Bioflocculation of green microalgae using activated sludge and potential for biogas production

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

Publication date: 2016

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

Link back to DTU Orbit

Citation (APA):
Bioflocculation of green microalgal using activated sludge and potential for biogas production

Maria Radovic, Dorotya Sarolta Wagner*, Irini Angelidaki, Borja Valverde-Pérez, Benedek Gy. Plósz

Department of Environmental Engineering, Technical University of Denmark, Miljøvej Building 115, DK-2800, Kgs. Lyngby, Denmark
*e-mail: dosaw@env.dtu.dk

1. INTRODUCTION

New technologies are developed to recover wastewater resources and increase energy yields in form of biogas [1].
- Potential energy recovery using microalga.
- Available harvesting methods are costly and energy intensive [2].

Objectives:
- Developing cost-efficient way of harvesting microalgae via bioflocculation using activated sludge from a short-SRT EBPR system.
- Assess the potential of energy recovery via biogas production from the harvested activated sludge-algal biomass.

2. METHODS

1. Flocculation experiments

Microalgal biomass:
- Mixed green microalgal culture cultivated on effluent wastewater: Chlorella sorokiniana and Scenedesmus sp.

Activated sludge:
- Taken from a short SRT (3.5 d) EBPR system [3]:
  - Solid-liquid separation after the aerobic phase (AS<sub>AE</sub>)
  - Solid-liquid separation after the anaerobic phase (AS<sub>AN</sub>)

Flocculation strategies:
- Strategy I: Flocculation of microalgae and activated sludge

2. Biomethane potential tests

Mesophilic conditions (37°C)
- Digestion scenarios:
  I. Algae
  II. Algae + polymer (20 mg/g algae)
  III. AS<sub>AE</sub>/AS<sub>AN</sub>, alone (activated sludge removed after the aerobic and after the anaerobic phase)
  IV. AS<sub>AE</sub>/AS<sub>AN</sub> + algae (10% ratio of algae:AS)
  V. AS<sub>AE</sub>/AS<sub>AN</sub> + algae + polymer (10% ratio of algae:AS, 20 mg polymerr/g algae)

3. Flocculation

1. Polymer dosing

- 27 mg polymer/g algae dosing results in 92 % microalgal recovery
- Restabilization effect results in lower recovery at high polymer dosages

2. Mixing ratio

Algae + activated sludge + polymer (16 mg/g algae)

3. Activated sludge settleability

- With increasing algae/activated sludge ratios more polymer dosing is required to reach optimal recovery
- Optimum dosing should be estimated for the specific operation conditions of the process

4. Biogas potential and energy recovery

1. Biogas potential of biomass

2. Energy recovery

- Co-digestion of microalgae with activated sludge removed after the anaerobic phase produces significantly higher methane than co-digestion of activated sludge taken after the aerobic phase due to stored PHA by PAO in the anaerobic phase of the EBPR and balanced nutrients due to co-digestion with microalgae

- Effective preservation of organic carbon via the EBPR up to 40% of the influent organic carbon is converted into methane
- Only up to 10% of the incoming COD is lost to the effluent of the EBPR

5. CONCLUSIONS

- An effective solution is proposed to harvest microalgal biomass and to significantly decrease the amount of polymer coagulant required;
- 97% microalgal biomass recovery was reached with 16 mg polymer/g algae
- Poorly settling sludge did not affect microalgal biomass recovery, however, due to bulking the biomass volume was increased;
- Optimum polymer dosing depends on the mixing ratio of algae and activated sludge;
- Co-digestion with biomass taken after the anaerobic phase enhanced biogas potential;
- Up to 40% of the influent COD of the EBPR was recovered as methane;
- Most of the COD was assimilated into biomass or mineralized to CO<sub>2</sub> and only up to 10% is lost in the effluent of the EBPR.