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# Mixed microbial culture-based syngas fermentation for the production of ethanol and methane

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## Abstract

The fermentation of synthesis gas is a promising approach for the production of biofuels as it combines benefits derived from both thermochemical and biochemical conversion processes. In this process, a wide range of feedstocks can be converted through gasification into synthesis gas, a mixture of $H_2$, CO and $CO_2$, which can be further converted biologically into gaseous and liquid biofuels. The fermentation of synthesis gas has been typically studied using pure microbial cultures. However, open mixed cultures may offer a series of advantages over pure cultures such as high adaptive capacity, resilience to syngas impurities and non-sterile operation [1, 2]. On the other hand, the poor understanding of the microbial interactions in mixed cultures usually leads to low product selectivity in fermentation processes. Thus, gaining a better control on the activity of the whole microbial community is fundamental for the further development of mixed culture-based fermentations.

In this work, a number of batch and continuous enrichment strategies were designed for enhancing the microbial activity of anaerobic sludge towards the production of methane and ethanol. The methanogenic potential of the anaerobic sludge was assessed through batch enrichments at different temperatures (37˚C and 60˚C). The ethanologenic potential of the anaerobic sludge was evaluated through batch enrichments at different initial pH conditions (6, 5.5 and 5) and through a continuous enrichment using a 2 L CSTR fermenter operated at pH 4.5, HRT of 5 days and a gas inflow rate of 10 mL/min. Subsequently, the effect of the HRT and the mass transfer on the distribution of fermentation products was studied.

The results showed that the batch enrichments led to less complex microbial consortia with a higher activity towards the targeted products. At the end of the batch enrichments, the methane yield of the mesophilic and the thermophilic methanogenic consortia corresponded to 81.4% and 92.6% of the theoretical maximum, respectively. Additionally, the study of the specific activity on $H_2/CO_2$, CO and acetate of the methanogenic enriched consortia revealed different patterns of activity between the two methanogenic microbial consortia. The ethanol yield obtained using the different ethanologenic enriched consortia was observed to increase as the initial pH was lowered, achieving a maximum ethanol yield of 17.7%, 33.3% and 59.8% of the theoretical maximum in enrichments at pH 6, 5.5 and 5, respectively. Similarly, the enrichment in continuous mode promoted a higher ethanologenic activity compared to the initial anaerobic sludge used, and both HRT and mass transfer were shown to be influencing parameters on the distribution of fermentation products under operation in continuous mode.

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## References

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