Modelling, Control, and Optimization of Microalgae Production in Photobioreactors

Microalgal-based technology is becoming an emerging and powerful solution for different industrial applications. They can be used to produce high value-added compounds, such as antioxidants, polyunsaturated fatty acids, cosmetics, pharmaceuticals, etc., to produce biomass or bio-diesel, or even to be used in the wastewater treatment process.

Microalgae culture can be cultivated in different type of photobioreactors depending on the final application. For instance, when high-value algal biomass is required, closed photobioreactors, and particularly, tubular photobioreactors, are normally used. On the other hand, when the production volume is most important than the quality, open photobioreactors are employed.

The microalgae production process is a very complex system, where the photosynthesis rate depends on solar irradiance and many other variables, such pH, dissolved oxygen (OD), or medium temperature. In most of the industrial photobioreactors, light requirements and operating temperature cannot be manipulated during normal operation and are determined by the reactor architecture. The rest of the variables should be handled using proper control techniques, especially for the pH and DO. These two variables need to be kept close to their optimal values and depend strongly on the photosynthesis rate.

This course deals with the analysis, study and application of modeling and control strategies for the optimization of the microalgae process production in large scale industrial photobioreactors. The proposed solutions try to achieve optimal work conditions that allow an efficient optimal growth of microalgae to be used for different purposes (cosmetic, human food, fish food and/or the wastewater treatment), trying to achieve an appropriate balance between the energy required for such a process, the injection of CO_2 for the maximization of microalgae production, and the recovery of costs through the resulting products.

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