Simulation of Continuous Bio-Reactor

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Abstract

Dynamic study of bioprocess system plays a central role in bioprocess control. It is in fact on the basis of the time required for the development of the knowledge process that the total design, analysis and implementation of monitoring and control methods are carried out. Within the framework of bioprocesses, the most natural way to determine the models that will enable the characterization of the process dynamics is to consider the material balance of major components of the process. This article will present simulation results of continuous bio-reactor. The mathematical models for the bio-reactor based on the material balance had been derived (Riggs and Karim, 2006) and would be adopted in this study. Those model were solved and simulated using Matlab. It is found that the dynamic responses of the bio-reactor due to a step change in feedrate are first order.

Key words: Simulation, bio-reactor, biochemical, fermentation

Introduction

Microbial fermentation is a process in which a population of micro-organisms are grown using certain nutrients under favorable surrounding conditions (temperature, pH, agitation, aeration, etc). It schematically corresponds to the transformation of substances (generally carbonaceous substrates) into products, resulting from metabolic activities of cells.

The main components of the reaction are as follows (Dochain, 2008):
- Substrates, denoted as $S_i$, which are necessary for the growth of micro-organisms, or even which are precursors of a compound to be produced. These substrates generally contain a source of carbon (glucose, ethanol, etc) and sometimes nitrogen ($\text{NO}_3$, $\text{NH}_4$, etc.) and phosphorus ($\text{PO}_4$, etc).
- Microbial biomasses, denoted as $x_i$.
- End products, denoted as $P_i$, for agri-foods (oils, cheese, beer, wines, etc), chemistry (solvents, enzymes, amino acids, etc), the pharmaceutical industry (antibiotics, hormones, vitamins, etc) or for the production of energy (bio-ethanol, biogas, etc.).

Bio-ethanol, as a clean and renewable fuel, is gaining increasing attention, mostly through its major environmental benefits. It can be produced from different kinds of renewable feedstock such as e.g. sugar cane, corn, wheat, cassava (first generation), cellulose biomass (second generation) and algal biomass (third generation). Sanchez and Cardona (2008) described the biotechnological production of bio-ethanol from different feedstocks. The agro-industrial wastes had been explored for their feasibility as culture media for the production of bioethanol (Bocanegra et al, 2015; Balat, 2011).

Previous research include kinetic study of batch ethanol production from sugar beet raw juice (Dodic at al, 2012). Continuous bio-reactors based on a CSTR are not commonly used in biotechnology industry although they are good candidates for the production of high volume products, such as, bioethanol. The design and development of continuous