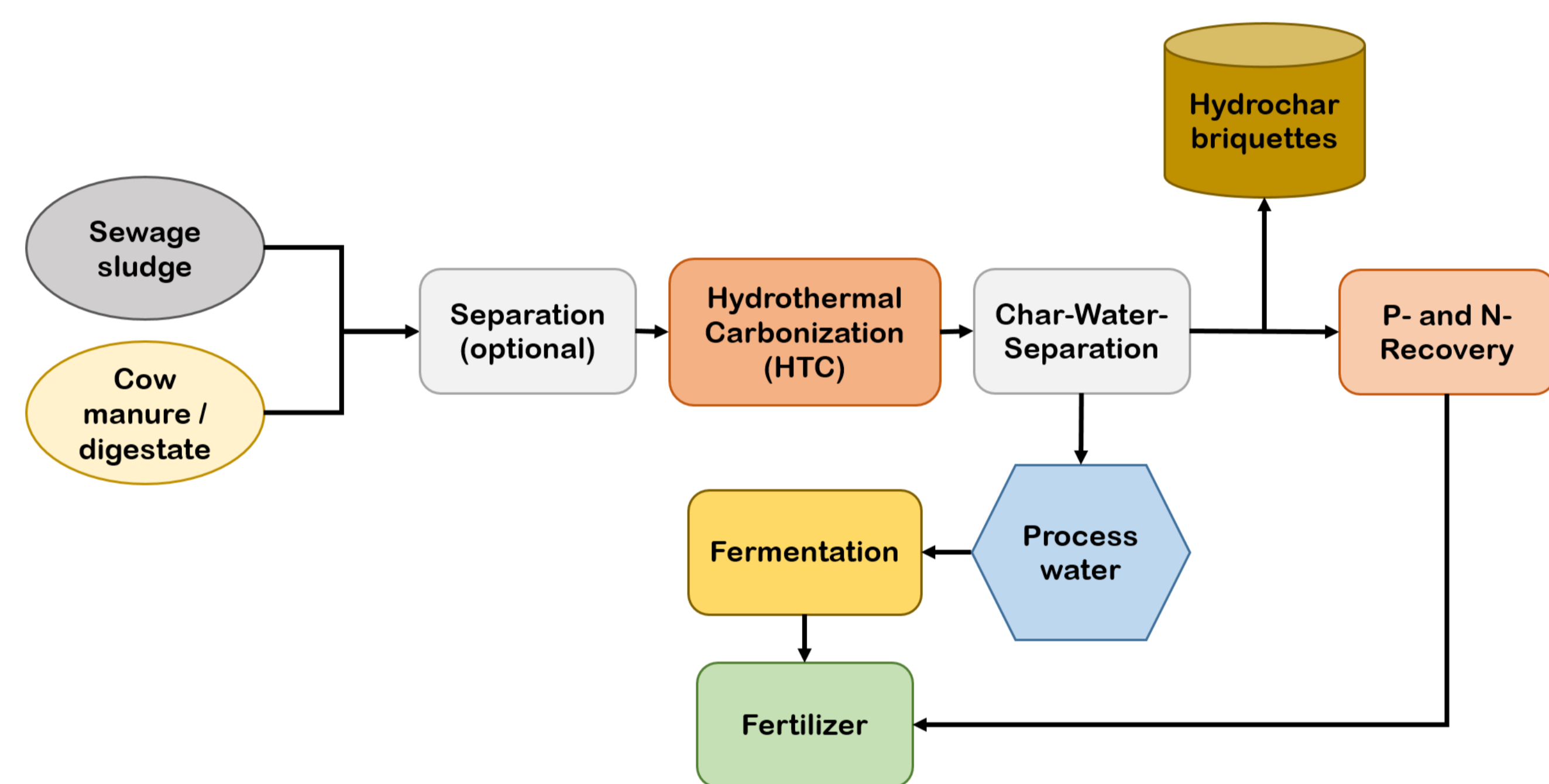


Figure 1: Process flowchart of the hydrothermal carbonization plant.

Project goals

- Optimization of a continuous HTC-reactor with a reactor volume of over 5 m³

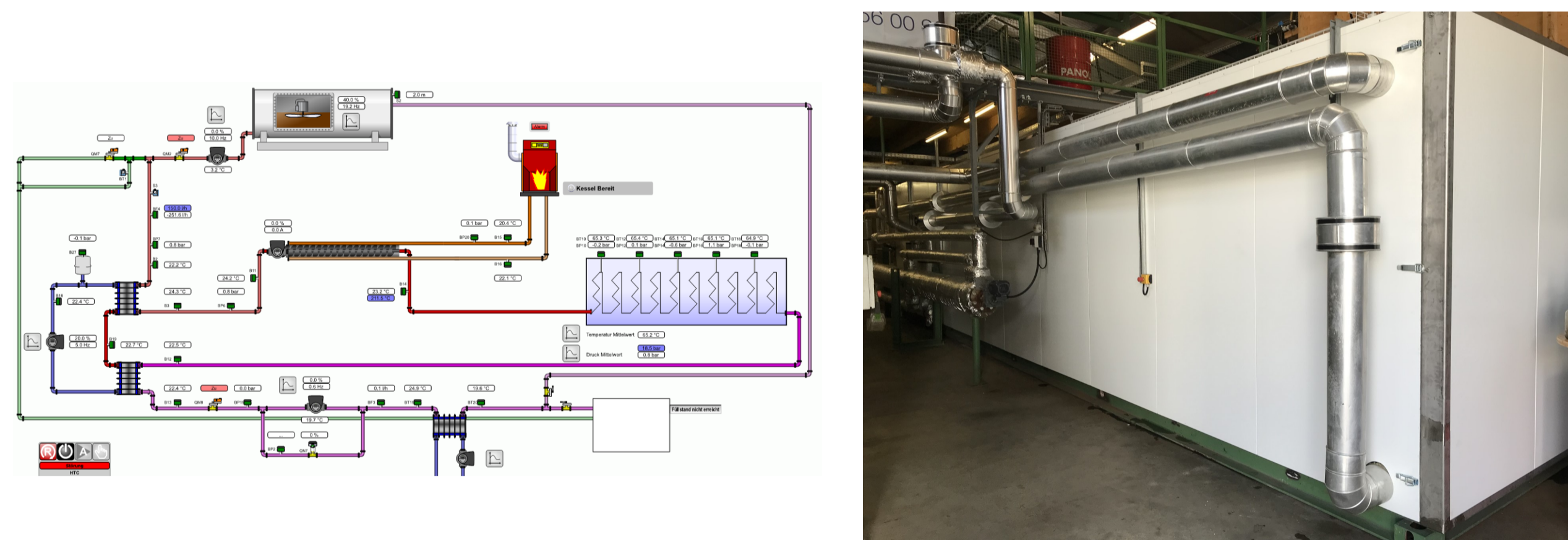


Figure 2: Plant schematic and optimized HTC-reactor.

- Energetic utilization of organic waste materials such as cow manure and sewage sludge
- Recovery of plant nutrients for agriculture
- Generation of an alternative biofuel

Evaluation

Optimizations of the HTC-plant are evaluated by monitoring the material flow for nutrients and heavy metals as well as the characterization and evaluation of char briquette products. Utilization of the liquid fraction for fermentation is also investigated.

Results

Material flow

- Over 86% of the nitrogen can be recovered in the process water
- Process water (PW) from sewage sludge contained over 83% of total phosphorus. This could be caused by the high particle content in the PW.

Process stability

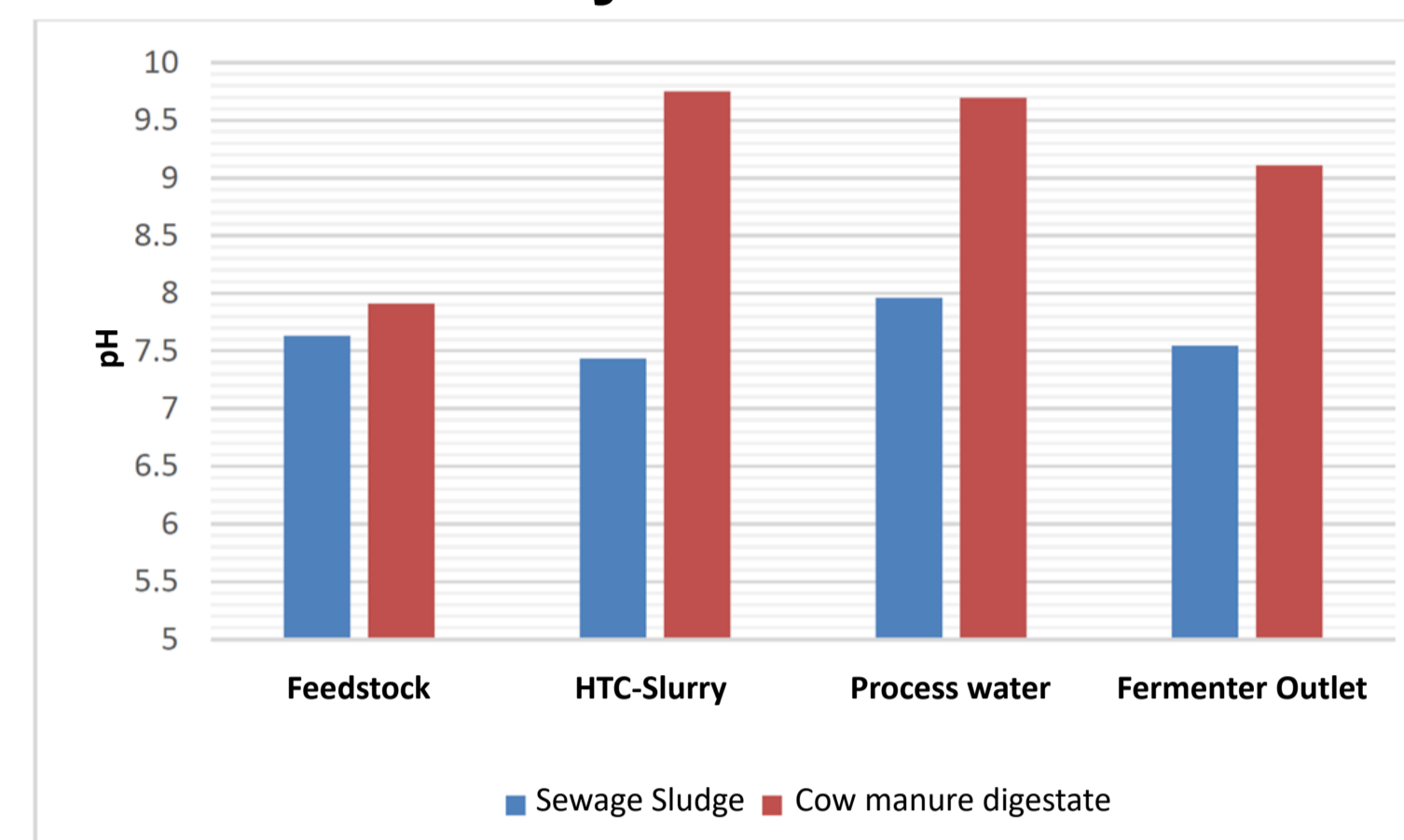


Figure 3: pH on different process stages.

Only minor pH changes were observed with sewage sludge. In contrast, the process water from HTC operated with cow manure digestate showed increased pH values of >9.5. Alkaline pH could have a negative impact on the fermenter biology.

Process water fermentation

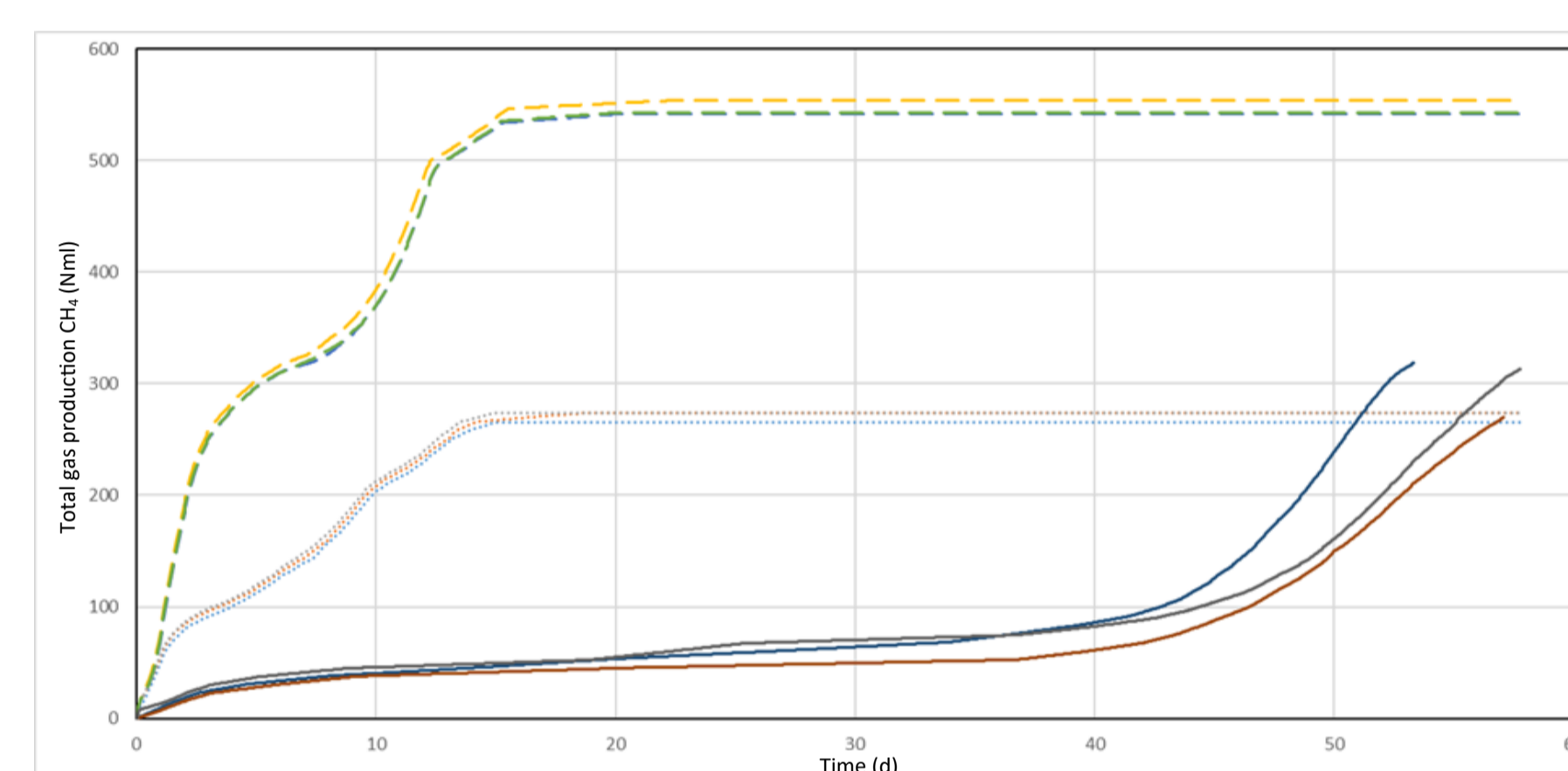


Figure 4: Gross methane generation in anaerobic biodegradation test. Cow-manure process water (solid line). Inoculum (dotted line) and internal cellulose standard (dashed line). Concentration of organic dry matter of the feeding material 2 g/kg (0.2%).

Adaptation of the fermenter biology is possible, but can take several weeks using an active biology from a fermentation plant.

Hydrochar composition

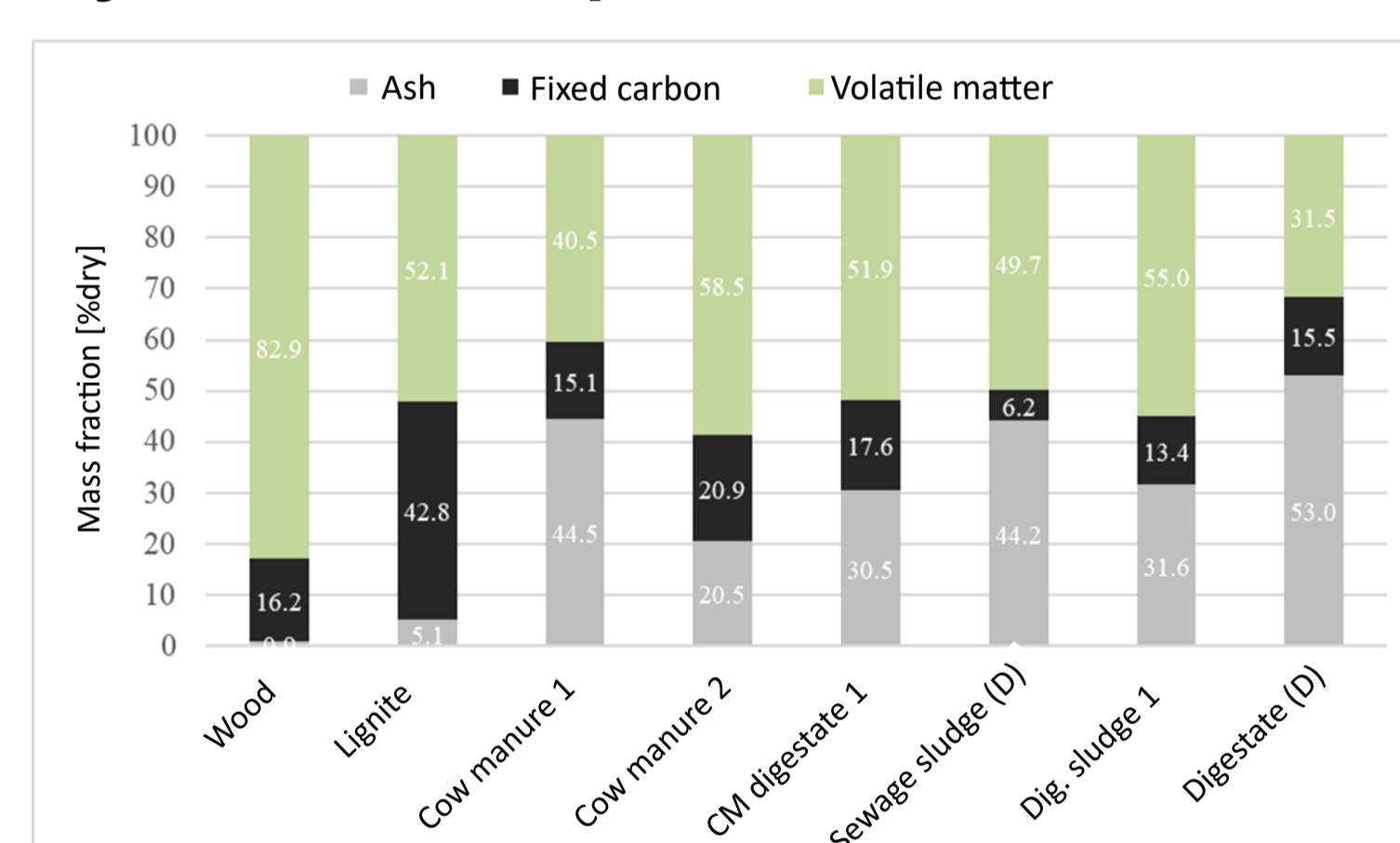
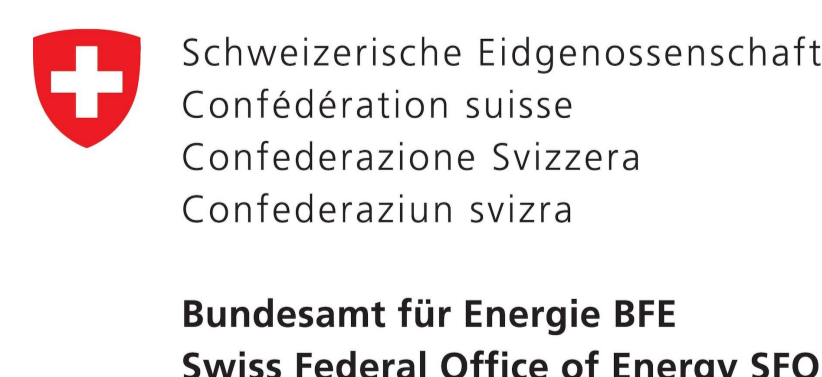
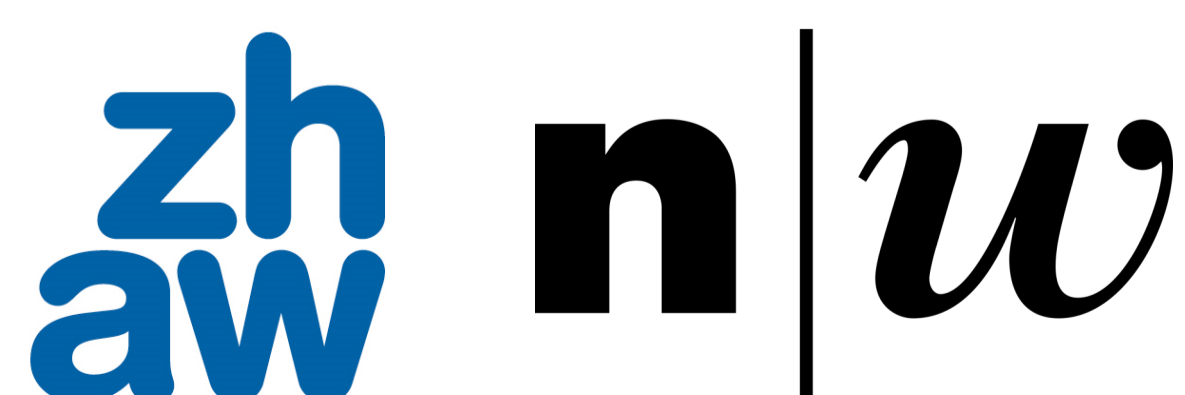


Figure 5: Results from proximate analyses. CM = Cow manure.

Compared to wood and lignite the cow manure and sewage sludge hydrochars have high ash contents at adequate melting behavior (softening: ~1200 °C, similar to coal). Without material utilization of the ash, this could cause disposal costs. Lower heating value 15 - 20 MJ/kg DM.

Conclusions and outlook

Based on initial results, sewage sludge is easier to process compared to cow manure. Differences in the input material are transferred to the char and their behavior for the char-water-separation. Investigations for an ideal separation method for both feedstocks are ongoing. The high ash contents are a major issue for the utilization as fuel and will limit potential applications. The main challenges regarding the HTC-plant could be solved during the plant optimization and a new pilot plant will be installed in summer 2019.



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