CURRENT RESEARCH AND DEVELOPMENT IN BIOTECHNOLOGY ENGINEERING AT IIUM

VOLUME III

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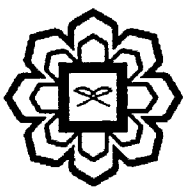

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CONTENTS

CHAPTER 22

DIFFUSION-REACTION OF SUBSTRATE IN CYLINDRICAL IMMOBILIZED BIO-CATALYST

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ABSTRACT

The mass transfer effect on the overall reaction rate in a cylindrical immobilized biocatalyst has been investigated theoretically. Zero order and first order kinetics were taken into consideration. The mass balance for the substrate on a cylindrical shaped biocatalyst results into an ordinary differential equation (ODE) which can be solved numerically and/or analytically using appropriate boundary conditions. Detailed steps for analytical solutions are presented for zero and first order kinetics. The differential equation for zero and first order kinetics was changed into a dimensionless form by defining suitable dimensionless variables. The concentration profiles inside the porous biocatalyst were obtained as a function of Thiele modulus.

Keywords: Immobilized Biocatalyst, Effectiveness Factor, Heterogeneous Reaction, Thiele Modulus, Cylindrical Geometry.

INTRODUCTION

In order to make a biocatalyst cost effective, long-term continuous operation and high yield enhancement is desirable, and the biocatalyst needs to be repeatedly used. This can be achieved by immobilizing technique where the enzymes or cells are entrapped in a porous artificial support known as immobilized biocatalyst (Doran, 1995). The product and reactants are allowed to diffuse in and out of the porous biocatalyst. This mass transfer has a direct effect on the reaction rate because the reaction in the porous part of the immobilized bio-catalyst only occurs after the substrate is transported into the reaction site. However, this argument is only true if the reaction rate is too high for the mass transfer to supply enough reactants to the reaction site making the reaction to be dependent on the availability of the substrate.

The kinetics behaviour of the immobilized biocatalyst is studied to provide a better understanding on the function of the certain biological membrane (Young and Kobayashi, 1972). The biological system in the porous biocatalyst can be described mathematically in term of ordinary differential equation having a set of boundary conditions. The general reactions kinetic in biological systems are zero order, first order and Michaelis-Menten kinetics. Zero and first order problems can be solved analytically, which is not the case for