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Amino Acids
& Derivatives

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# IMMOBILIZED ENZYMES: TECHNIQUES AND APPLICATIONS

*J. David Rozzell*

## CONTENTS

## 13.1 INTRODUCTION

Immobilized enzymes have captured the interest of biotechnologists since the 1950s, but it was with the work by Katchalski-Katzir and Chibata and co-workers in the 1960s that research activities in this area began to accelerate, culminating in the First Enzyme Engineering Conference in 1971. Significant efforts towards improved immobilized-enzyme preparations continue today as new uses emerge. The first industrial application of enzymes in immobilized form was for amino acid production, as reported by Chibata and co-workers at Tanabe Seiyaku in Japan in 1969 [1]. This group immobilized L-aminoacylase for use in a packed-bed reactor in the resolution of various DL-amino acids into their corresponding optically pure enantiomeric forms. Since that time, enzymes in immobilized form have become increasingly important as catalysts for the production of amino acids, as well as numerous other substances.

By way of definition, immobilized-enzyme biocatalysts consist of the enzyme, in varying degrees of purity, attached to or otherwise retained by a support matrix. At one extreme, intact dead cells (which are effectively bags of enzymes) may be bound to a support for use as a catalyst; at the other extreme, partially purified or purified forms of the enzyme(s) of interest may be immobilized. Driving the development of this technology is the fact that the immobilization of an enzyme can improve the economics of its application, improve the quality of the product produced, or both. By changing from batch to continuous operation, one can often significantly reduce the economics of an enzyme-catalyzed reaction. Other advantages, such as improved control of the reaction, leading to better uniformity of the product and greater ease of product recovery, are also often achieved through the immobilization of an enzyme.

In assessing the economics of a process using a biological catalyst (enzyme), the critical issue is not the cost of the biocatalyst itself but rather the contribution of the biocatalyst to the cost of the final product. Biocatalyst costs themselves depend on various components, including enzyme or cell production, support matrix, auxiliary reagents, and the loss of activity associated with immobilization. However, the important factors which determine the cost contribution of the biocatalyst are the yield of product, the volumetric productivity achieved in the process, the product concentration attained, and the useful lifetime of the biocatalyst under operational conditions. This chapter will survey immobilization methods, with special attention being paid to those which have been found useful in amino-acid production. The methods discussed here are not meant to be exhaustive but rather illustrative of what has been developed.

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