A Green Micro-Algal Growth Model developed in the Activated Sludge Modeling Framework

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- Tertiary treatment step for nutrient removal
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- Open pond reactors
- Closed photobioreactors (e.g., flat panel reactors)

Algal biomass applications:
- Direct use for biofuel production (e.g., biodiesel or biogas)
- Biofertilizer (the indirect use for biofuel production)
- High value products (e.g., pigments)

**1. INTRODUCTION**

Microalgae photobioreactors can be used for wastewater treatment as:
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**2. OBJECTIVES**

- Development of a process model for the photobioreactor in the Activated Sludge Modelling (ASM) framework:
  - Connecting conventional wastewater treatment plants with photobioreactors
  - Simulation of the micro-algal uptake, storage and growth on phosphorus and nitrogen

- Parameter estimation through targeted experiments:
  - Micro-batch experiments
  - Assessment of the growth rate under different light intensities
  - Batch experiments
  - Assessment of the growth and nutrients uptake under limitation by different macronutrients (N, P)

**3. MATERIALS AND METHODS**

- Microorganisms: mixed green microalgal culture of Chlorella sp. and Scenedesmus sp.
- Culturing of microalgae:
  - MWC-Se growth medium
  - Constant temperature (20°C)

- Algal biomass applications:
  - Algal biomass; B) Nitrate in the bulk liquid; and C) Nitrogen internal quota.

**4. RESULTS**

Simulation results with the calibrated model compared with an independent measured dataset:

**Process rates**

\[
R1 \left[ \text{g N m}^{-2} \text{d}^{-1} \right] = k_{R1} \frac{S_{NH4}}{S_{NH4} + K_{NH4}} \frac{X_{alg,PP}}{X_{alg,N}} (X_{alg,PP} - X_{alg,N}) \\
R2 \left[ \text{g N m}^{-2} \text{d}^{-1} \right] = k_{R2} \frac{S_{PO4}}{S_{PO4} + K_{PO4}} \frac{X_{alg,PP}}{X_{alg,N}} (X_{alg,PP} - X_{alg,N}) \\
R3 \left[ \text{g P m}^{-2} \text{d}^{-1} \right] = k_{R3} \frac{S_{PO4}}{S_{PO4} + K_{PO4}} \frac{X_{alg,PP}}{X_{alg,N}} (X_{alg,PP} - X_{alg,N}) \\
R4 \left[ \text{g COD m}^{-3} \text{d}^{-1} \right] = k_{R4} \frac{S_{COD}}{S_{COD} + K_{COD}} \frac{S_{alg}}{S_{alg} + K_{alg}} \\
R5 \left[ \text{g COD m}^{-3} \text{d}^{-1} \right] = k_{R5} \frac{S_{COD}}{S_{COD} + K_{COD}} \frac{S_{alg}}{S_{alg} + K_{alg}} \frac{S_{PO4}}{S_{PO4} + K_{PO4}} \frac{X_{alg,PP}}{X_{alg,N}} (X_{alg,PP} - X_{alg,N}) \\
R6 \left[ \text{g COD m}^{-3} \text{d}^{-1} \right] = k_{R6} \frac{S_{COD}}{S_{COD} + K_{COD}} \frac{S_{alg}}{S_{alg} + K_{alg}} \frac{S_{PO4}}{S_{PO4} + K_{PO4}} \frac{X_{alg,PP}}{X_{alg,N}} (X_{alg,PP} - X_{alg,N})
\]

**5. CONCLUSION**

- A process model for green micro-algal growth has been identified and developed using the systematic approach of the activated sludge models.
- The model accurately describes the micro-algal growth under constant light intensities.

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