university of groningen / faculty of science and engineering

MINIATURIZED ANAEROBIC DIGESTERS
as screening tool for biogas production from lignocellulosic waste streams

Information

Ids Dijkstra | s2659069
ids.dijkstra@rug.nl

Bachelor Integration Project IEM

1st supervisor: dr. J. Krooneman
2nd supervisor: dr. ir. H. Kloosterman

INTRODUCTION

Biogas is expected to fulfil a big role in reaching EU energy targets due to various sustainable contributions. Amongst biogas production, the implementation of anaerobic digestion (AD) is well known as a useful renewable energy producer due to the arrangement of its main design structure and pathways. A biomass with high potential biogas production in AD is the feedstock lignocellulosic waste. A trend in down-scaling in biotech industry is left out of scope of current research efforts in biogas production industry.

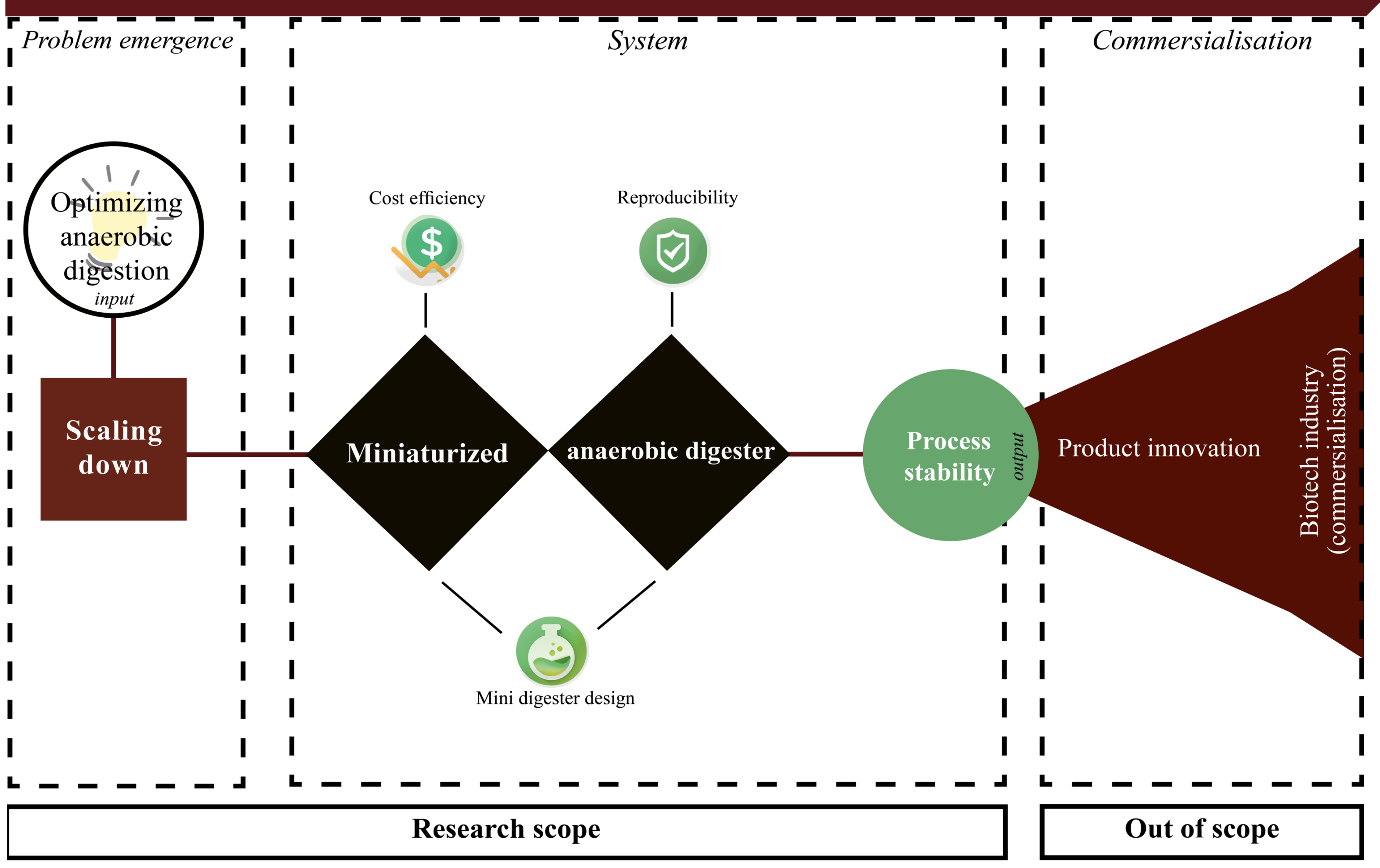
The two main **research questions** of this thesis are:

1. What is a valid design for a 38mL mini digester that should mimic a 380 mL mini digester?
2. Is it possible to mimic the performance of a 380 mL mini digester in a 38 mL mini digester that both run on lignocellulosic waste?

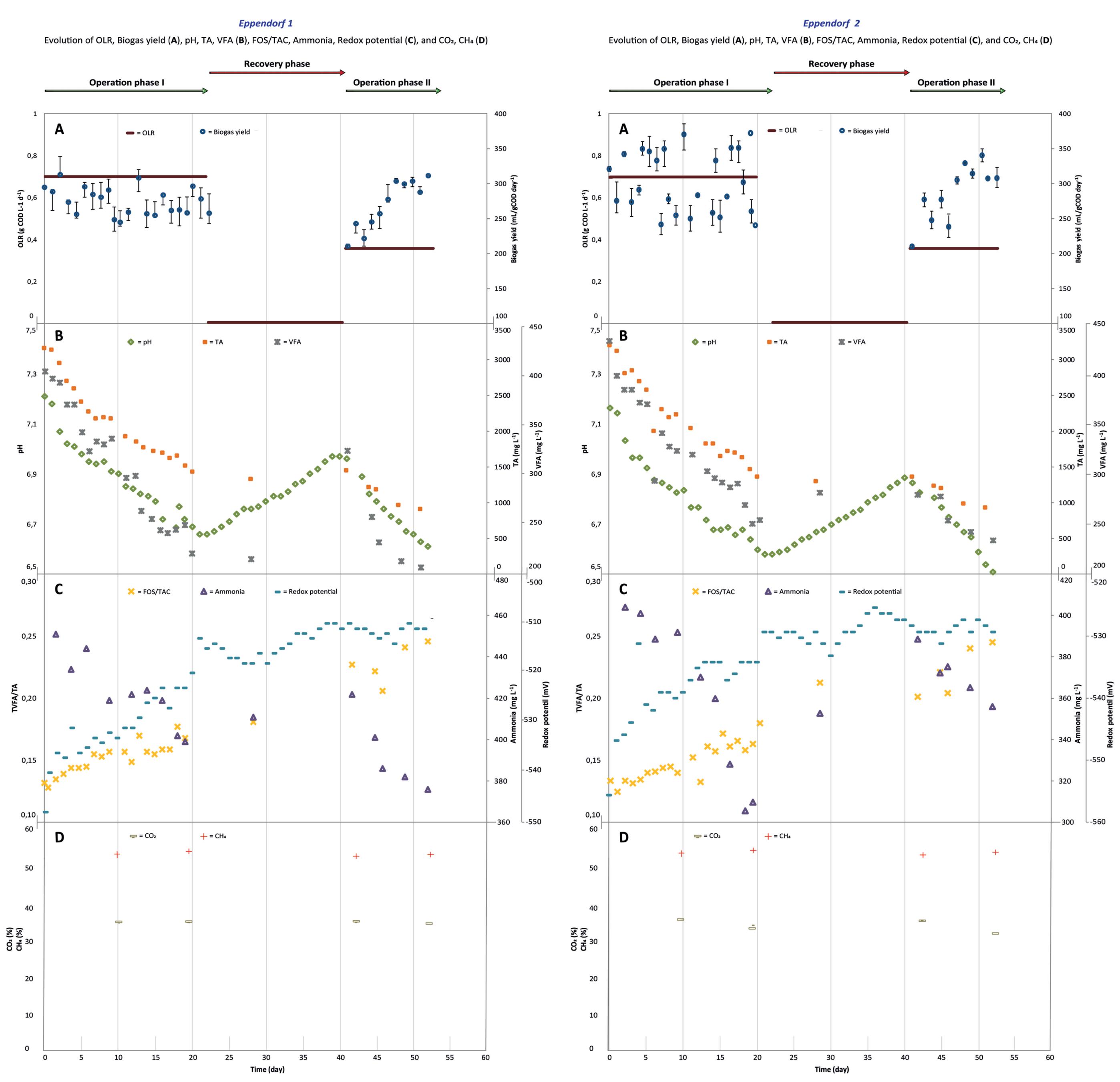
Experimental Design

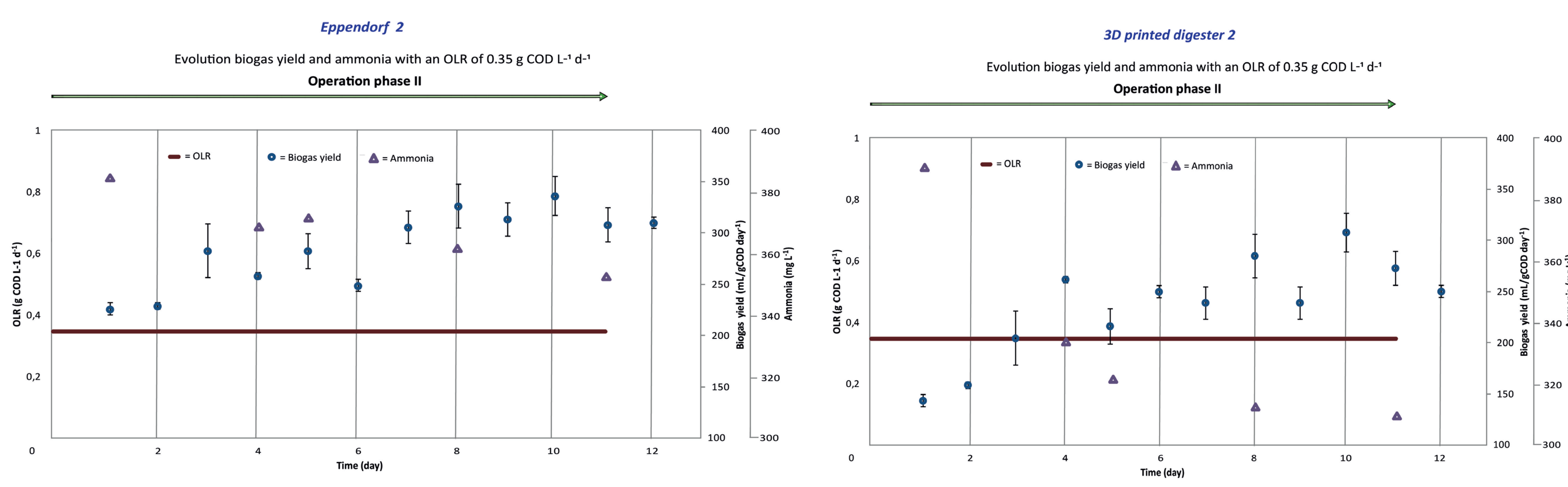
The experimental design consisted of four miniaturized digesters of the respective sizes; 380 mL, 380 mL, 38 mL, and 38 mL. The 38 mL digesters were designed with the computer aided design (CAD) program Autodesk Fusion, whilst the 380 mL digesters were supplied. The CADs were fabricated using a stereolithography based 3D printer. The experimental design configurations were chosen to be semi-continuously feeding, low-speed mixing, and mesophilic temperature operation. The digesters were fed with the lignocellulosic material fine sieved fraction (FSF) obtained from a municipal wastewater treatment plant. The to be assessed parameters were chosen to be pH, VFA, TA, VFA/TA (FOS/TAC), redox potential, ammonia, CH_4-, and CO_2 content.

SYSTEM DESCRIPTION



Results





Background knowledge

AD is the biological process of decomposition of complex organic matter by a microbial consortium in an oxygen-free environment. AD follows four metabolisms in which the organic matter gets converted to carbon dioxide and methane (biogas) in the presence of engaging microorganisms. Parameters and design specifications that potentially influence the stability of AD are temperature, mixing, pH, total alkalinity (TA), volatile fatty acids (VFA), organic loading rate (OLR), redox potential, and ammonia. Optimisation studies in AD involve miniaturized digesters, however, control and design is still very complex and lacks research. Usual reactor configurations like temperature control and mixing are difficult because they influence the communities, and consequently the process stability.

Conclusion

AD was proven to convert FSF into biogas in all mini digesters. Decreasing digester size resulted in the proposed comparison study between 38 mL and 380 mL digesters. The biogas yield trends in all digesters were micked and the yield differences appeared negligible. In addition, a cost benefit analysis based on several assumptions showed the feasibility of scaling-out the 38 mL digester. The return on investment of a plant consisting of one million 38 mL digesters appeared to be 16% with a break-even point after 6.25 years.