Assessment of Volatile Fatty Acids by thermophilic anaerobic digestion of blackwater and kitchen waste

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16th of June

9th International Conference on Sustainable Solid Waste Management.
OUTLINE

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INTRODUCTION

Linear economy

Circular economy

EXTRACT  PRODUCE  CONSUME  DISCARD

EXTRACT  PRODUCE  CONSUME  REDUCE  REUSE  RECYCLE
INTRODUCTION

VFA production via microbial fermentation using mixed microbial cultures is gaining interest

Organic streams (wastes)
- Lignocellulosic biomass
- Food waste
- Waste activated sludge
- Dairy wastewater

BIOREFINERIES

Partial anaerobic digestion:
- Hydrolysis
- Acidogenesis
- Acetogenesis
- Methanogenesis

Valuable resources
- Bioenergy
- Hydrogen
- Mixed VFA

Platform chemicals
INTRODUCTION

INTRODUCTION

HOUSEFUL project proposes an innovative paradigm shift towards a circular economy for the housing sector. The main goal is to develop and demonstrate an integrated systemic service composed of 11 circular solutions. This integrated systemic service will aim at the circular management and efficient use of water, waste, energy and material resources for all stages of European building’s life-cycle.

WASTE

This project has received funding from the European Union’s Horizon 2020 research and Innovation programme under grant agreement N°776708. The information reflects only the author’s view, and the Commission is not responsible for any use that may be made of the information it contains.
Decentralized co-digestion of blackwater and kitchen waste through wet anaerobic digestion: To balance the C/N ratio and have synergistic effects in an anaerobic system.
Two-stage anaerobic digestion

1st stage - Acidogenic fermentation
2nd stage - Anaerobic digestion

Blackwater & kitchen waste (Obtained from LEITAT facilities) → Acidogenic reactor → VFA-rich stream → Settler → VFA-rich supernatant → Biogas

Sludge recirculation → Digestate (to compost) → Membrane module → Effluent
AnMBR at laboratory scale

1. Acidogenic fermentation: Batch operation

   Inoculum: Sludge from the mesophilic anaerobic digester of Terrassa WWTP
   T = 55ºC
   pH = 5.5
   HRT = 3 - 2 days
   V = 15 L

2. Anaerobic digestion: Continuous operation

   Inoculum: Granular sludge from a UASB reactor installed in a juice factory.
   T = 35ºC
   pH = 7.5
   V = 5 L
RESULTS: Acidogenic fermentation reactor

Black water amount was increased progressively

To increase the VFA production is needed to augment the KW added per batch due to its high biodegradability and the balance it brings to the carbon/nitrogen ratio of BW.
RESULTS: Acidogenic fermentation reactor

BW = 7 kg
KW was increased progressively until 2 kg.

The production of lactate is reported to be detrimental for the following methanogenesis!

+ Deterioration of biomass settleability
VFA valorization through anaerobic digestion to exemplify how to link the VFA bioproduction process with a real potential application.

High efficiency removal of VFA

Biogas composition

\[76 \% \text{CH}_4, 24 \% \text{CO}_2\]
AnMBR pilot plant

1. Acidogenic fermentation

**Reactor:** 550 L of working volume.

**Settler:** 450 L of working volume

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### Equivalent COD (mg/L)

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<th>Batch 4 end</th>
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- **Soluble COD**
- **Acetate**
- **Propionate**
- **Butyrate**
- **Valerate**
- **Hexanoate**
2. Methanogenesis stage

**UASB reactor:** 250 L of working volume.

Start-up expected: End of June.
Conclusions

Scale-up
- This work allows to decide and obtain the key parameter to scale-up the technology
- Selection of the optimum conditions for each stage

KW:BW
- The higher the ratio KW:BW, the higher VFA concentration in the acidogenic fermentation and biogas production in the UASB reactor
- High concentration of suspended solids in the effluent of first stage that affects the UASB reactor performance

Validation
- Successfully technical validation of the AnMBR system demonstrating the capability of treating blackwater and kitchen wastes to obtain biogas, sludge and regenerated water with good quality
- Further optimisation is required for different ratios of KW:BW
QUESTIONS?
THANK YOU!

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