Technical University of Denmark

Co-digestion of microalgae and activated sludge following a novel bioflocculation method

Wágner, Dorottya Sarolta; Radovici, M.; Angelidaki, Irini; Valverde Pérez, Borja; Plósz, Benedek G.

Publication date:
2016

Document Version
Publisher's PDF, also known as Version of record

Technical University of Denmark

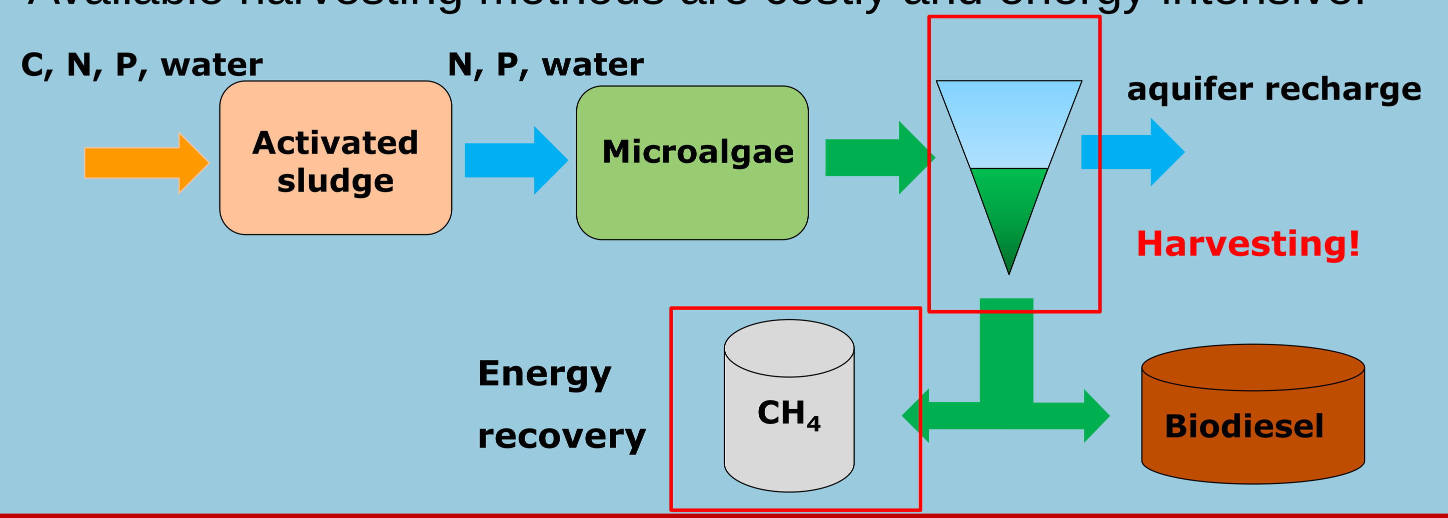
Co-digestion of microalgae and activated sludge following a novel bioflocculation method

Dorottya Sarolta Wágner*, Maria Radovici, Irini Angelidaki, Borja Valverde-Pérez, Benedek Gy. Plósz

*dosaw@env.dtu.dk, DTU Environment, Department of Environmental Engineering, Technical University of Denmark, Miljøvej, Building 113, 2800 Kgs. Lyngby, DENMARK

1. INTRODUCTION

- New technologies are developed to recover wastewater resources and increasing energy yields in form of biogas.
  → Potential energy recovery using microalgae.
- Available harvesting methods are costly and energy intensive.



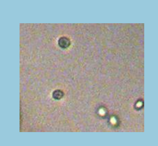
2. OBJECTIVES

- **Cost-efficient** way of harvesting microalgae via **bioflocculation** using wasted activated sludge.
- Assess the **biogas potential** from the harvested activated sludge-algal biomass.

3. MATERIALS AND METHODS

Mixed green microalgal culture cultivated on effluent wastewater:

Chlorella sorokiniana and *Scenedesmus sp.*



Activated sludge from a short SRT (3.5 d) EBP2R system:

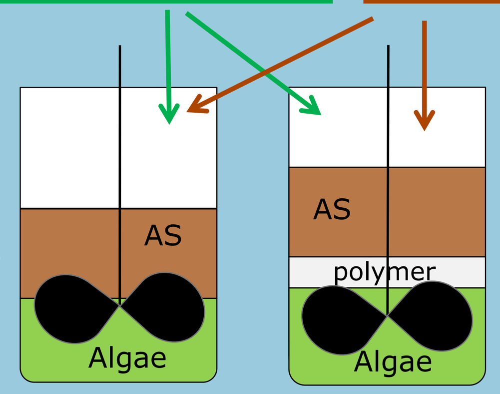
Two wasting strategies:

Solid-liquid separation after the aerobic phase (AS_{AE}) and after the anaerobic phase (AS_{AN})

Two-step flocculation

Strategy I

1. step:
Algae is flocculated with activated sludge



Strategy II

1. step:
Algae is coagulated with cationic polymer (PDADMAC)

2. step:
Activated sludge is added to enhance the flocculation

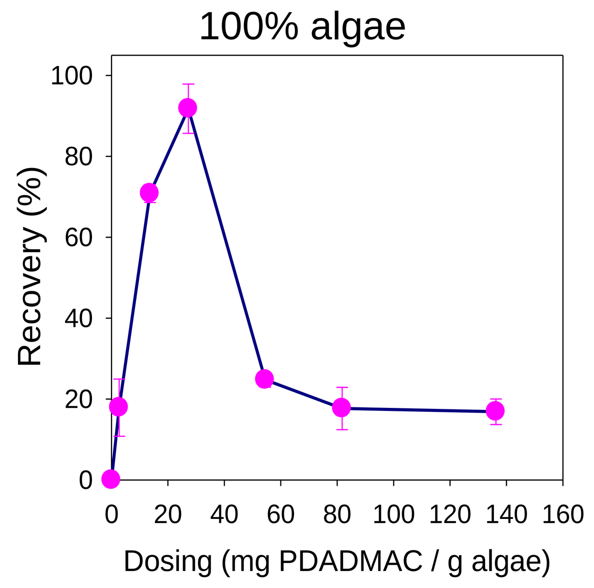
Biogas potential

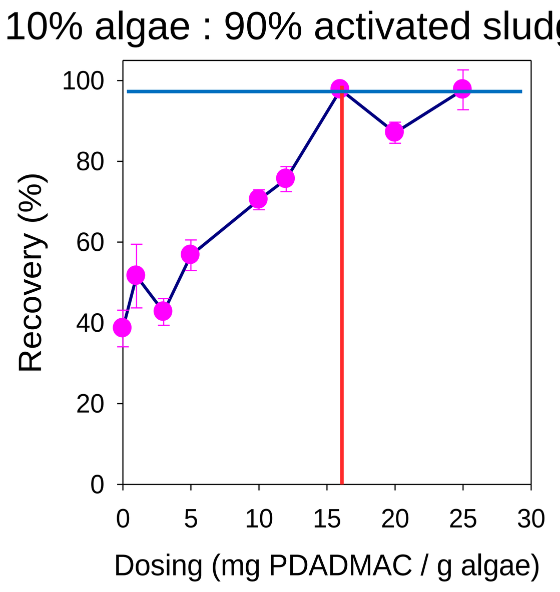
- Mesophilic conditions (37 ºC)
- Digestion scenarios:
  I. Algae
  II. Algae + polymer (20 mg/g algae)
  III. AS alone (aerobic and anaerobic sludge)
  IV. AS_{AE}/AS_{AN} + algae (ratio 10% of algae/AS)
  V. AS_{AE}/AS_{AN} + algae + polymer (ratio 10% of algae/AS, 20 mg polymer/g algae)

4. RESULTS

Effect on microalgal recovery of:

(i) Polymer dosing

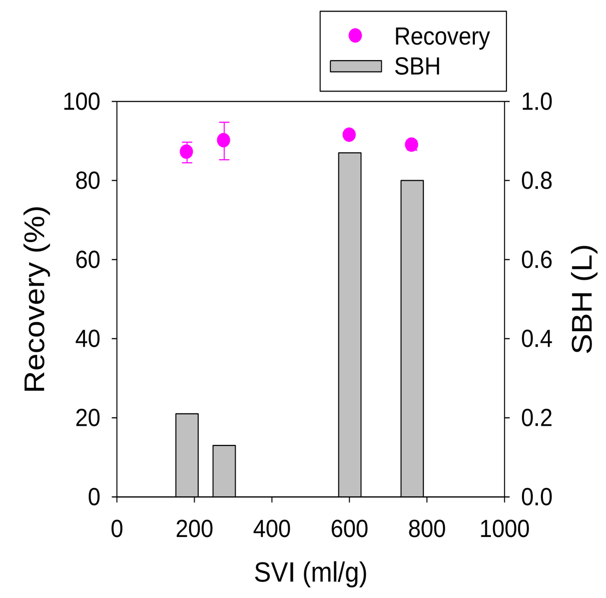




- **27 mg polymer /g algae** dosing results in **92 % recovery**
- **Restabilization** effect results in lower recovery

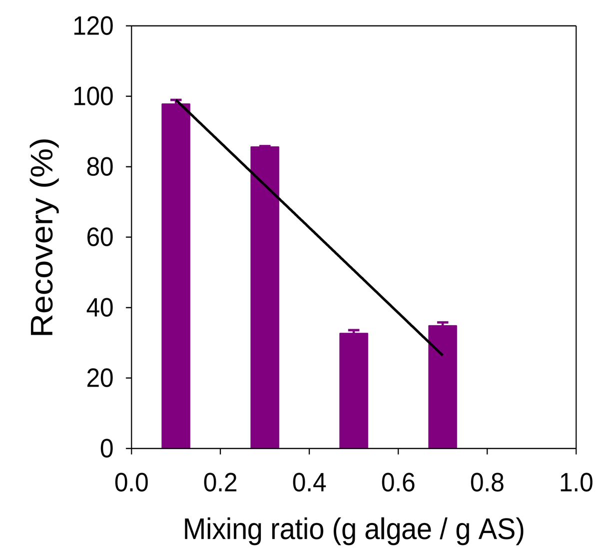
- Microalgal recovery with activated sludge used as flocculant (strategy I) is low (40%) → **we need a coagulation aid** (strategy II)
- **16 mg polymer /g algae** dosing results in **97 % recovery**

(ii) Activated sludge settleability



- **Bulking events** in activated sludge systems cause **poorly settling sludge → The sludge blanket height (SBH) increases**
- The efficiency of the flocculation does not deteriorate, the **microalgal recovery stays sufficient** (>90%)

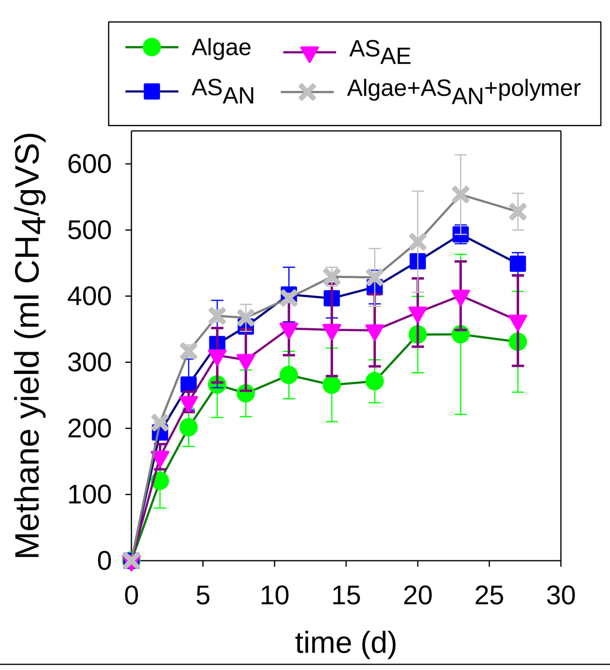
(iii) Mixing ratio

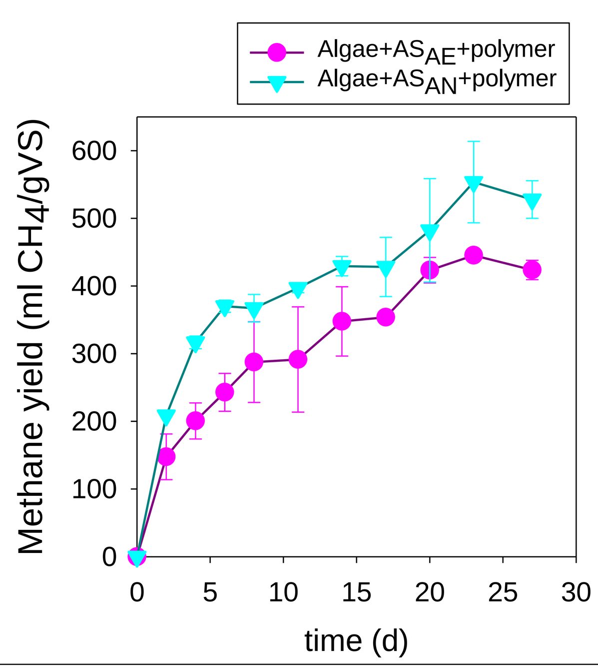


- With **increasing algae /activated** sludge ratios **more polymer dosing** is needed
- **Optimum dosing** should be estimated for the **specific operation conditions** of the process

Energy recovery through biogas production

- **Co-digestion** with AS wasted after the **anaerobic phase** produces significantly **higher** (P<0.05) **methane** than when AS taken after the **aerobic phase** is used → effective preservation of organic carbon via the EBP2R, by the **PHA stored by PAO** in the anaerobic phase → up to **40% of the influent organic carbon is converted into methane**





Sample	Methane yield at day 27 (ml CH_4 /gVS)
Algae	331± 76
AS_{AE}	363± 68
AS_{AN}	449± 17
Algae + AS_{AE}	400± 22
Algae + AS_{AN}	**560± 24**
Algae + poly	341 ± 121
Algae + AS_{AE} + poly	424± 14
Algae + AS_{AN} + poly	**528± 28**

5. CONCLUSION

- An **effective** solution is proposed to harvest the microalgae
- **97%** microalgal biomass **recovery** was reached
- **Poorly settling** sludge did not improve microalgal biomass **recovery**
- **Optimum polymer** dosing should be estimated for **specific operational conditions**
- **Co-digestion** with AS wasted after the **anaerobic phase enhanced** biogas potential
- Up to **40% of the COD was recovered as methane**

ACKNOWLEDGEMENT

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

DTU INWATECH