Simultaneous biogas upgrading and biochemicals production using anaerobic bacterial mixed cultures - DTU Orbit (18/04/2019)

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A novel biological process to upgrade biogas was developed and optimised during the current study. In this process, CO2 in the biogas and externally provided H2 were fermented under mesophilic conditions to volatile fatty acids (VFAs), which are building blocks of higher-value biofuels. Meanwhile, the biogas was upgraded to biomethane (CH4 >95%), which can be used as a vehicle fuel or injected into the natural gas grid. To establish an efficient fermentative microbial platform, a thermal (at two different temperatures of 70°C and 90°C) and a chemical pretreatment method using 2-bromoethanesulfonate were investigated initially to inhibit methanogenesis and enrich the acetogenic bacterial inoculum. Subsequently, the effect of different H2:CO2 ratios on the efficiency of biogas upgrading and production of VFAs were further explored. The composition of the microbial community under different treatment methods and gas ratios has also been unravelled using 16S rRNA analysis. The chemical treatment of the inoculum had successfully blocked the activity of methanogens and enhanced the VFAs production, especially acetate. The chemical treatment led to a significantly better acetate production (291mg HAc/L) compared to the thermal treatment. Based upon 16S rRNA gene sequencing, it was found that H2-utilizing methanogens were the dominant species in the thermally treated inoculum, while a significantly lower abundance of methanogens was observed in the chemically treated inoculum. The highest biogas content (96% (v/v)) and acetate production were achieved for 2H2:1CO2 ratio (v/v), with Acetoanaerobium noterae, as the dominant homoacetogenic hydrogen scavenger. Results from the present study can pave the way towards more development with respect to microorganisms and conditions for high efficient VFAs production and biogas upgrading.

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