SynFerm – Lab scale testing of syngas fermentation using model gas.

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1. Introduction

The SynFerm project [1] is a two-year project that started 1 January 2023 and involves the WoodRoll® gasification technology developed by Cortus (SE) and the solid-state biological methanation system developed by Q Power Oy (FI). The other project partners are NSR AB, Biokraft International AB, Linköping University, and the Baltic Energy Innovation Centre (coordinator). The project has received public funding by the Swedish Energy Agency.

2. Project targets

Q Power's mobile biological methanation pilot plant will be installed at the WoodRoll® site in Höganäs and a partial syngas flow will be diverted to the pilot plant. The aim is to show:

- A methane formation rate of 10 litre CH_4/litre reactor volume and day
- An electric consumption less than 0.02 kWh/kWh CH_4 for the syngas fermentation
- Complete conversion of CO (below detection limit)
- Residual H_2 in the final product less than 2%.

3. Lab scale testing

Prior to the biological methanation of real syngas in the pilot plant, lab scale testing of syngas fermentation using model gas was performed at Q Power's laboratory in Finland.

Model gas composition

The model gas composition was selected to resemble the real syngas in the WoodRoll® gasifier (Table 1).

Table 1. Typical gas composition in the WoodRoll® gasifier.

Gas component	[%-vol]
CO	30
H_2	58
CO_2	10
CH_4	2

Experimental set-up

The lab scale testing was performed with a gas flow of 10 litre/hour and three 250-liter reactors in series (Figure 1).

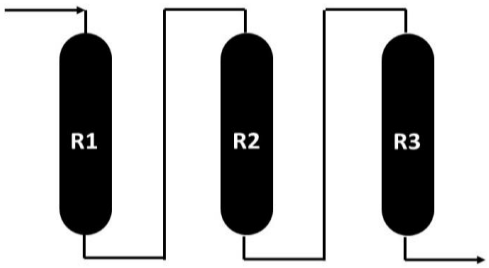

Figure 1. Layout of the biological methanation set-up.

By having the reactors in series, the gas composition and other data of relevance could be measured after each reactor.

A mixed culture of microbes, originally obtained from the marshland surrounding the Q Power headquarter in Finland, were used in the reactors.

4. Results

The gas composition after each reactor, during the first week of operation, is shown in Table 2. The values have been normalised to account for accuracy issues.

Table 2. The gas composition in the feed and after each rector, expressed as vol-%.

	Feed-in gas	R1	R2	R3
CH_4	2.5	15.1	51.4	60.7
H_2	56.0	44.4	11.1	3.6
CO_2	11.0	19.9	29.7	35.7
CO	30.5	20.7	7.8	0.0

When CH_4 is formed, the volume is contracted. At full conversion, the volume flow coming out of R3 is 2.4 times less than the incoming volume flow.

It is evident that the biological water-gas shift (WGS) reaction, converting CO and water to CO_2 and H_2, took place during the lab scale testing. There was still some residual H_2 left after the last reactor, but the set-up had only been operating for a week and, if residual hydrogen continues to remain also after longer operation, it can easily be separated using membrane technology. Unfortunately, there was a technical problem with the micro-feeders when the feeding rate was increased during the second week of operation, so this is still an open question.

It is also evident that the microbes adapt rather quick to gas streams containing CO. In fact, there was no CO in the gas stream after the last reactor.

Despite the problems with the micro-feeders, the lab scale testing gave us the answers we were looking for related to the WGS reaction and the prospect of complete CO conversion.

5. Next step

The lab scale testing showed that the microbes are able to convert CO and the next step is to install Q Power's mobile biological methanation pilot plant in Höganäs (SE) and feed it with real syngas from the WoodRoll® gasifier.

Figure 2. The biological methanation plant is lifted in place. Photo: Jörgen Held.

The mobile biological methanation plant arrived to Höganäs at the end of January 2024. The commissioning and the measurement campaign is planned to take place during Spring 2024.

6. References

[1] Held, J. et al. SynFerm – efficient syngas fementation of gasified woody biomass, p77-78 in Conference proceedings – 9th International Conference on Renewable Energy Gas Technology, 15th – 16th of May, Berlin, Germany. ISBN 978-91-981149-8-0.

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