Assessment of the electrical energy demand for different aeration regimes in aerobic wastewater treatment

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HO GENT

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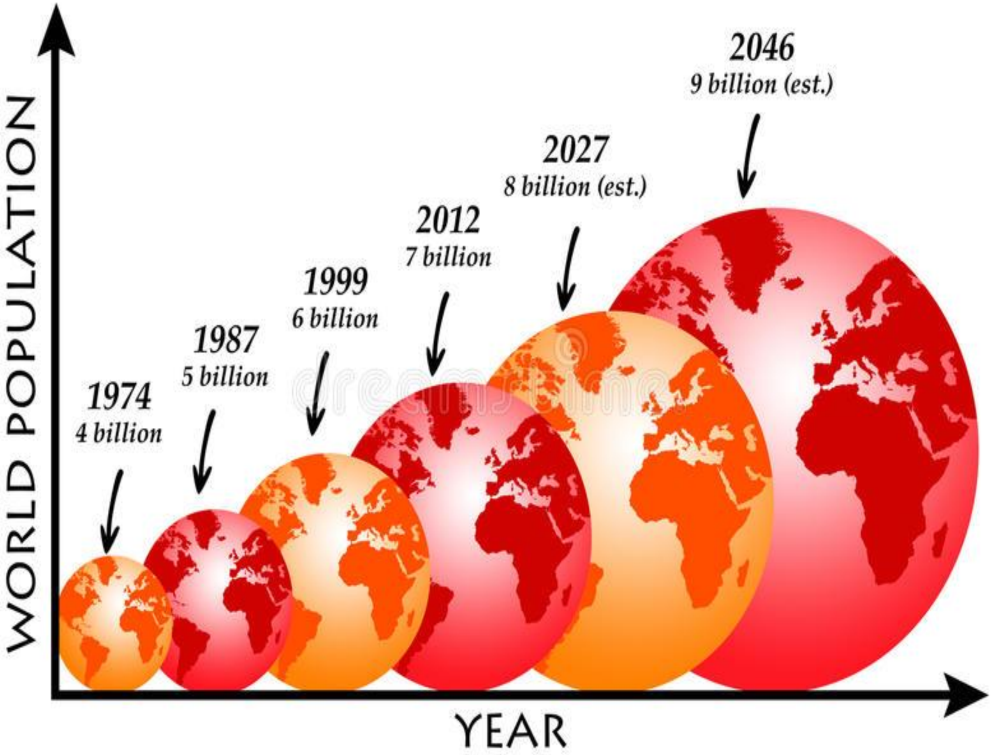
Optimisation of WWTP

use of eDNA in aquatic biodiversity studies

Ecuador: VLIR-UOS: IKIAM - Network

INTRODUCTION

- GLOBAL WARMING:



INTRODUCTION

➔ Waste water ➔ WWTP

INTRODUCTION

- Wastewater treatment contributes to global warming


➔


➔

$NO_3^- \rightarrow NO_2^- \rightarrow NO \rightarrow N_2O \rightarrow N_2$

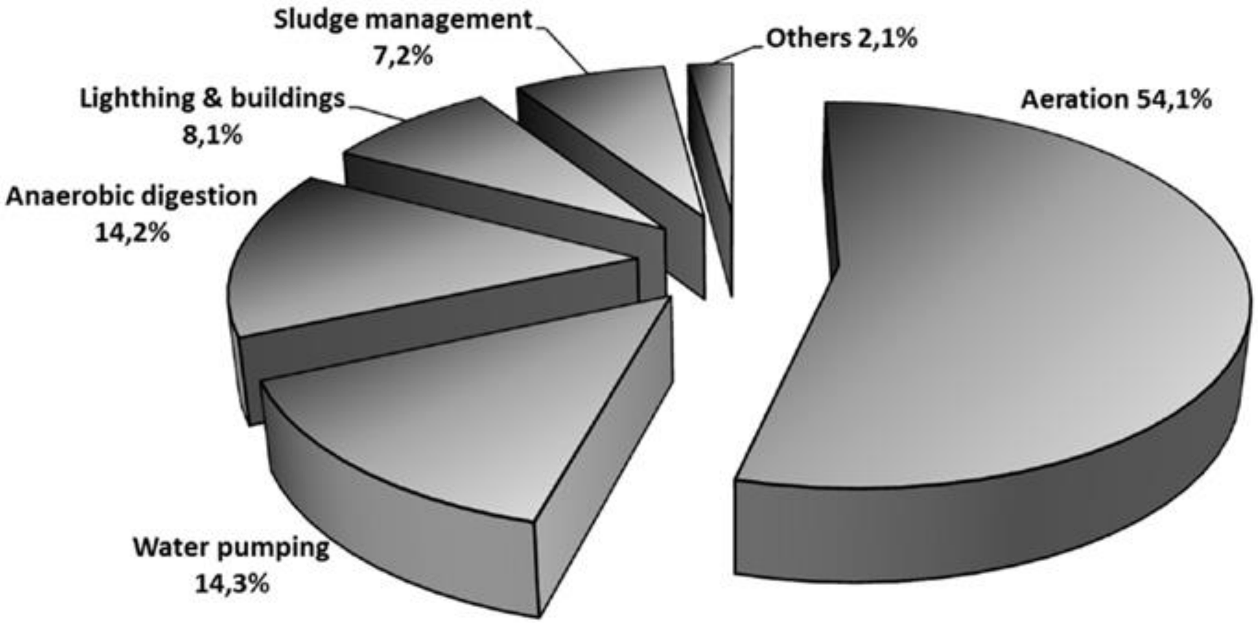
denitrification

$NH_3 \rightarrow NH_2OH \rightarrow NOH \rightarrow NO \rightarrow NO_2^- \rightarrow NO_3^-$

nitrification

INTRODUCTION

- Wastewater treatment contributes to global warming



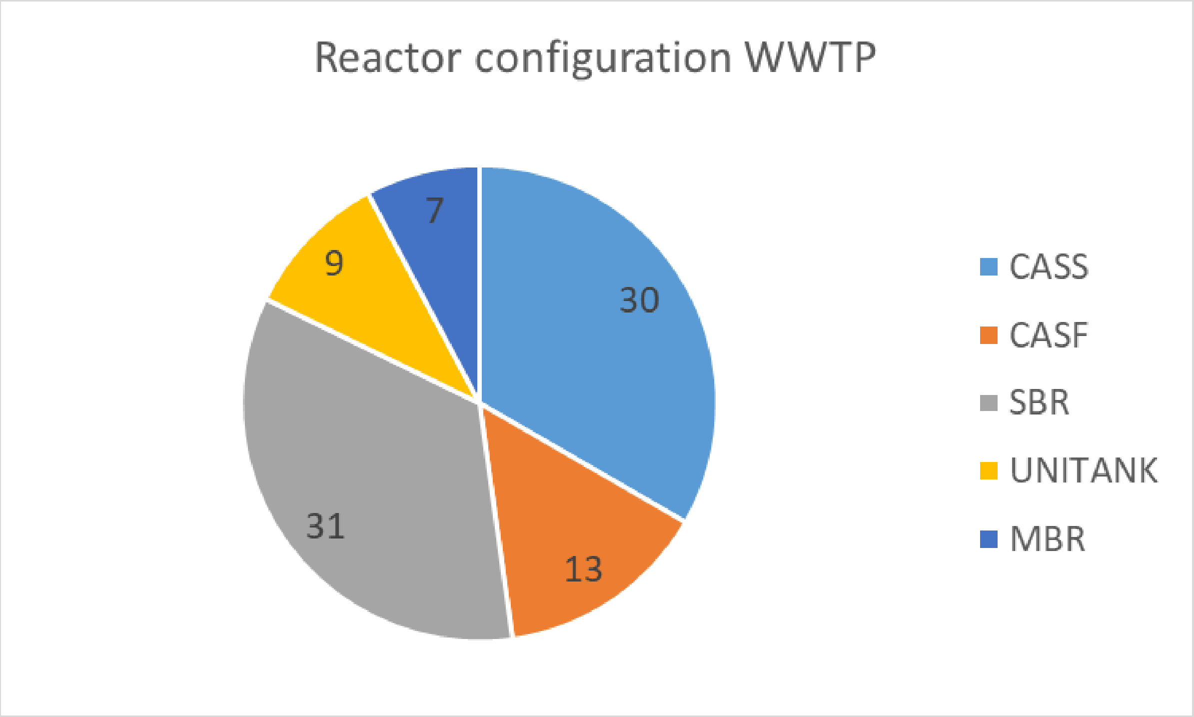
INTRODUCTION

- Industrial wastewater treatment in Flanders (Belgium)
  - Results of a survey conducted between September 2016 – May 2018
  - 90 companies managing their own WWTP (response=26%) *(Cornelissen et al., 2018)*

- In accordance with results of Duck & Berckmoes (2019)
  - 157 companies adressed
  - 49 responses (response = 31%)

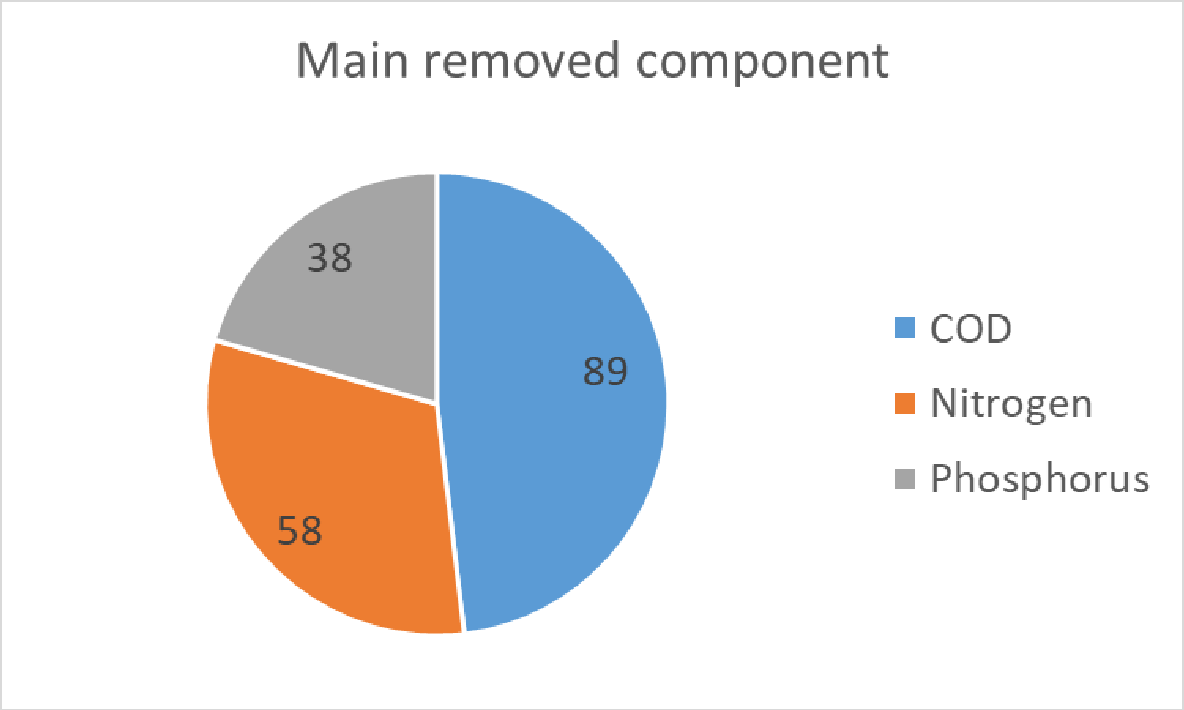
INTRODUCTION

- *(Cornelissen et al., 2018)*



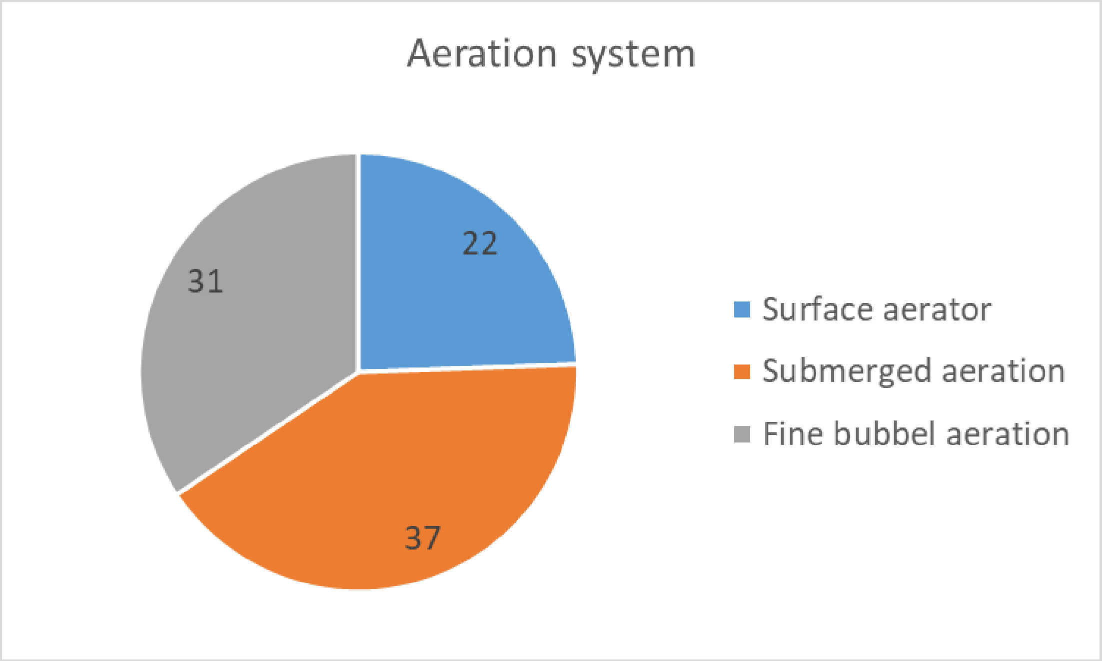
INTRODUCTION

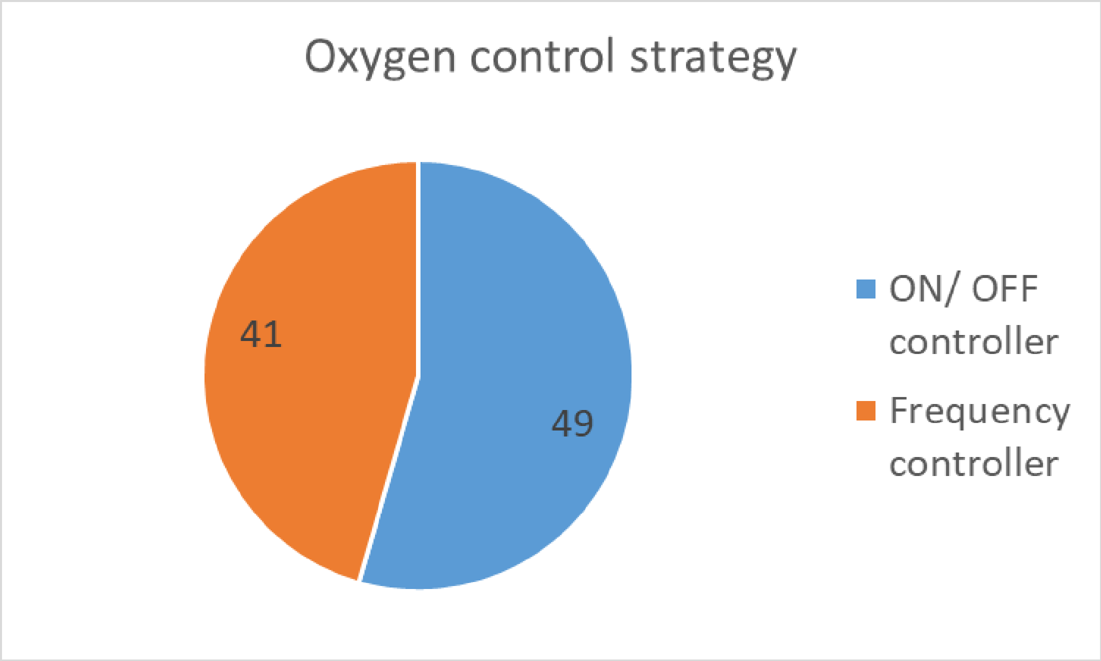
- *(Cornelissen et al., 2018)*



INTRODUCTION

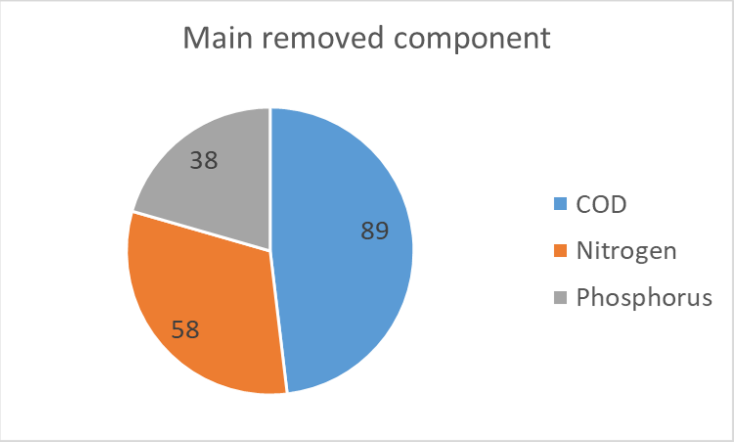
- *(Cornelissen et al., 2018)*





INTRODUCTION

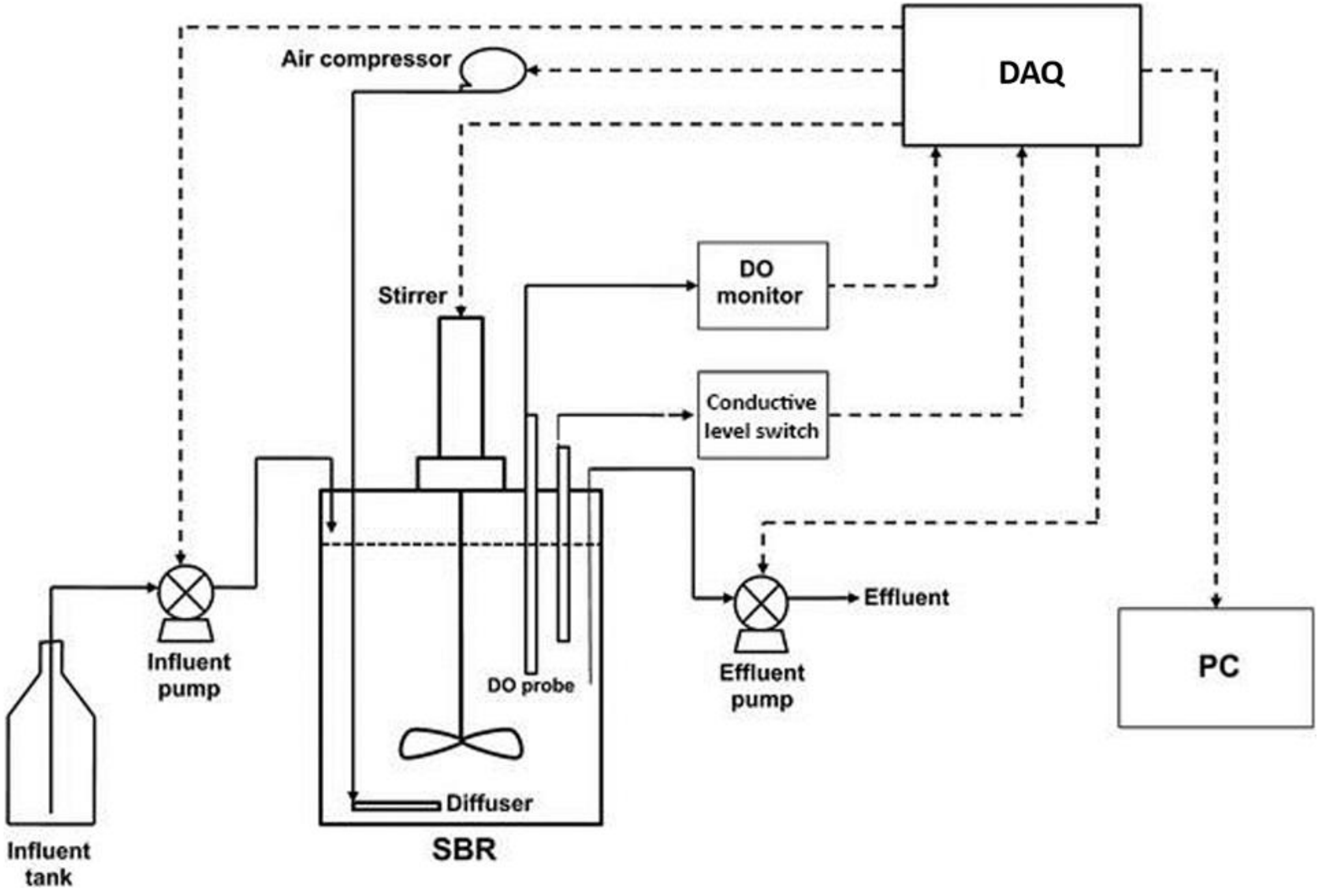
- *(Cornelissen et al., 2018)*
  - $E = 2.11 \pm 1.22\ kWh\ m^{-3}_{wastewater}$
  - $E = 1.22 \pm 0.33\ kWh\ kg^{-1}_{COD\ removed}$ *(in case of only COD removal)*
  - $E = 4.58\ kWh\ kg^{-1}_{COD\ and\ N\ removed}$ *(COD and nitrogen removal)*



RESEARCH OBJECTIVES

- Implementation of different oxygen control strategies
  - Lab scale SBR reactor
- Assessment of the energy demand for each oxygen control strategy
- Evaluation of the sludge characteristics and effluent quality

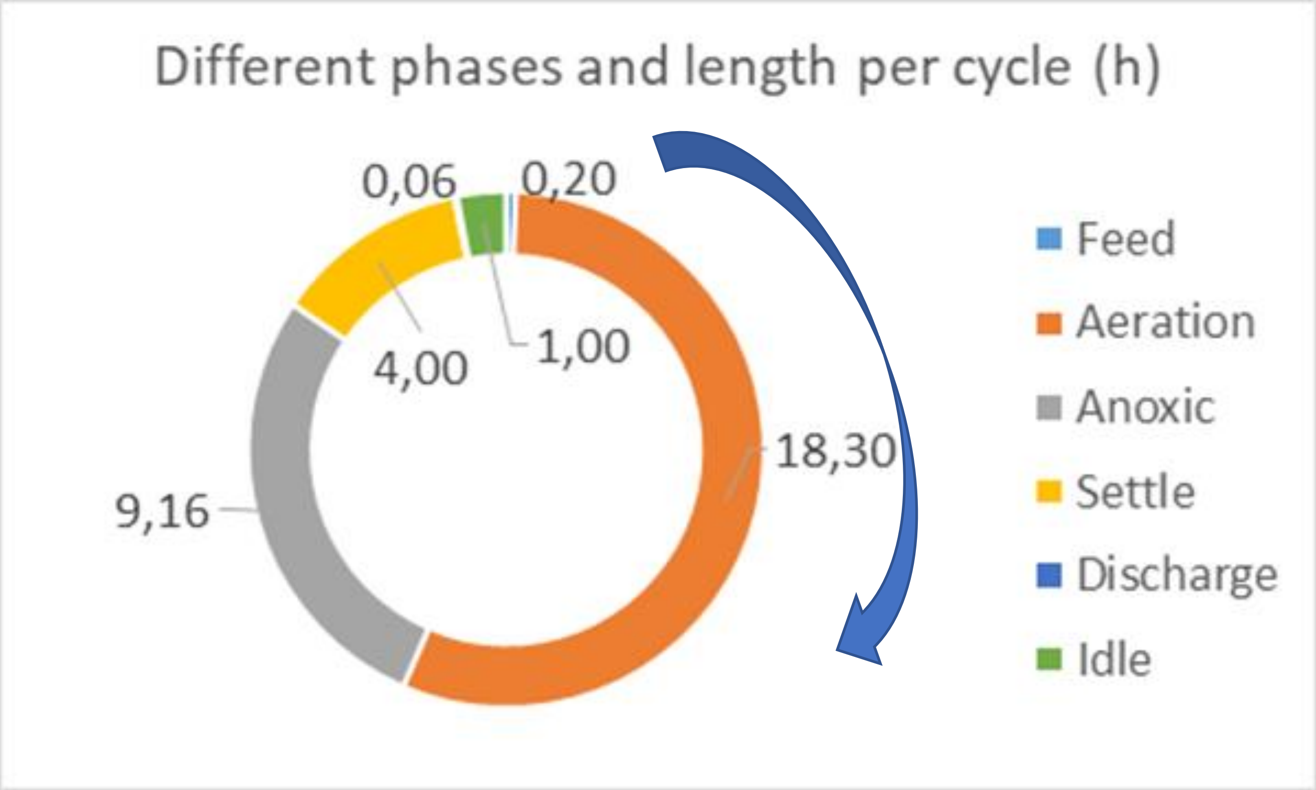
EXPERIMENTAL SET-UP



EXPERIMENTAL SET-UP

Parameter	Unit	Value
Chemical oxygen demand	mg O_2 L^{-1}	1723 ± 159
Total nitrogen	mg N L^{-1}	21.0 ± 13.6
Total phosphorus	mg P L^{-1}	1.86 ± 0.55
Hydraulic retention time	d^{-1}	1.34
Organic load	kg COD kg^{-1} MLSS d^{-1}	0.35

EXPERIMENTAL SET-UP



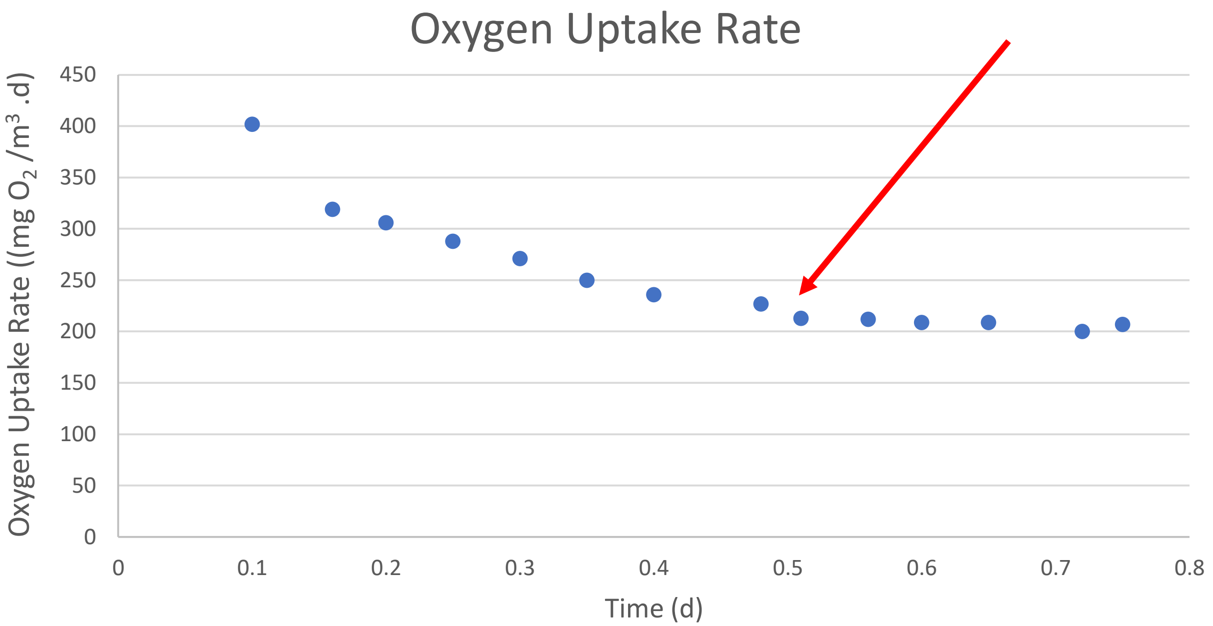
EXPERIMENTAL SET-UP

Two different control strategies were used:

1° On – off control within oxygen range

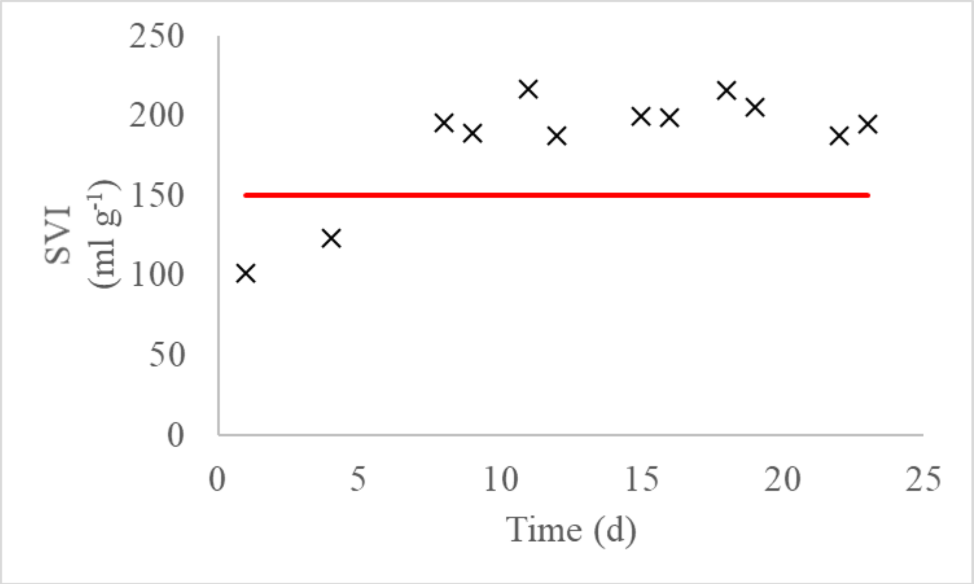
2° On – off control with addition of inline OUR measurement

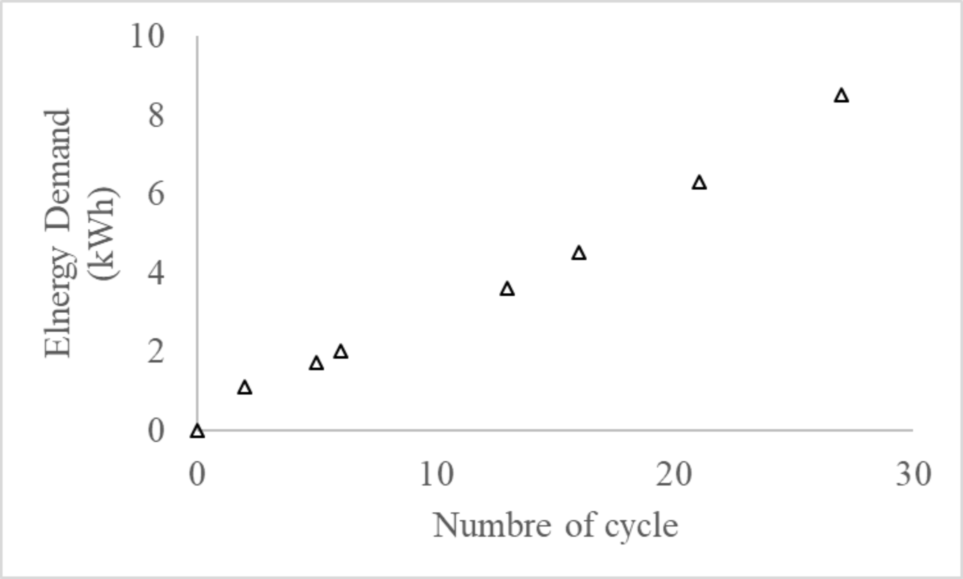
EXPERIMENTAL SET-UP



RESULTS AND DISCUSSION

- Evolution of sludge volume index (SVI) and energy demand (ED) during first control strategy

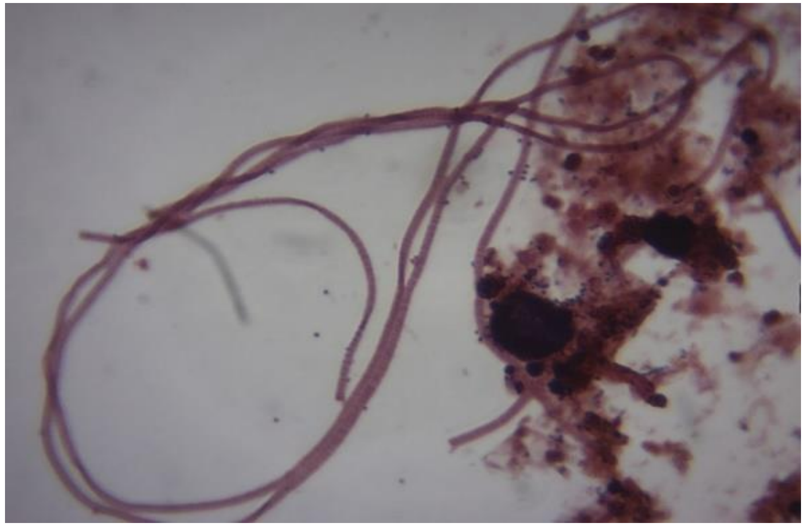




$E = 1.57\ kWh\ m^{-3}$

RESULTS AND DISCUSSION

- Microscopic research of the sludge



Gram Staining

Neisser Staining

RESULTS AND DISCUSSION

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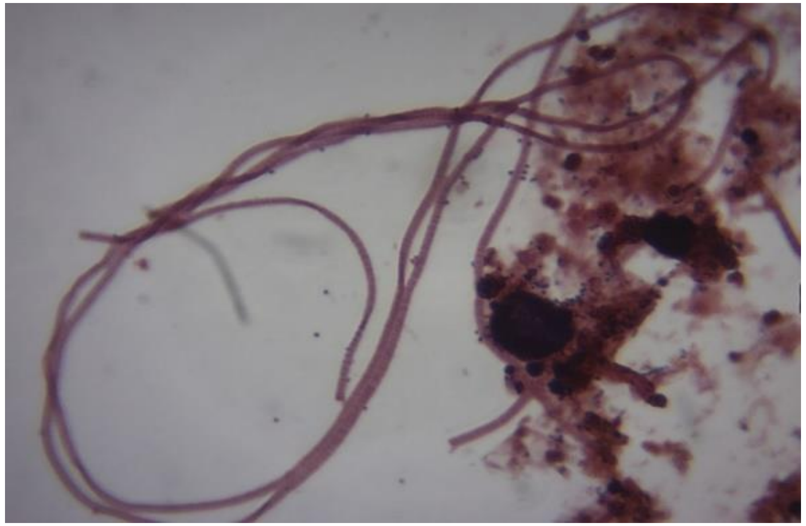

Gram Staining → Negative

Neisser Staining → Negative

Filament T 021N

RESULTS AND DISCUSSION

SVI>150;

E= 1.57 kWh m^{-3}

Identification filamentous bacteria

T 021 N

Chlorination:

8 days

4 g Cl_2 kg^{-1} MLSS d^{-1}

Adjustment of N in inffuent

RESULTS AND DISCUSSION

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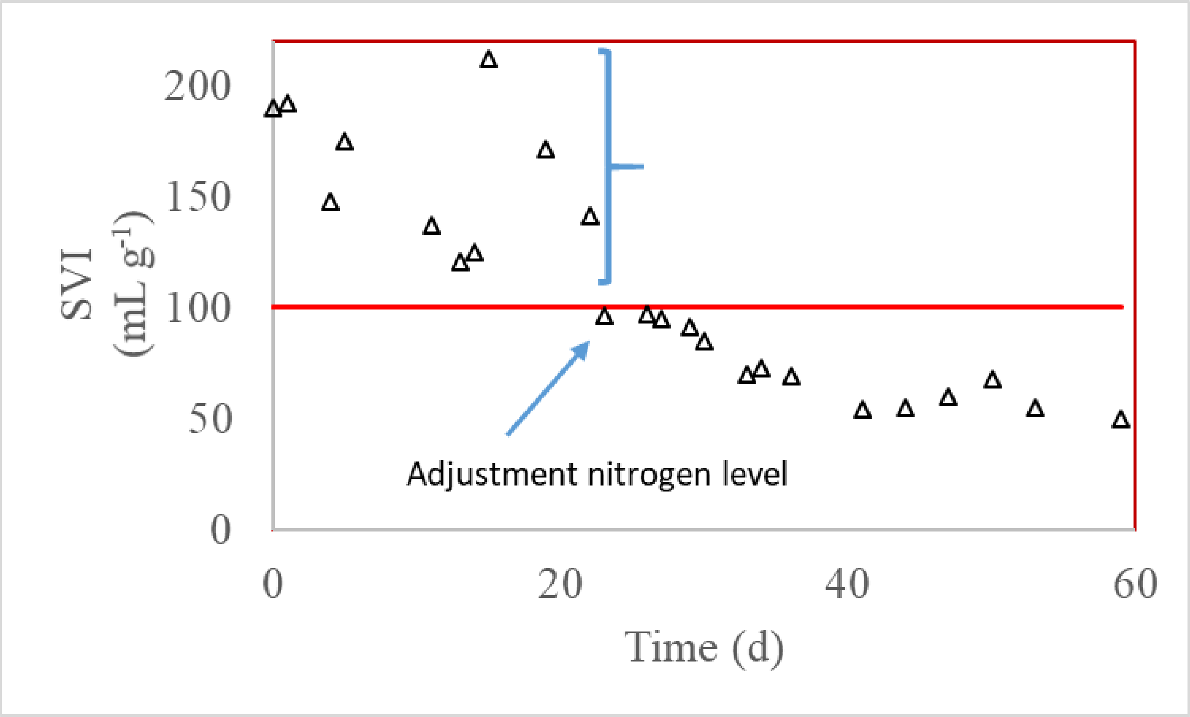

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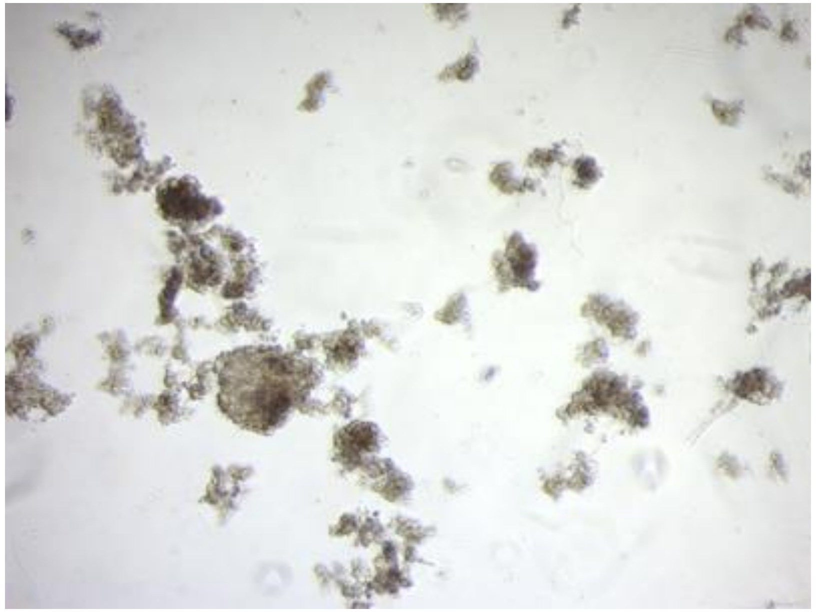
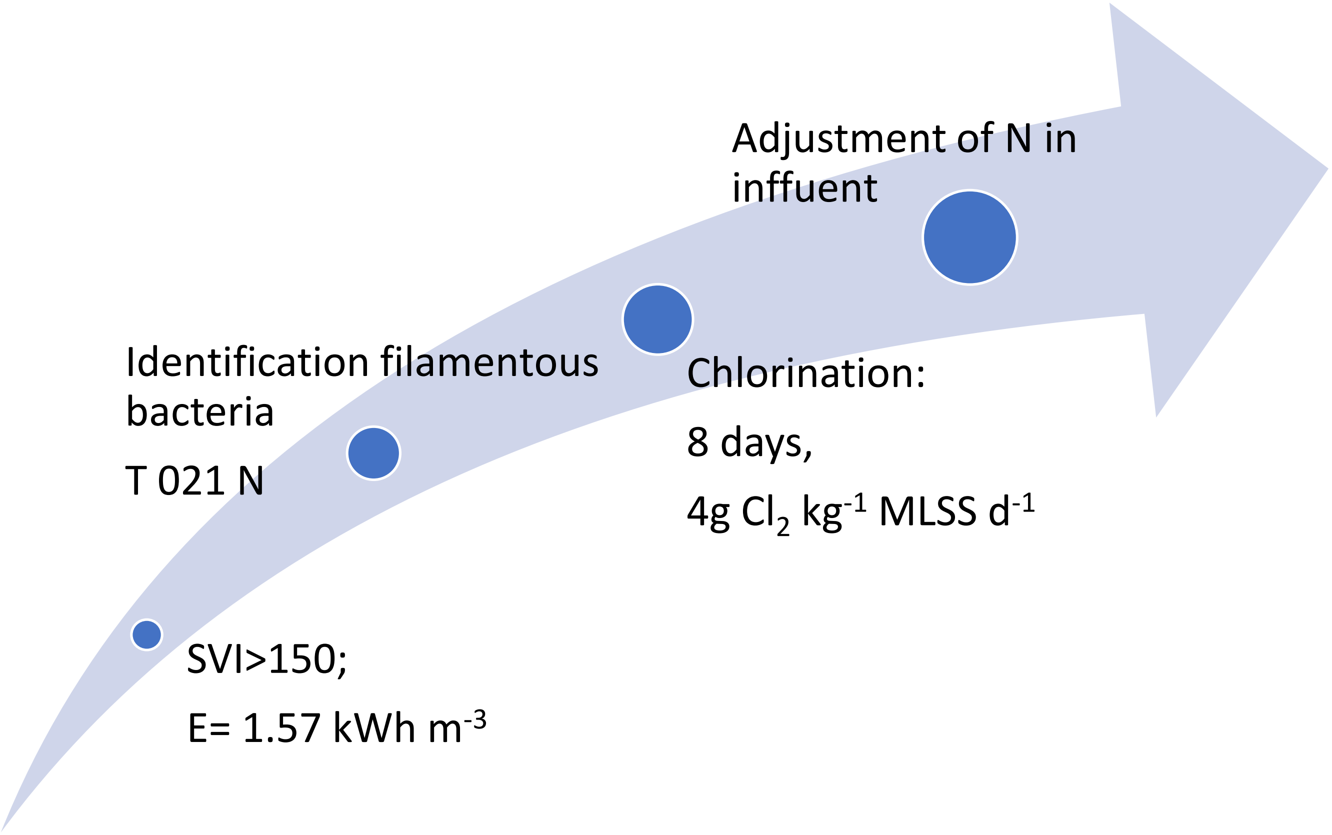


RESULTS AND DISCUSSION



E = 1.57 kWh m^{-3}

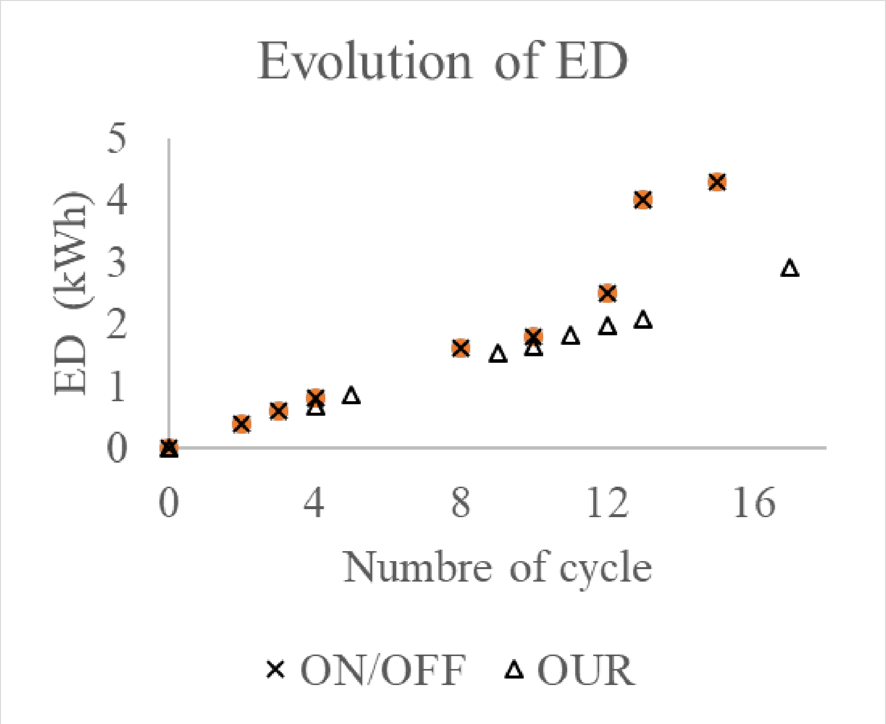
↓

E = 1.00 kWh m^{-3}

57% reduction

RESULTS AND DISCUSSION

- Comparison of energy demand with different control setting



ON/OFF : E = 1.00 kWh m^{-3}
OUR: E = 0.86 kWh m^{-3}

14% reduction

RESULTS AND DISCUSSION

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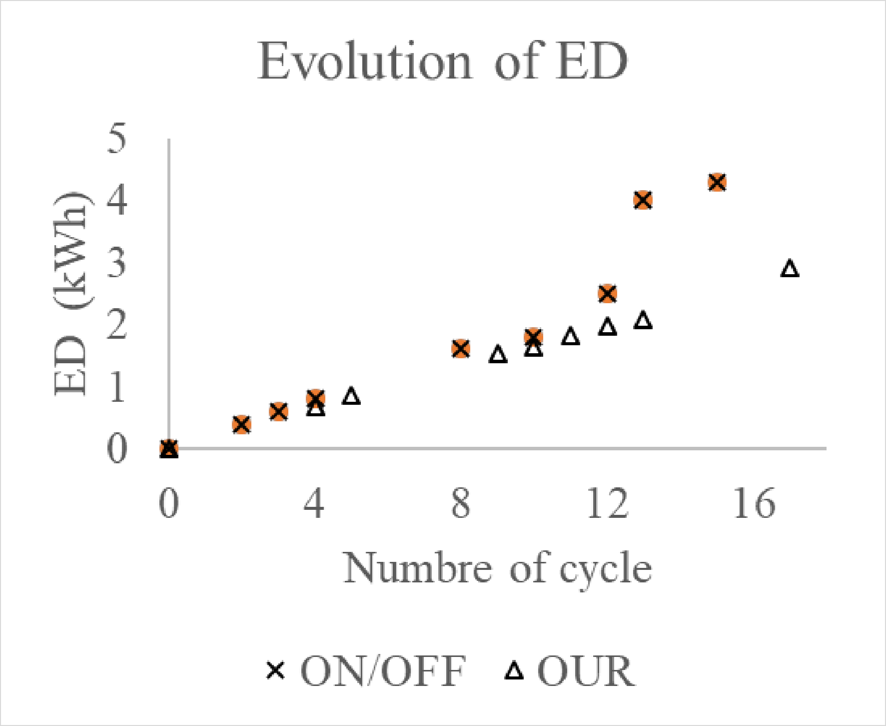
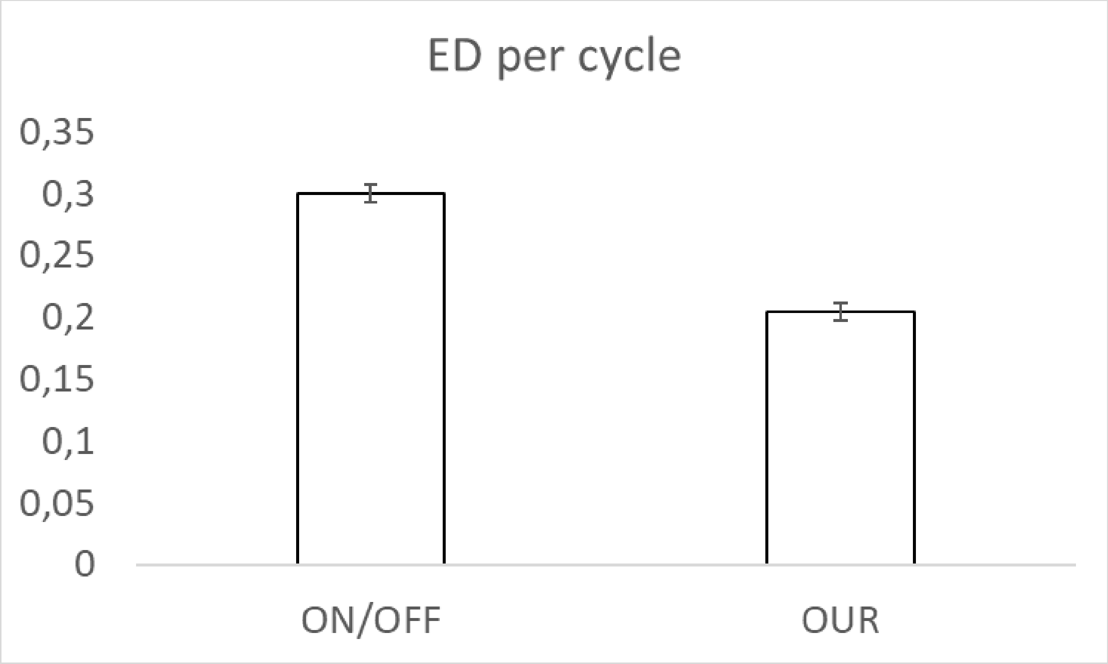
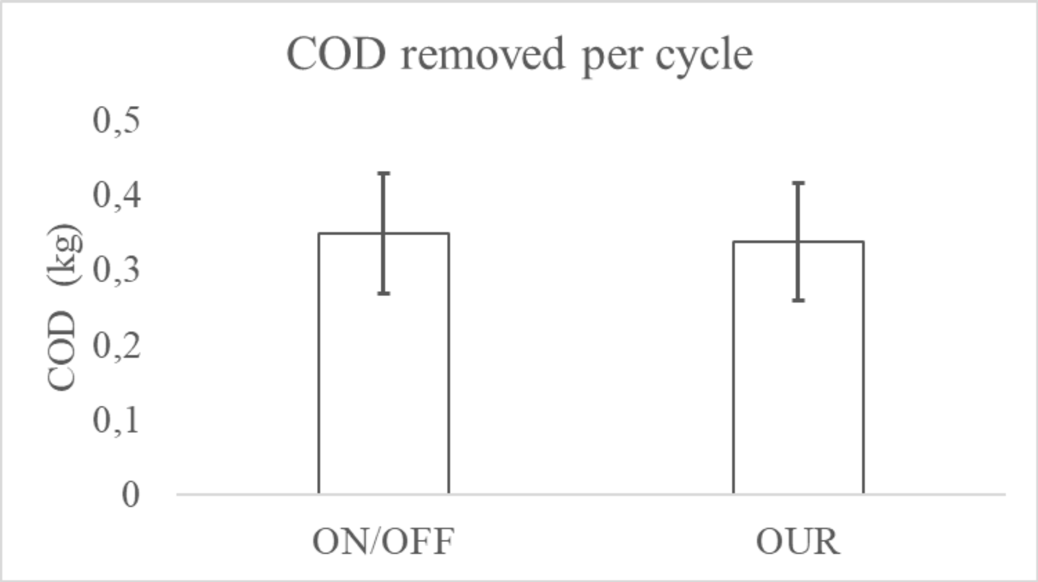


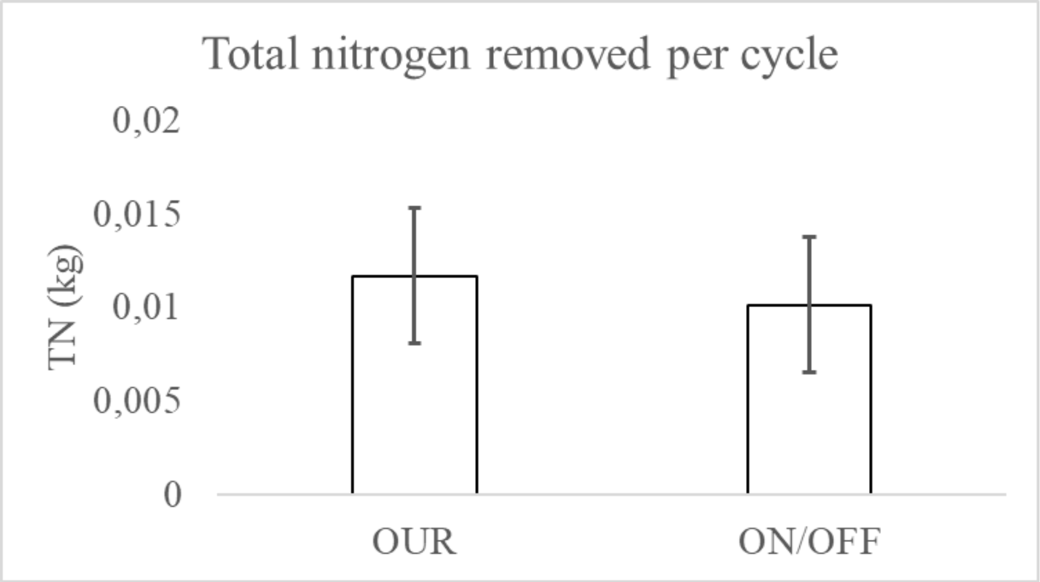


$ED_{OUR} < ED_{ON/OFF}$ P = 0.01 (α=0.05)

RESULTS AND DISCUSSION

- Comparison of removed COD and N

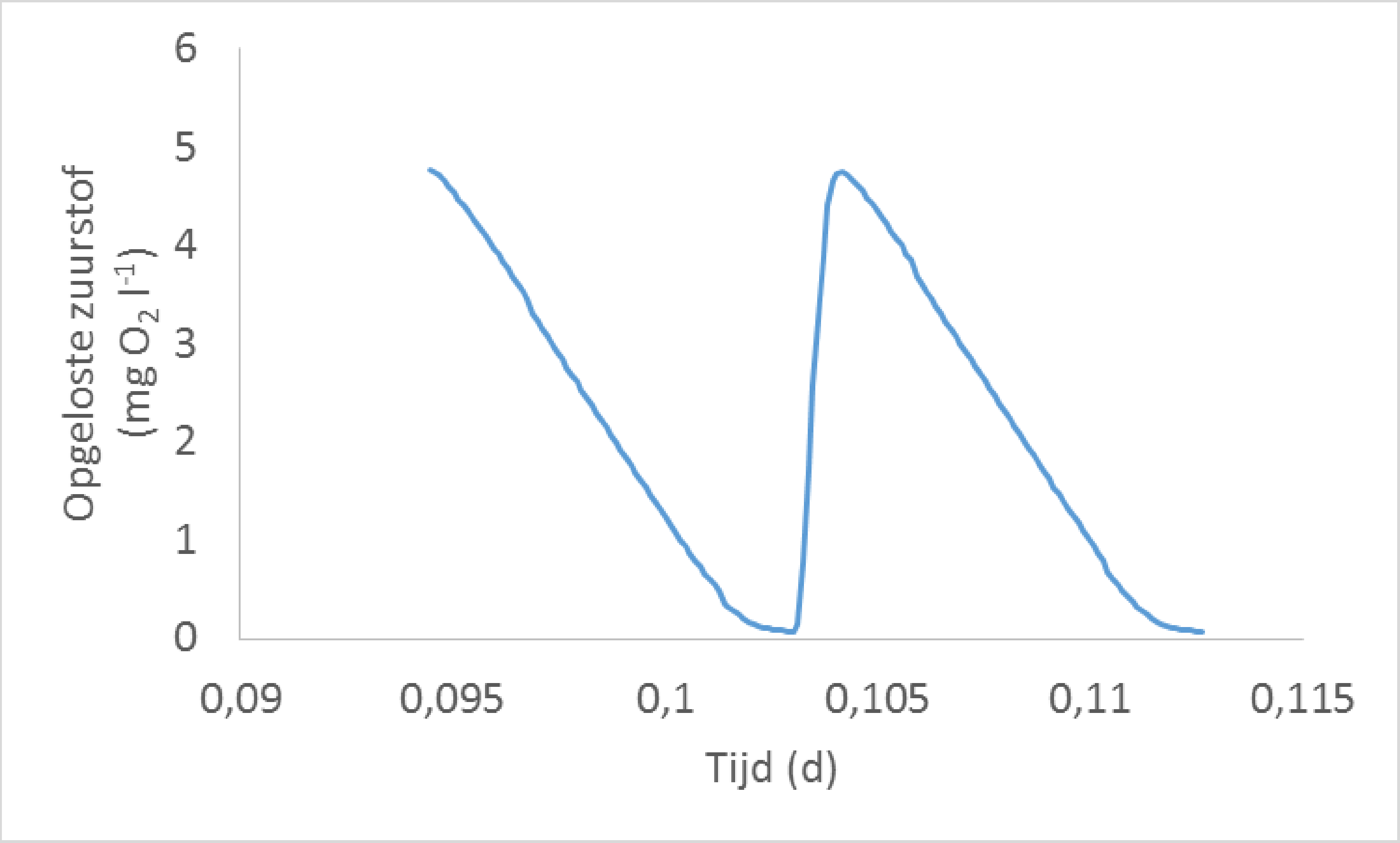




General Conclusions

- Abundant hydrophobic filamentous bacteria in activated sludge have next to a negative effect on the sludge settleability, also a negative effect on the ED of the blowers for aeration
  - It is important to identify the filamentous species and how to prevent them, in order to obtain an energy efficient aeration
- The usage of a more advanced aeration control, like an additional inline OUR control has the potential reduce the ED of the aeration system and will not have a negative effect on the effluent quality

Questions?


6
5
4
3
2
1
0
Opgeloste zuurstof
(mg O_2 l^{-1})
0,09
0,095
0,1
0,105
0,11
0,115
Tijd (d)