Microalgae and cyanobacteria modeling in water resource recovery facilities: A critical review

Microalgal and cyanobacterial resource recovery systems could significantly advance nutrient recovery from wastewater by achieving effluent nitrogen (N) and phosphorus (P) levels below the current limit of technology. The successful implementation of phytoplankton, however, requires the formulation of process models that balance fidelity and simplicity to accurately simulate dynamic performance in response to environmental conditions. This work synthesizes the range of model structures that have been leveraged for algae and cyanobacteria modeling and core model features that are required to enable reliable process modeling in the context of water resource recovery facilities. Results from an extensive literature review of over 300 published phytoplankton models are presented, with particular attention to similarities with and differences from existing strategies to model chemotrophic wastewater treatment processes (e.g., via the Activated Sludge Models, ASMs). Building on published process models, the core requirements of a model structure for algal and cyanobacterial processes are presented, including detailed recommendations for the prediction of growth (under phototrophic, heterotrophic, and mixotrophic conditions), nutrient uptake, carbon uptake and storage, and respiration.

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