Pressure fermentation – optimizing biogas production for injection into the gas grid

Anna Wonneberger, Frank Graf

A threatening global climate change and the finite nature of fossil resources make it necessary to explore more and more renewable energy sources and to face the thus emerging challenges. Beside solar energy, wind and water power, utilisation of biomass plays a central role. Applying anaerobic fermentation wet biomass can be converted to biogas which mainly consists of methane and carbon dioxide. After cleaning and upgrading biogas can be injected into the gas grid and thereby takes advantage of the existing supply infrastructure.

Until 2030 the German government plans to substitute 10 % of the consumed natural gas by upgraded biogas or synthetic natural gas (SNG). Up to now biogas from 44 fermentation plants is upgraded and injected into the German gas grid. About 60 further projects are in a planning or construction phase. Assuming an average gas production of 700 m^3/h (STP) of upgraded biogas per plant, the construction of 1.700 new plants is needed until 2030 in order to reach the target set by the federal government.

The fermentation process, however, is so far neither designed nor optimized for a subsequent gas upgrading step. A two stage pressure fermentation provides an innovative approach to improve the fermentation process with respect to grid injection. The schematic setup is shown in figure 1.

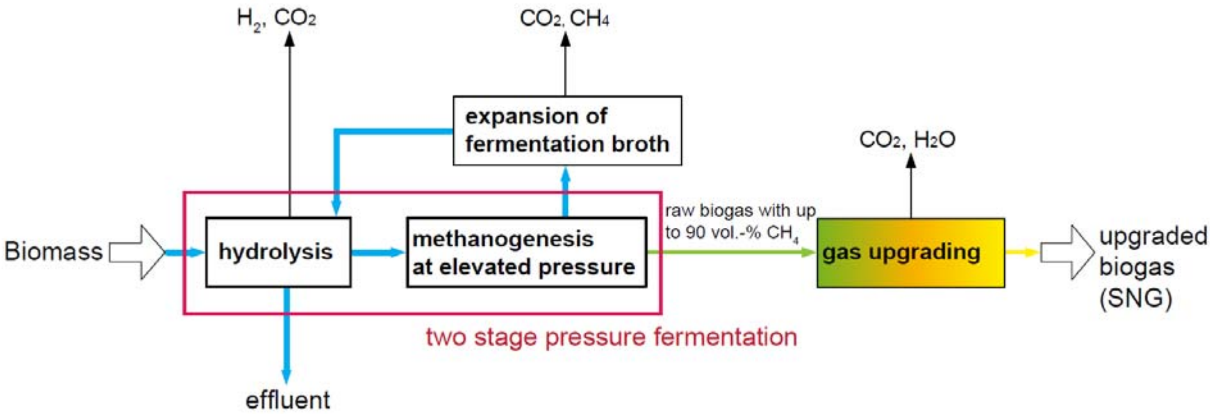

Figure 1: Schematic setup of the two stage pressure fermentation process

This process enables the production of biogas at elevated pressure. For the injection into the gas grid with 16 bar net pressure 1.7 % of the fuel energy is necessary only for compression. If the gas is already produced at 16 bar (or slightly higher to buffer eventual pressure losses) costs for upgrading could be reduced by 10 - 15 % and investment costs for a gas compressor can be avoided. Furthermore the two stage setup produces a hydrogen rich gas stream in the first stage which can be used for additional electricity generation and/or to provide process heat.

In addition, biogas from fermentation at elevated pressure has advantages concerning the biogas composition. A conventional biogas consists of about 50 vol.-% methane and 50 vol.-% carbon dioxide. These main components show different solubilities in aqueous solutions as fermentation broth. The solubility of carbon dioxide in water at 30°C is about 23 times higher, than the solubility of methane. This leads to an enrichment of methane in the gas phase during the fermentation. Methane contents can reach up to 90 vol.-% leading to savings in the upgrading process. This will further reduce investment and operating costs of biogas upgrading plants.

The poster presentation will show first results determined by mathematical modelling of the pressure fermentation to reveal the crucial parameters for plant design. Furthermore the influence of pressure in the methanogenesis (second) stage on gas composition will be evaluated, as well as the influence of the operating conditions of the expansion stage on the composition of the expansion gas.