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PREDICTIVE MODEL FOR MICROALGAE GROWTH IN CONTINUOUS CULTURE TUBULAR PHOTOBIOREACTOR: EFFECT OF LIGHT AND TEMPERATURE

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ABSTRACT

This paper aims to develop a theoretical model for growth of microalgae *Chlorella pyrenoidosa* in a tubular photobioreactor combining the effect of photo-limitation, culture temperature and flow velocity. The objective is to estimate the effect of these parameters on total biomass production in a tubular photobioreactor. The motivation of this study rests on the fact that maximum growth of microalgae can only be obtained by keeping the optimal growth conditions in the photobioreactor. Hence, a predictive theoretical model could prove useful for (a) optimizing the growth condition, and/or (b) development of an efficient controlling unit for maintaining optimal conditions. In this paper, a systematic approach is adopted to (a) estimate the light intensity distribution in the photobioreactor, (b) evaluate the temperature distribution, and (c) determine the growth of microalgae due to rise in temperature and absorbed light. The distribution of light intensity in the photobioreactor was determined using the radiative transfer equation in participating medium. Next, the temperature distribution within the photobioreactor was determined using the energy conservation equation that assumes absorbed light energy and cellular metabolism as a source. Lastly, the cellular growth was estimated by coupling the temperature and light intensity in a growth equation, namely Monod equation. The results revealed maximum and minimum growth of microalgae at the periphery and at the center of the tube, respectively. Additionally, the rise in temperature above optimal value led to substantial reduction in biomass production. In fact, four degree increase in water bath temperature led to 39 % reduction in biomass production. It was further noted that the flow velocity has insignificant effect on the total biomass production in comparison to the photo-limitation and culture temperature.

Keywords ─ Tubular photobioreactor, Microalgae, Radiative transfer equation, Specific growth rate, Biological heat transfer