

Analytical and Data-driven Models to Predict Algae Biofilm Growth in Water Treatment

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Harmful algal blooms (HABs) are a growing public health concern both nation and worldwide. Last year there were 25 major sites of HABs in the state of Utah alone. These blooms are caused in part by excess nutrients (nitrogen and phosphorus) being discharged from wastewater treatment plants (WWTPs). To combat the growing prevalence of HABs the state of Utah is imposing new nitrogen and phosphorus effluent standards for WWTPs. Utah State University is working in collaboration with Central Valley Water Reclamation Facility (CVWRF), the largest municipal WWTP in the state of Utah treating 60 million gallons per day, and WesTech Engineering-Inc. to develop a novel biological process to help WWTPs meet these new standards. This process is the rotating algae biofilm reactor (RABR) that removes nutrients from wastewater by producing algae biomass that can be used in bioproduct production. The RABR consists of disks rotating through a growth substrate (wastewater) to produce an attached growth biofilm and remove nutrients from the substrate. This biofilm can be mechanically harvested and converted into value-added bioproducts including biofuels, bioplastics, animal feed, and fertilizers. Extensive research has been conducted on the RABR at laboratory and pilot scales, but in preparation for scale-up and industrial applications a mathematical model describing the system must be developed. Due to high concentrations of nitrogen and phosphorus in the growth substrate and high summertime light intensity, the system is often light inhibited. An analytical model has been adapted from work performed by Bara and Bonneford that describes light limited algae growth. This model will be augmented using sparse identification of nonlinear dynamics (SINDy), a data-driven approach allowing for the identification and development of important growth terms, on data previously collected from the RABR at laboratory and pilot scales along with data currently being collected.

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