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

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

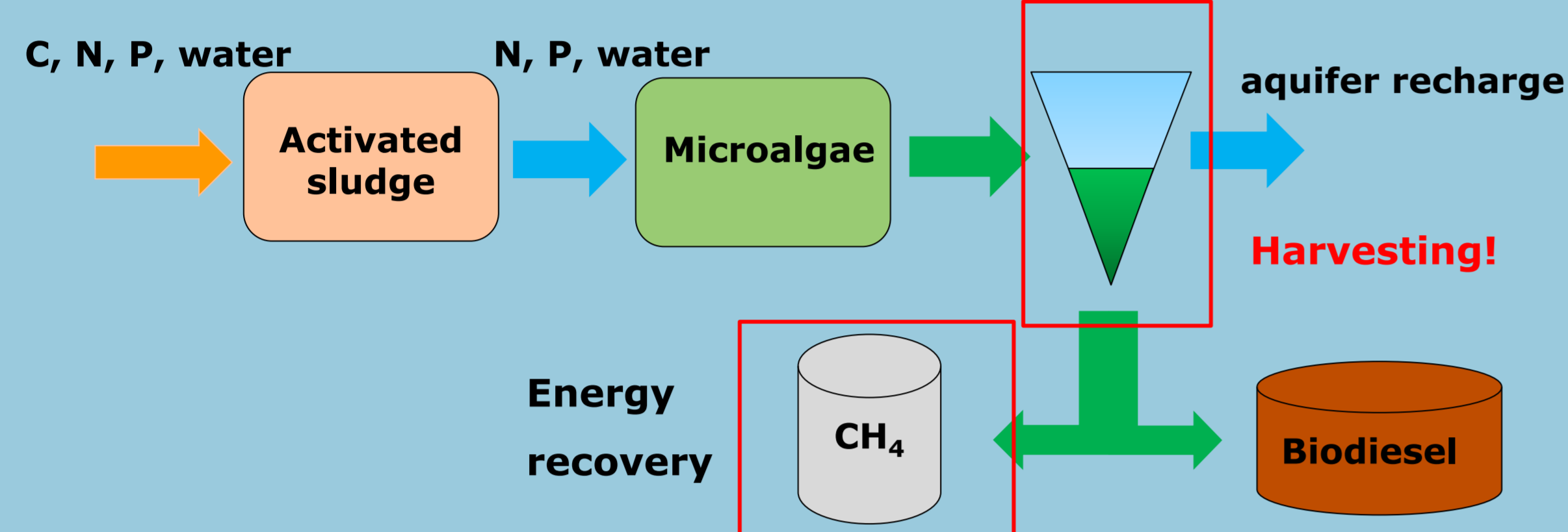
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1. INTRODUCTION

- 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

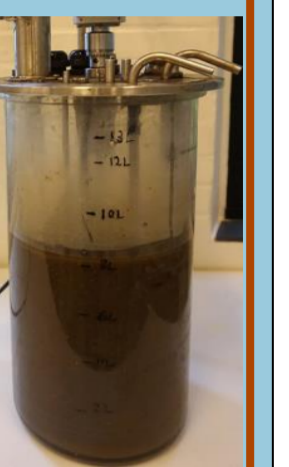
- Cost-efficient** way of harvesting microalgae via **bioflocculation** using wasted activated sludge.
- Assess the **biogas potential** from the harvested activated sludge-algal biomass.

3. MATERIALS AND METHODS

Mixed green microalgal culture cultivated on effluent wastewater:
Chlorella sorokiniana and *Scenedesmus* sp.

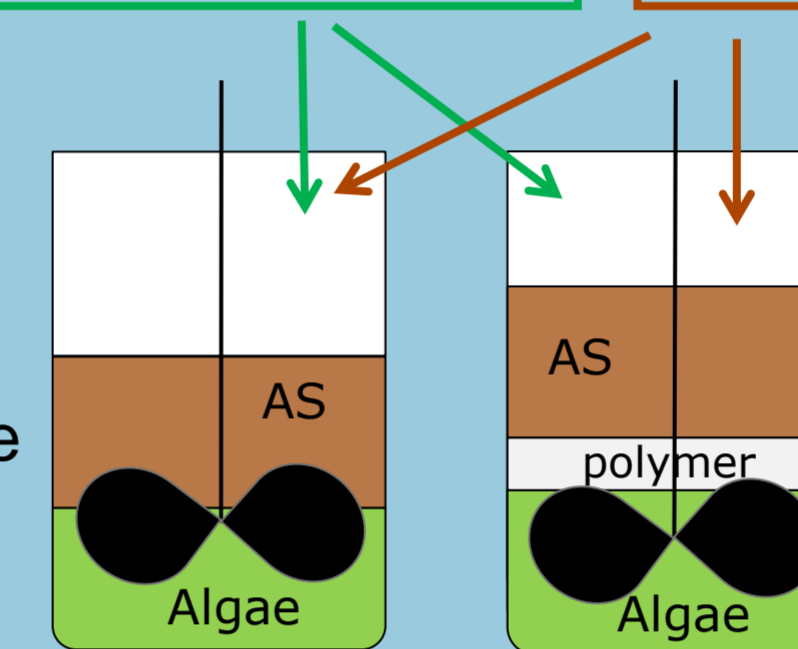


Activated sludge from a short SRT (3.5 d) EBP2R system:
Two wasting strategies:
Solid-liquid separation after the aerobic phase (AS_{AE}) and after the anaerobic phase (AS_{AN})



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

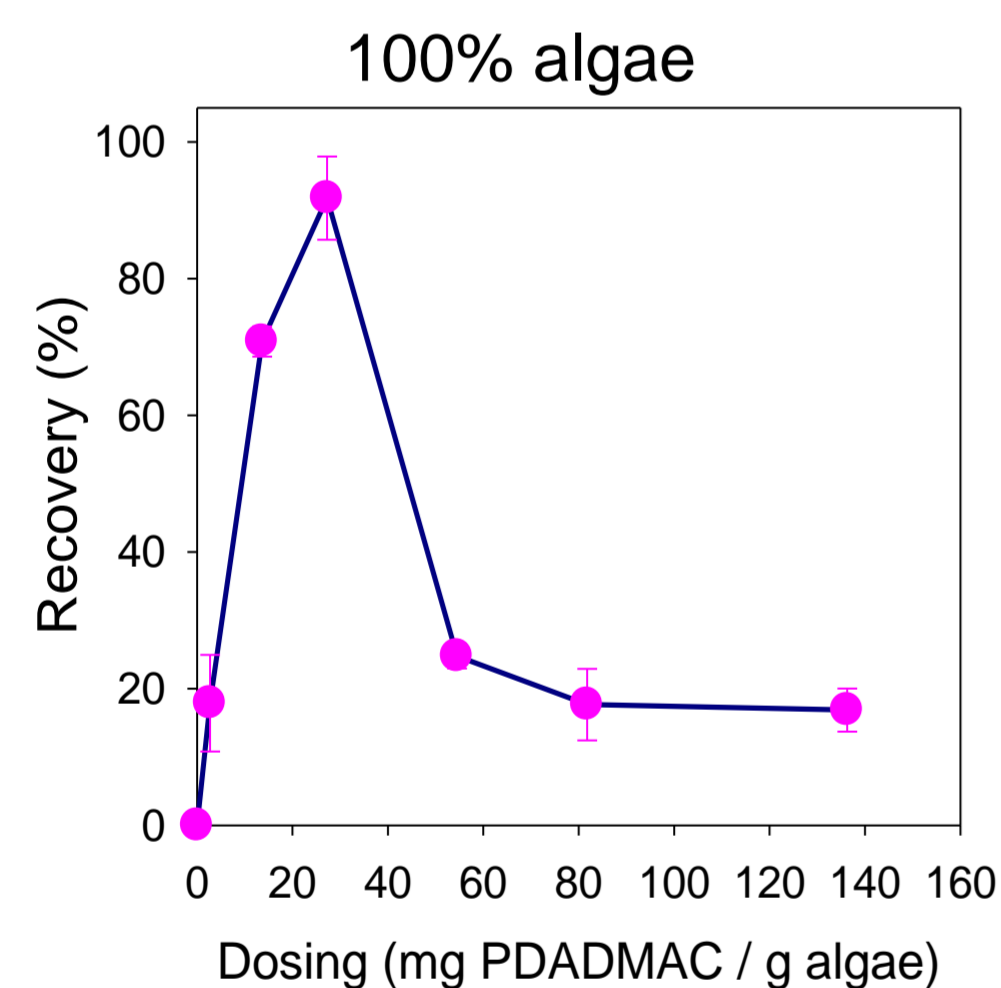
- Mesophilic conditions (37 °C)
- Digestion scenarios:
 - Algae
 - Algae + polymer (20 mg/g algae)
 - AS alone (aerobic and anaerobic sludge)
 - AS_{AE}/AS_{AN} + algae (ratio 10% of algae/AS)
 - AS_{AE}/AS_{AN} + algae + polymer (ratio 10% of algae/AS, 20 mg polymer/g algae)



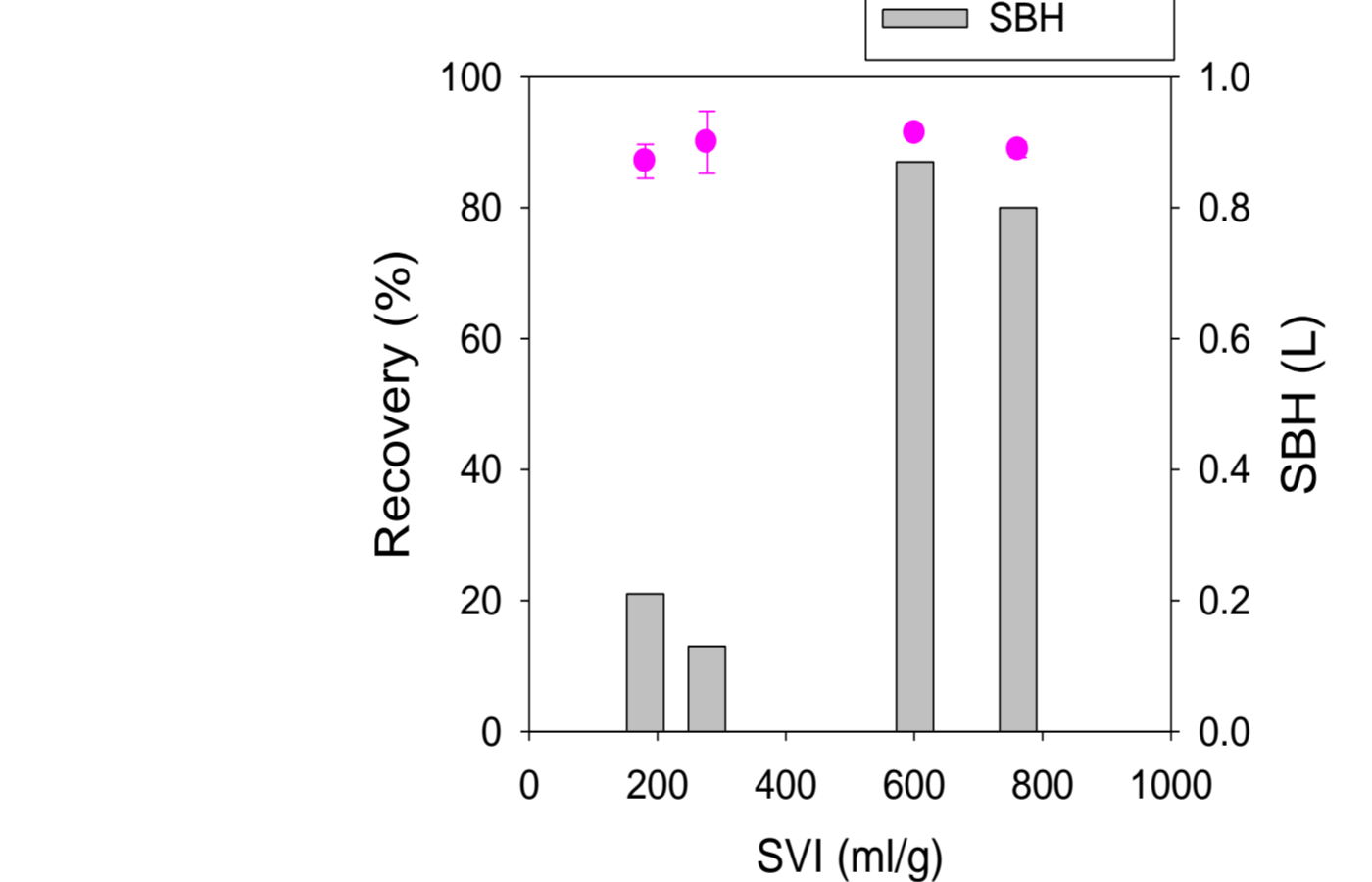
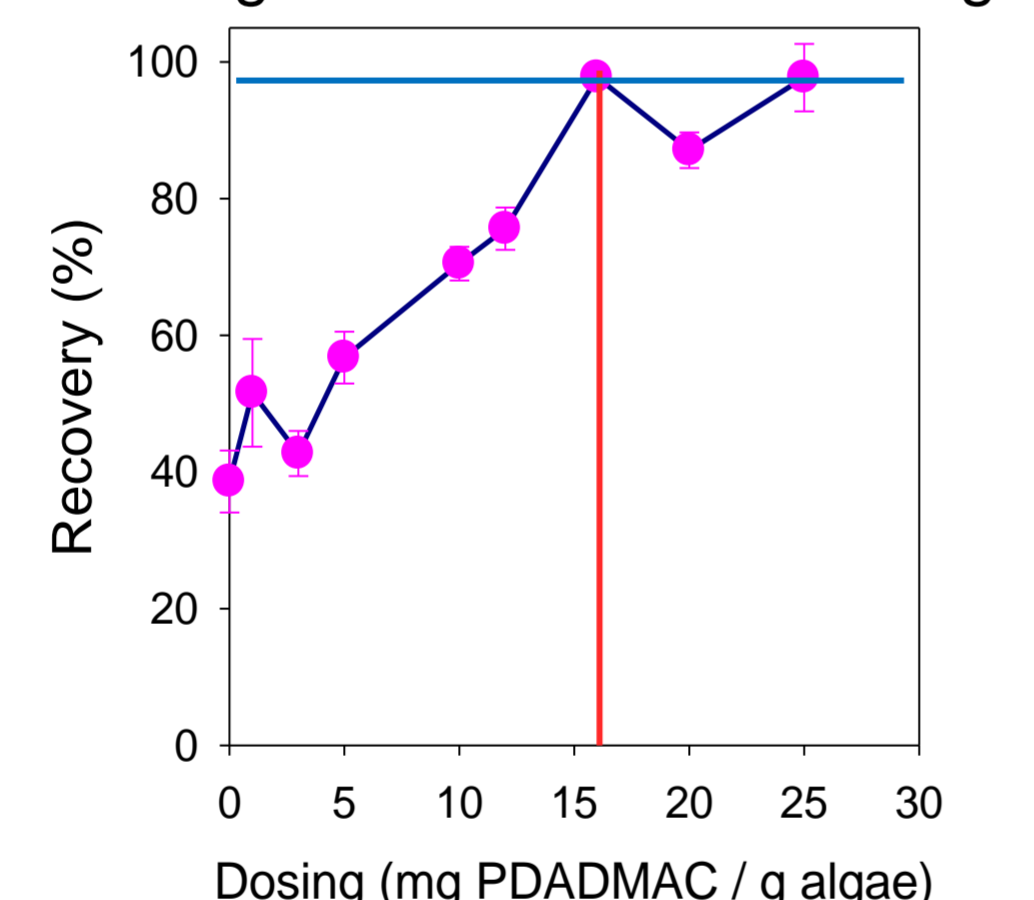
4. RESULTS

Effect on microalgal recovery of:

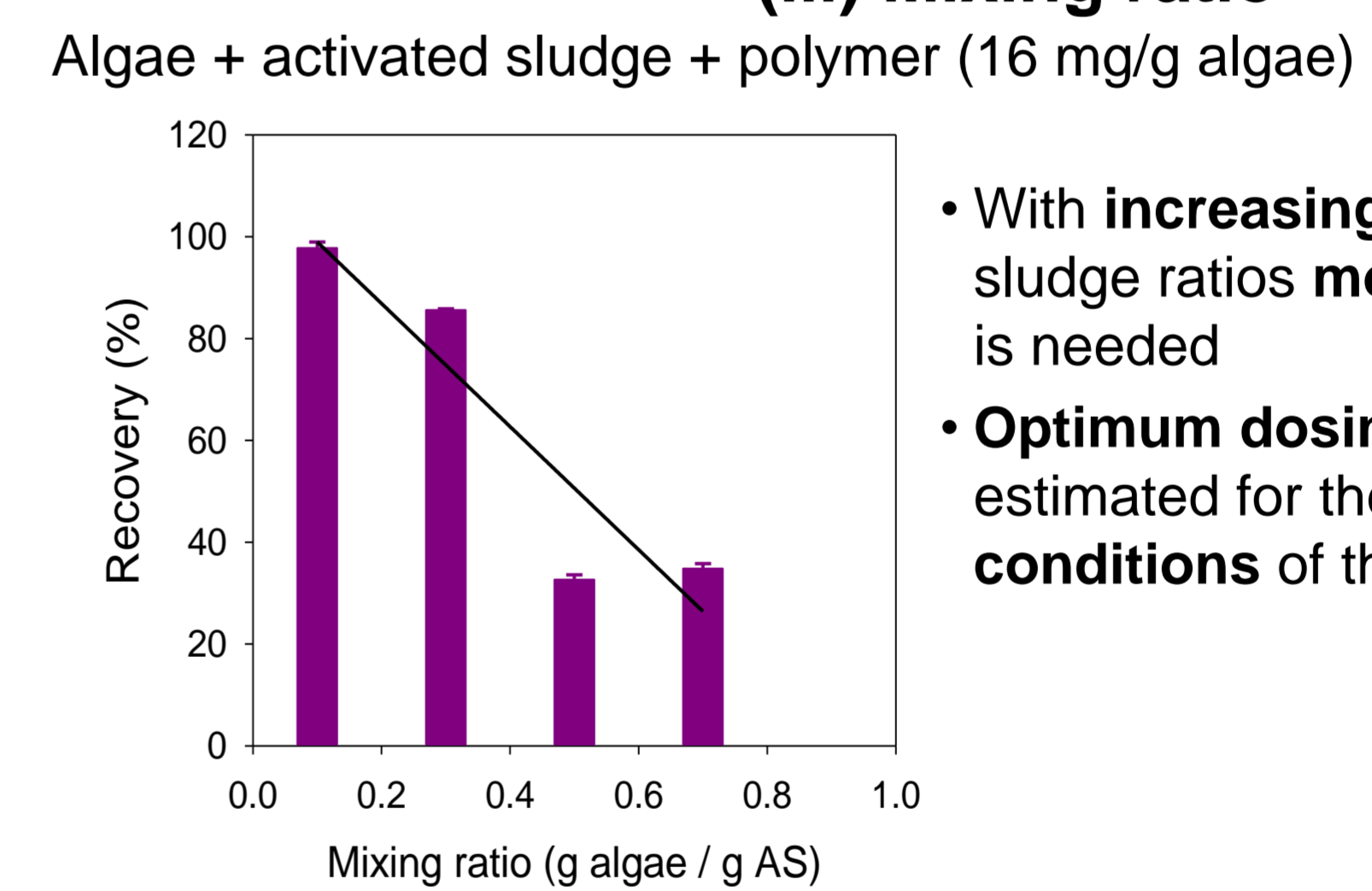
(i) Polymer dosing



(ii) Activated sludge settleability



(iii) Mixing ratio



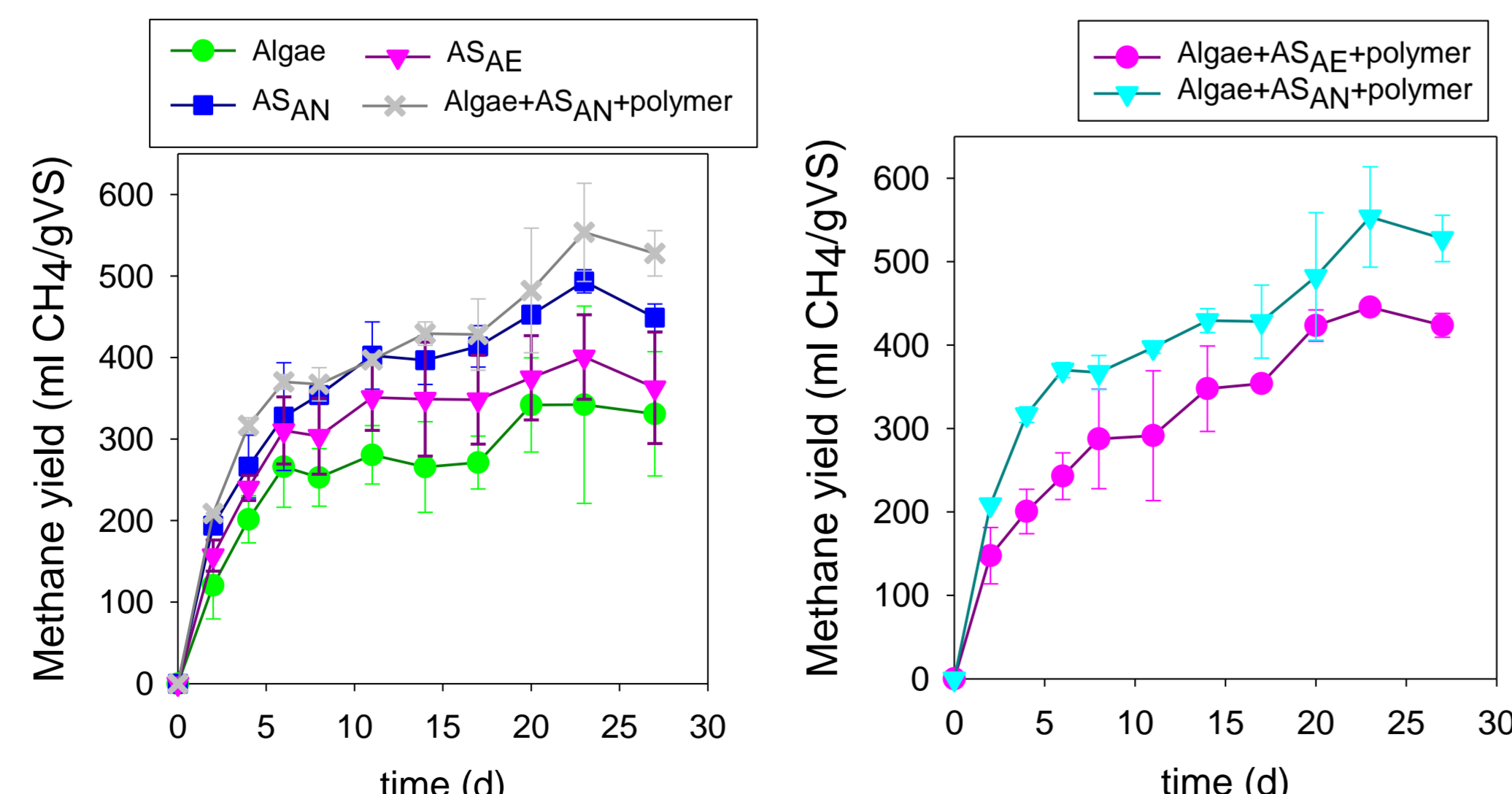
- 27 mg polymer /g algae** dosing results in **92 % recovery**
- Restabilization** effect results in lower recovery
- Microalgal recovery with activated sludge used as flocculant (strategy I) is low (40%) → **we need a coagulation aid** (strategy II)
- 16 mg polymer /g algae** dosing results in **97 % recovery**

- 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%)**

- 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

