

ORIGINAL PAPER

Equilibrium and kinetics of protein binding on ion-exchange cellulose membranes with grafted polymer layer

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Received 16 August 2012; Revised 19 September 2012; Accepted 19 September 2012

The performance of weak and strong anion- and cation-exchange membrane adsorbents with a grafted gel layer (Sartobind Q, D, S, and C) was investigated using six proteins: bovine serum albumin, human serum albumin, α -lactalbumin, β -lactoglobulin, lysozyme, and myoglobin. Static binding experiments were used to assess the effect of pH and buffer concentration and to determine the adsorption isotherms for selected membrane/protein combinations. The equilibrium data were duly described either by the Langmuir or Freundlich isotherms. Dynamic binding experiments were carried out for the same membrane/protein combinations in a broad range of linear flow velocity. Both the dynamic binding capacity at 10 % breakthrough and the final binding capacity at complete breakthrough were independent of the flow velocity despite strong dispersion of the adsorption zone. A good match between the equilibrium data from static and dynamic experiments was obtained for the anion exchangers. The correlation between the dynamic binding capacity and protein molecule size was observed for the strong cation exchanger. This was due to the different accessibility of the gel layer for the protein molecules.

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Keywords: membrane chromatography, ion-exchange chromatography, protein, adsorption isotherm, static binding capacity, dynamic binding capacity

Introduction

The industrial purification processes of proteins usually consist of one or several chromatographic steps. The performance of the chromatographic steps is often a key factor for the efficiency of the whole production process. The distribution of separated molecules between the liquid and solid phases is generally dependent on a number of parameters. Most of these parameters are directly linked to the nature and structure of the solid phase.

In the early period of process chromatography, stationary phases were optimised mostly for their binding capacity (Peterson & Sober, 1956). They were capable of binding large amounts of separated molecules but their process performance was poor. Substantial progress has subsequently taken place in the field of chromatographic separation. The permanent de-

velopment of alternative separation approaches significantly changed the character of process optimisation. Since chromatographic processes are costly, efforts have been made to maximise their productivity and to minimise the corresponding costs.

These objectives primarily depend on adsorbent properties and process conditions (DePhillips & Lenhoff, 2001; Finette et al., 1997; González-Patino et al., 1993; Hahn et al., 2005; Hubbuch et al., 2003; Langford et al., 2006; Stein & Kiesewetter, 2007). Since the former process parameters are fixed in the stage of process design, special attention has to be paid to adsorbent choice. Accurate identification of the relation process conditions–adsorbent structure–separation performance is crucial. Since the separation performance results from a very complex interplay of hydrodynamic, mass transfer and thermodynamic phenomena, it has to be carefully examined ex-

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