DEVELOPMENT OF A SIMULTANEOUS BIOREACTOR SYSTEM (SBRS) FOR HIGH THROUGHPUT SCREENING AND CHARACTERIZATION OF METHANOGENS AT HIGH PRESSURE

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INTRODUCTION

Biomethanisation is a biotechnological process for the production of methane (CH_4), applying methanogenic microorganisms which are referred to as methanogens. Methanogens are characterized by a generally strictly anaerobic metabolism and can utilize various substrates for growth and CH_4 production. The substrates used can be either acetate, methylated compounds or C_1-compounds such as, e. g. carbon dioxide (CO_2) or formate. Hydrogenotrophic methanogens deploy molecular hydrogen (H_2) as the electron donor for the reduction of CO_2 to CH_4 and for the autocatalytic growth. These organisms produce CH_4 and water (H_2O) as metabolic end products. This process is referred to as hydrogenotrophic, autotrophic methanation of CO_2 with the following stoichiometry (neglecting biomass formation)[1-3]:

$$CO_2 + 4\ H_2 \rightarrow CH_4 + 2\ H_2O$$

However, not many methanogenic strains were yet examined at different pressure levels in the field of CO_2 based biological-methane-production (CO_2-BMP). To perform reproducible CO_2-BMP screening experiments at high throughput (HT) a simultaneous bioreactor system (SBRS) was developed.

EXPERIMENTAL

The SBRS can be used for screening methanogens in a closed batch cultivation mode at pressures up to 50 barg. The system possess a gas inlet and outlet allowing an independent filling of the separate vessels. Furthermore, heating jackets and digital pressure sensors were mounted to measure and control the pressure and temperature online.

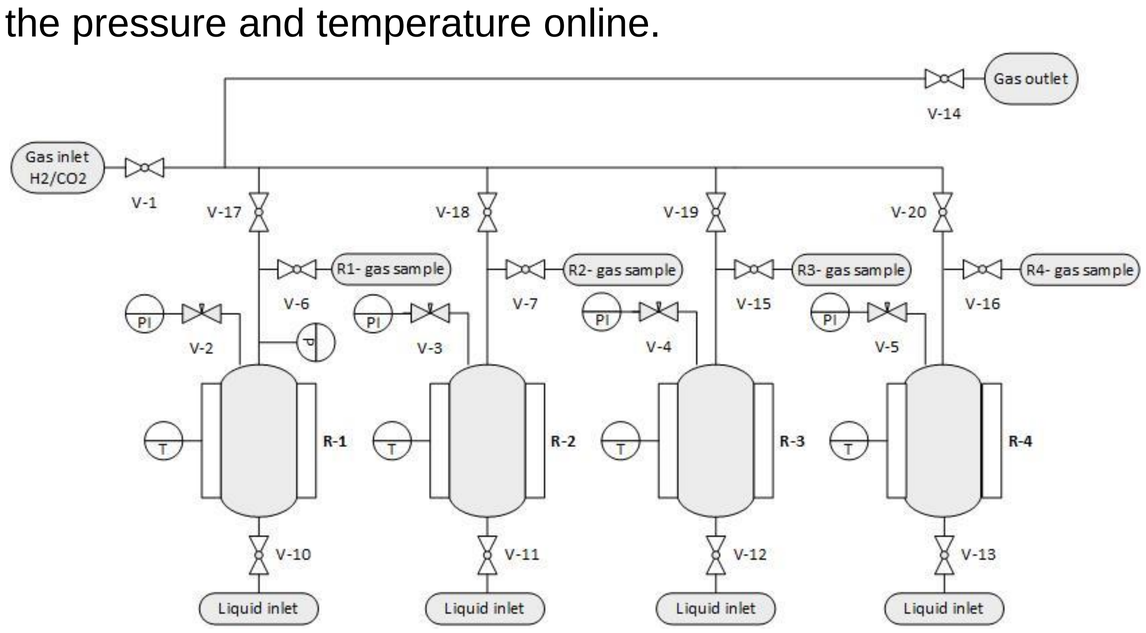

Figure 1: Flow sheet of the SBRS.

As a proof of concept, *Methanobacterium thermaggregans* was cultivated in the SBRS which allowed to verify the ability to convert CO_2 and H_2 to CH_4 at 10 bar for the selected strain.

RESULTS & CONCLUSION

The monitoring of individual experiments was carried out primarily by means of pressure measurements. Following the reaction stoichiometry methanogenic CH_4 production leads to a pressure drop in the reactor. This pressure drop was seen in all experiments performed with *Methanobacterium thermaggregans*, sustaining the ability of the strain to actively convert CO_2 at an elevated pressure.

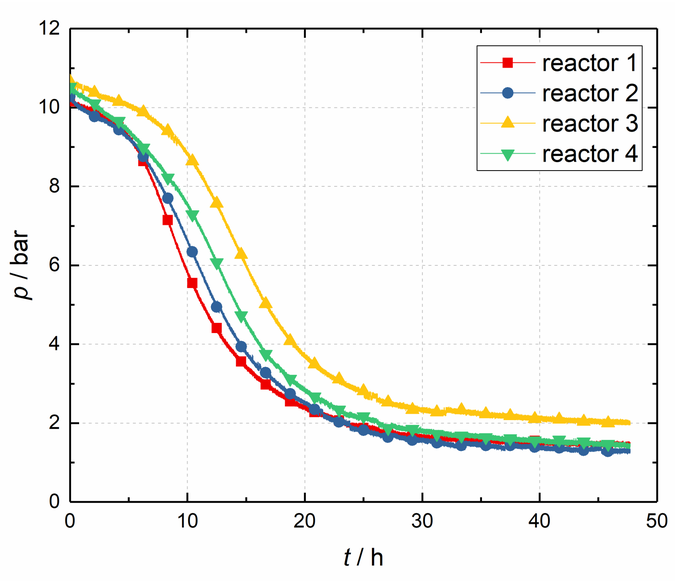

Figure 2: Pressure profile of the experiment at 10 bar H_2:CO_2 = 4:1.

Figure 2 shows the pressure curve of a test run with an inoculation pressure of 10.65±0.18 barg. The results shows immediate gas conversion without appearance of a lag phase. The exponential trend for gas conversion suggests a amplification of the conversion ability over time which indicate the possibility of growth associated conversion. This is followed by the stationary phase in which the microorganisms adjust the gas conversion and change their physiology to survival strategies[4-6].

The production of CH_4 was checked by GC measurements for each experiment. The results showed that a final CH_4 concentration of at least 99.7 % (dry gas) was reached in each of the reactors. The remaining percentages are non converted CO_2, as only H_2, CO_2 and CH_4 were normalized during the GC measurements. Thus, other substances such as H_2O are not considered.

The experiments show a good comparability for the results obtained from the four reactors and it is concluded, that the SBRS is a suitable HT bioreactor system for fast characterization and screening of methanogens and gas converting microorganisms.

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