A novel continuous bioproduct purification process by application of multi-fluidised bed adsorption

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Abstract

Liquid Fluidised bed adsorption (FBA) is a technique that combines solid-liquid separation and product adsorption in a single step. However, the application of a multi-fluidised bed system (MFBS), where each bed is sequentially operated on-line to achieve a prerequisite dynamic capacity of adsorbed product and then taken off-line for adsorbent washing and desorption, would facilitate continuous processing of a productive batch. Unbroken, repetitive operation of this cycle would decrease the adsorbent inventory and increase the maximum batch size. We report application of a pellicular adsorbent, to the direct recovery of an intracellular enzyme in fluidised bed adsorption processes. Productive performance is directly compared for similar volumes of adsorbent and feedstock deployed in (i) the discontinuous application of single FBA and (ii) continuous MFBS. The bed switching inherent in MFBS facilitated an enzyme productivity greater than single bed unit FBA which required unproductive periods of adsorption, washing and regeneration. The generic application of MFBS to the rapid recovery of bioproducts in continuous operations will be discussed.

Keywords: Bioproduct purification; pellicular adsorbent; multi-fluidised bed adsorption; continuous process.

Introduction

Liquid Fluidised bed adsorption has emerged as an efficient method for the recovery of products from complex feedstocks demonstrating advantages over the traditional methods of recovery, e.g. circumventing the need for clarification of feedstocks before application to a fixed bed chromatography column (Chase, 1994; Lyddiatt, 2002). In fluidised beds, liquid is pumped upwards through a bed of adsorbent beads which, in contrast to a packed bed, is not constrained by an upper flow adapter. Thus, the bed can expand and spaces open up between the adsorbent beads. The expansion of adsorbent particles creates increased voidage in the bed, which permits the free flow of cells, cell debris and other particulate materials as the targeted product is captured. Therefore, the need for prior removal of cells and/or debris is eliminated.

Although adsorption in fluidised beds provides a considerable saving in cost and time over conventional purification techniques, it still deploys a discrete operation (batch process), which is quite usual in biotechnology processes (Jahanshahi *et al*., 2002a).

In general, the disparate unit operation of protein product and purification recovery, such as micro-and ultra-filtration, liquid packed and fluidised bed chromatography and gel filtration, which when combined allow the development of a downstream processing train, all share the common characteristic of single batch use during an individual recovery operation. The inventory of adsorbent required for the effective operation of chromatographic aspects of the recovery train is therefore defined by the binding and subsequent productive capacity of the adsorbent. Efforts to reduce the adsorbent quantities required for effective recovery process operations have concentrated on enhancing capacity through the alteration of adsorbent attachment of specific chemical ligands (Hjorth, 1997). In process chromatography, an increase in ligand concentration above a critical concentration may result in high adsorption strengths