CURRENT RESEARCH AND DEVELOPMENT IN BIOTECHNOLOGY ENGINEERING AT IIUM

VOLUME III

Editors:

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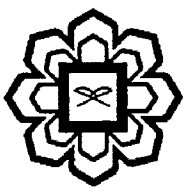

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CHAPTER 23

DIFFUSION-REACTION OF SUBSTRATE IN IMMOBILIZED SLAB BIOCATALYST FOR MICHAELIS-MENTEN KINETICS

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ABSTRACT

The mass transfer effect on the overall reaction rate in a biocatalyst with a slab geometry containing an immobilized enzyme or cells has been investigated theoretically; Michaelis-Menten kinetics was studied. Numerical solution is used to solve the diffusion-reaction problem for Michaelis-Menten kinetics. The numerical scheme used was shooting method employing Runge-Kutta fourth order method for the solution of system of ODE-IVP. The numerical solution was validated by comparing with the exact solutions for the zero and first order reactions. A third order polynomial solution to the differential equation is also proposed. The approximate solution shows close agreement with the numerical solution within the range of parameters of practical significance. The concentration profiles within the catalyst slab were obtained as a function of Thiele modulus which in turn was used to evaluate effectiveness factor.

Keywords: Immobilized Biocatalyst, Effectiveness Factor, Michaelis-Menten Kinetics, Approximate Solution, Slab Geometry.

INTRODUCTION

The investigation on the reaction involving solid (e.g., immobilized enzyme/cell) and liquid (reactants) phases are important in bio-processing to provide a better insight into the function of certain biological membrane (Bischoff, 1965). In obtaining more economical biocatalyst, the biocatalyst is set to have continuous operation and significant yield enhancement. This can be achieved by entrapping the enzymes or cells into a porous artificial support making the repeated use of the biocatalyst (Doran, 1995). This artificial support is also known as immobilized biocatalyst. In most of biological reactions there is no large temperature gradient thus the rate of reaction depends on the mass transfer outside or within the solid catalyst due to the concentration difference of the substrate. Normally convection is been neglected due the small size of the pores. This assumption helps in simplifying the overall model equation (Doran, 1995).

With already much work has been done in immobilized biocatalyst with spherical geometry, here slab geometry is chosen since it can be used with reasonable accuracy to approximate a sphere in the limit of very small thickness of the immobilized layer of enzymes/cells relative to the large radius of sphere. The problem is also coupled with