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Impact of influent quality on green microalgal cultivation with used water resources – experimental assessment combined with image analysis

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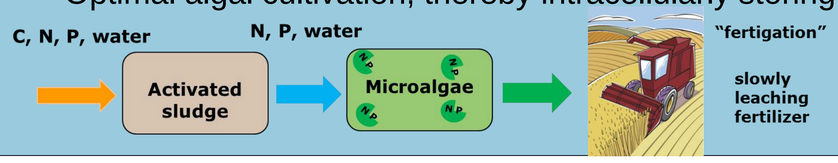
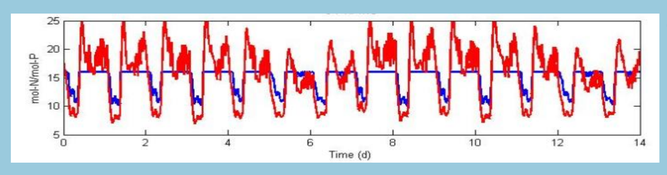
1. INTRODUCTION

- New technologies are developed to recover wastewater resources → Potential resource recovery (water, nutrients, energy) using microalgae
- Resource recovery through a two-stage bacterial-algal system:
  - Enhanced biological phosphorus removal and recovery system (EBP2R) to produce green microalgal growth medium with optimised N-to-P ratios[1]
  - Optimal algal cultivation, thereby intracellularly storing N and P



EBP2R performance: Control system fails to keep the optimal N-to-P ratio when the nitrogen influent load is low [2]



- This variation of the N-to-P ratio can:
  - Deteriorate PBR performance
  - Alter the microalgal community grown in the PBR

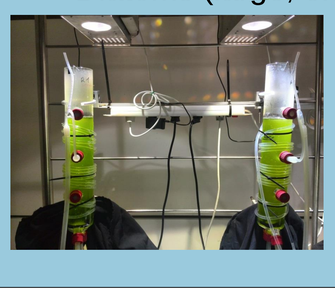
2. OBJECTIVES

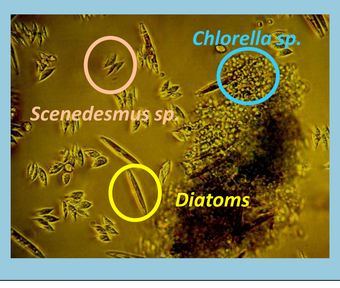
- Test the impact of the expected **variability of the EBP2R effluent quality on the algal cultivation and nutrient removal**
- Develop a **method to quantify different microalgal species** within a mixed consortium using **microscopy and image analysis**

3.MATERIALS AND METHODS

Photobioreactor performance assessed in **lab-scale** reactors:
- 1.4 L open reactors treating the effluent of an EBPR with varying N-to-P ratio
- Two cultivation scenarios:
  - Mixed microalgal consortium of *Chlorella sp.* and *Scenedesmus sp.*
  - Monoculture of *Chlorella sp.*

Microbial diversity analysis and quantification via novel image analysis tool: **shape recognition**
- *Chlorella sp*. (round and small individual cells)
- *Scenedesmus sp*. (elongated cells arranged in two/four-cell colonies)
- Diatoms (large, elongated single cells)

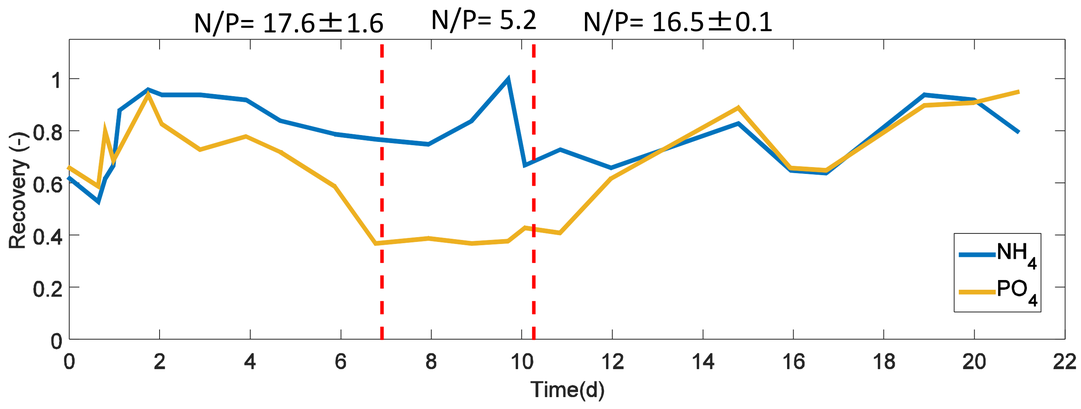


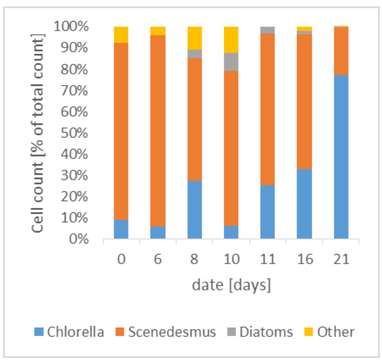


4. RESULTS

Photobioreactor performance with mixed microalgal consortium

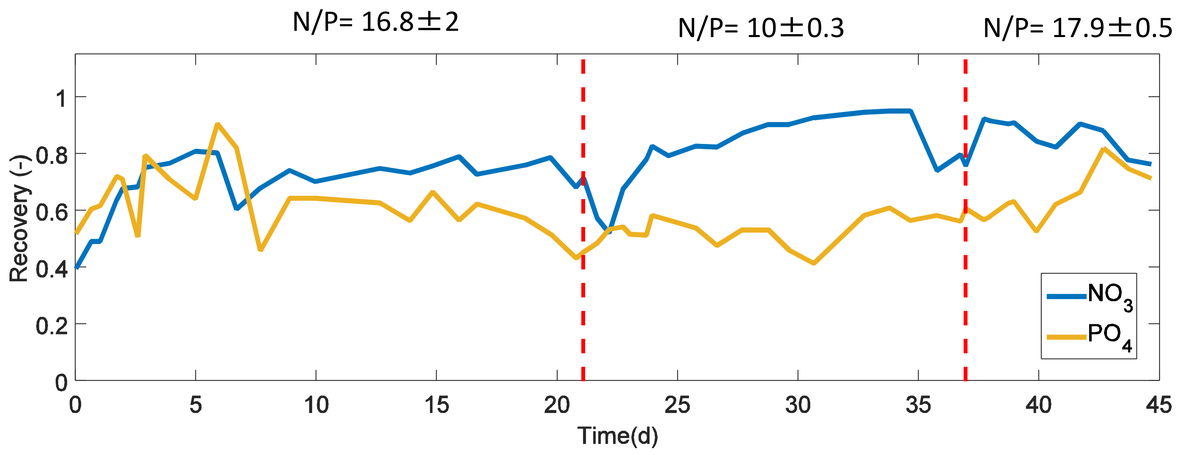
- Culture contamination after shifting the N-to-P ratio to 5 by Diatoms present in the influent
- Poor phosphorus removal (40%) at low N-to-P ratio (due to presence of Diatoms)
- After the N-to-P ratio was shifted back to 17 the Diatoms were washed out and consequently the P removal was recovered





Photobioreactor performance with monoculture of *Chlorella sp*.

- Stable microbial community throughout the cultivation: Chlorella sp. (100%)
- Stable phosphorus removal
- Enhanced nitrogen removal after the nitrogen limited period



5. CONCLUSION

- **N-to-P ratio** is a powerful tool for **microbial community control** in open PBRs cultivating mixed consortia
- **Contamination** by Diatoms can **deteriorate** the process **performance**
- PBR cultivating **monoculture** of *Chlorella sp.* can be operated **without contamination**
- **EBP2R** can **support** optimal **algal** growth

ACKNOWLEDGEMENT

E4WATER Economically and Ecologically Efficient Water Management in the European Chemical Industry

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References:
[1] Valverde-Pérez, B., Ramin, E., Smets, B.F., and Plósz, B. Gy., 2015. EBP2R – An innovative enhanced biological nutrient recovery activated sludge system to produce growth medium for green microalgae cultivation. Water Research, 68, 821-830
[2] Valverde-Pérez, B., Fuentes-Martínez, J.M., Flores-Alsina, X., Gernaey, K.V., Huusom, J.K., Plósz, B.Gy., 2016. Control structure design for resource recovery using the enhanced biological phosphorus removal and recovery (EBP2R) activated sludge process. Chemical Engineering Journal, 296, 447-457