

Adsorptive bubble separation method in the recovery of a biomolecule

Sourav Poddar,^{a,b*} Jasmina Khanam^{c*} and Prasenjit Pradhan^c

Abstract

The present work aims to separate an amino acid (*L*-phenylalanine) from a highly dilute aqueous solution by the 'adsorptive bubble separation method'. Separation is based on the principle of adsorption at the interphase of the gas bubble and aqueous phase and subsequent amino acid extraction in the top layered nonaqueous phase. The operation was carried out in a long glass column with a comprehensive solvent chamber at the top. Design-Expert software optimizes the process parameters, and the process involves three variables: gas (nitrogen) flow rate, extractant, and solvent quantity, which control responses, recovery percentage, and the ratio of enrichment. The design models are found to be significant. The maximum recovery of amino acid observed was 75.545% and the value of the enrichment ratio was 3.87. In addition, two models were generated by the software, which was statistically significant ($P < 0.05$). Therefore, this process is adopted as it is of straightforward construction, eco-friendly, and less costly than other methods previously known to recover *L*-phenylalanine from a dilute solution. © 2022 Society of Chemical Industry (SCI).

Keywords: adsorptive bubble separation method; optimization; *L*-phenylalanine; recovery % (RP%); enrichment ratio (ER)

INTRODUCTION

The importance of amino acids is well recognized nowadays, owing to their application in many industrial processes, particularly in the food, pharmaceutical, and cosmetic industries. Such biomolecules are generally produced through the enzymatic method and microbial fermentation, especially by metabolically engineered strains of *Escherichia coli* and *Corynebacterium glutamicum*, which have a high growth rate and well-defined physiological characteristics.^{1–3}

These biomolecules are harvested from a bulk fermentation broth after the completion of the production process, by following a series of steps in downstream processing, which is a significant part and determinant of the cost factor in modern biotechnology. The product is recovered from the supernatant aqueous medium after the removal of microorganisms by various methods: precipitation, crystallization, chromatographic separation, and electrodialysis. The recovery process of small biomolecules produced in fermenter broth must be chosen based on some considerations such as the load of the compound in the aqueous medium, properties of the compound, and operational cost (energy, material). After the bulk separation, however, about 0.5–1.5% of the residual product remains in the waste solution, and it is often found to be very expensive to recover residual product or treat wastewater.⁴ It may be retrieved using ion-exchange/solvent-impregnated resins, which is costly. Cost becomes a major factor when a process handles a large quantity of material. Therefore, there is a commercial interest in finding cost-effective methods (e.g., solvent sublimation method) that can separate smaller biomolecules from fermentation wastewater.^{5,6}

Each bioseparation process involves a series of steps that bring about enhanced product cost owing to product loss. Reducing the number of steps in the separation operation is desirable because of the low product yield and product loss associated with

serial steps. Developing techniques that reduce the number of steps is gaining popularity to increase yield and minimize the complexity of downstream processing. The membrane separation process, and chromatographic, crystallization, and electrodialysis^{7–9} methods are costly, especially for recovering small molecules from very dilute aqueous solutions.

Extraction is an important technique used in the chemical industry, and it is also widely applied in biotechnology as the first step in recovering primary and secondary metabolites. Extraction competes with many other separation methods, such as adsorption, precipitation, chromatography, distillation, membrane separation, and crystallization. Adsorption has the disadvantage of low loading capacity because of poor selectivity, but it can be combined with some other techniques and applied to low-concentration solutions. Furthermore, alternative extraction techniques, like reactive extraction involving extractants, have been investigated to improve product recovery selectivity.^{10,12}

In most cases, amino acid recovery is accomplished through extraction and crystallization at the isoelectric point and

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Adsorptive Bubble Separation Techniques

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Advanced Physicochemical Treatment Processes Lawrence K. Wang, Yung-Tse Hung, Nazih K. Shammass, 2007-11-10 The past thirty years have witnessed a growing worldwide desire that positive actions be taken to restore and protect the environment from the degrading effects of all forms of pollution air water soil and noise Because pollution is a direct or indirect consequence of waste the seemingly idealistic demand for zero discharge can be construed as an unrealistic demand for zero waste However as long as waste continues to exist we can only attempt to abate the subsequent pollution by converting it to a less noxious form Three major questions usually arise when a particular type of pollution has been identified 1 How serious is the pollution 2 Is the technology to abate it available and 3 Do the costs of abatement justify the degree of

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and engineering provided a well informed discussion of the problems encountered as well as possible directions of future technological developments It is hoped that this book is not only a good record of the presentations made formal and informal analyzing the state of the art in flotation but will also be helpful for students scientists and technologists working in the fields of separation processes and in particular mineral processing and wastewater engineering All the invited speakers and the participants made this summer school possible worthwhile and enjoyable The sponsorship by the NATO Scientific Affairs Division is gratefully acknowledged The Editors would like to thank the members of the Organizing Committee Dr B A

Bovine Science Muhammad Abubakar, 2022-02-23 Bovine Science Challenges and Advances presents up to date knowledge of bovine health covering both introductory topics and more advanced concepts Chapters cover such topics as new techniques in bovine science and development health and risk factors and diagnosis of disease in bovines and production and reproductive technologies and advancements

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