Microalgae Production in an Open-Raceway-Pond: Analyzing the Paddle Wheel Velocity Effect on the L/D Frequency

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Microalgae have received much attention as potential feedstock for the third-generation biofuel. Considering the scale of production needed and the economics associated, an open-raceway-pond cultivation system is likely to be the choice for the commercial production. Hence, a model that can be used to determine an optimal balance between biomass production and operating cost can be highly valuable on the way to a successful commercialization of microalgal biofuel.

In this study, we consider light as one of the dominant factors for the biomass production. Even though light is imperative for microalgae to grow, if exposed for too long, microalgae can go into a photo-inhibited state, resulting in a reduced biomass production. Hence, the length of exposure is a crucial parameter for the biomass production. An integrated model is constructed by combining the Droop model to describe the biomass production and the Han model to illustrate the physiological property of microalgae with respect to light. The effect of light on the biomass production is observed through mixing. Two simulations are conducted: With mixing and without. From the simulations, it is seen that 1.5 times higher biomass production is achieved by applying mixing. To link the effect of light to a raceway pond velocity varied by mixing, a term called ‘Light/Dark frequency (L/D frequency)’ that describes a dynamic pattern of light is designated. It is postulated that higher biomass production can be reached because the velocity and the L/D frequency are directly proportional, however, beyond a certain velocity region (above 0.3m/sec), the effect of velocity becomes insignificant to the biomass production. As the pumping accounts for a major portion of the operation cost, by connecting these results with power consumption, the optimal mixing condition for the biomass production can be found.

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