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Steady State and Dynamic of Gluconic Acid Production by *Aspergillus Niger*

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Abstract: Batch and continuous fermentation of gluconic acid production has been studied. The kinetic parameters of the fermentation process were determined from the batch experimental data. The continuous fermentation was modeled to be carried out in a stirred tank reactor. The effect of hydraulic retention time on the steady state continuous fermentation process of glucose by *Aspergillus niger* to produce gluconic acid was investigated. The result showed that increasing the hydraulic retention time caused the cell amount and gluconic acid concentration at the outlet stream increased but the glucose concentration at the outlet stream decreased. The steady state simulation result was useful for fermenter size determination. Dynamic behaviour of gluconic acid production through fermentation by *Aspergillus niger* was also studied for a fermenter with 24 h hydraulic retention time. Applying step change of inlet substrate concentration resulted in first order response of cell, substrate and product concentration with all having positive gain. On the other hand, applying step change of inlet cell concentration has resulted in positive gain for cell and product concentration and negative gain for substrate concentration with first order response for all those three parameters.

Key words: Gluconic acid, continuous fermentation, modeling, dynamic, *Aspergillus niger.*

1. Introduction

D-Gluconic acid is one isomer of 2,3,4,5,6-pentahydroxyhexanoic acid. It is a noncorrosive, nonvolatile, nontoxic, mild organic acid [1]. It has many applications. These include chemical, pharmaceutical, food, textile, and animal feed [2, 3]. Gluconic acid salts (calcium and iron) have been used in the formulation of health supplement. In the food industry, gluconic acid is used as acidulant. Gluconic acid and its sodium salt is also used to clean aluminium can, prevent milkstone in dairy industry, and wash glass bottle [1].

Fermentation process has many advantages for producing D-gluconic acid because it is low cost, has mild reaction conditions, and can use renewable resources for the raw material. Microbial species such as *Aspergillus niger*, and *Gluconobacter oxydans* have been utilized in many researches to produce gluconic acid by fermentation. Biotransformation of glucose to free gluconic acid using *Gluconobacter oxydans* has been investigated which included the fermentation kinetic. It was reported that the glucose substrate and gluconic acid inhibited the cell growth [4].

The design and operation of a fermenter needs the understanding of complex biological reactions. This requires mathematical modeling to describe the process more simply but still represent the process quite well. Fermentation kinetic data are absolutely needed in developing the mathematical model which is necessary for the design, scale-up, optimal control and economic analysis of fermentation process. Theses models may lead to the development strategies for the fermentation optimization to ensure its economic viability. There have some researches regarding the gluconic acid production through fermentation. Liu et al. proposed mathematical model for gluconic acid fermentation by *Aspergillus niger* and reported that the model could

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