Wastewater resource recovery with green microalgae – modelling the microalgal growth, nutrient uptake and storage using ASM-A

Wágner, Dorottya Sarolta; Valverde Perez, Borja; Sæbe, M.; Bregua de la Sotilla, Marta; van Wagenen, Jonathan Myerson; Smets, Barth F.; Plósz, Benedek G.

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Wastewater resource recovery with green microalgae – modelling the microalgal growth, nutrient uptake and storage using ASM-A

Dorottya S. Wágner*, Borja Valverde-Pérez, Mariann Sæbø, Marta Bregua de la Sotilla, Jonathan Van Wagenen, Barth F. Smets and Benedek Gy. Plósz

1. INTRODUCTION

- Conventional wastewater treatment focuses on the destruction of organic chemicals and nutrients.
- Domestic wastewater should be considered as a resource of energy, nutrients and fresh water.
- Potential resource recovery using microalgae.
- Microalgal biomass can be used as a slow leaching fertilizer.
- No further use

2. OBJECTIVES

- Development of a microalgal process model in the ASM framework compatible with activated sludge models
- Identification of biokinetic processes for photoautotrophic and heterotrophic microalgal growth including nutrient uptake and storage

3. MATERIALS AND METHODS

- Mixed green microalgal culture of Chlorella sp. (Sorokiniana) and Scenedesmus sp.
- Targeted experiments in 3 scales:
  - 2 mL microbatch
  - 24 L open airlift PBR
  - 1-L batch

4. RESULTS

Model calibration using descending cycles (cycle 2):

- We calibrate the model for each descending cycle.
- We obtain an average parameter set from the 4 cycles.

Two-step model evaluation to test the following hypothesis:

- What is the influence of culture history and substrate availability on parameter estimates?
- Can we use a default parameter set?
- Can we explain the discrepancy as a result of parameter variability?

- Step 1 – Janus coefficient
  - J<1 calibrated model prediction is good
  - J>1 calibrated model prediction fails

- Step 2 – Monte Carlo simulations
  - On the 4 ascending cycles
  - Using average parameter values estimated from model calibration

The biokinetic processes of ASM-A:

<table>
<thead>
<tr>
<th>Process rates</th>
</tr>
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<tbody>
<tr>
<td>R1 (g N m⁻² d⁻¹)</td>
</tr>
<tr>
<td>R2 (g N m⁻² d⁻¹)</td>
</tr>
<tr>
<td>R3 (g P m⁻² d⁻¹)</td>
</tr>
<tr>
<td>R4 (g COD m⁻² d⁻¹)</td>
</tr>
<tr>
<td>R5 (g COD m⁻² d⁻¹)</td>
</tr>
<tr>
<td>R6 (g COD m⁻² d⁻¹)</td>
</tr>
</tbody>
</table>

The discrepancy between measured and simulated data is explained by parameter variability for algal biomass, ammonia and phosphate concentrations and the phosphorous storage.

- The prediction of internal nitrogen quota is influenced by the substrate availability.
- The prediction of soluble nitrate is compromised by the culture history.

5. CONCLUSION

- A novel process model in the ASM framework for predicting algal behavior in PBR has been identified, calibrated and critically evaluated.
- Different scale lab experiments have been used to estimate different parameter sets
- The model can predict algal biomass, ammonia, phosphate and internal PP quota using a mean parameter set
- The prediction of internal nitrogen quota is influenced by the substrate availability and the soluble nitrate is compromised by the culture history

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