

CHT™ Ceramic Hydroxyapatite: Use in Expanded Bed Adsorption Mode

Introduction

Expanded bed adsorption (EBA) is a cost saving procedure in which target molecules are purified from crude unfiltered feedstock without the need for separate clarification, concentration, and initial purification steps.¹ The expansion of the adsorbent bed suspends the adsorbent particles and allows particulates to pass upward through the bed during the application of crude feed to the column. The target molecule is recovered by reversal of the flow to pack the expanded bed and by application of the elution buffer.

CHT (catalog #157-0080) is an ideal chromatographic support for use in expanded bed systems due to its unique biomolecule binding characteristics,² high specific gravity (s.g. = 3), and high mechanical stability. CHT, $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$, is a sintered form of calcium phosphate that can be used to separate and purify proteins, enzymes, nucleic acids, viruses, and other macromolecules. Its unique mechanism of separation involves both electrostatic interactions and the formation of calcium coordination complexes.

The spherical ceramic nature of CHT overcomes the physical and chemical instability that limits traditional hydroxyapatite use in biotherapeutic/EBA manufacturing processes. CHT is available in two porosities (Type I and Type II) and three particle size ranges (20, 40, and 80 μm mean). For EBA, only the CHT 80 μm bead has the proper particle density and size to achieve a stable fluidized bed and the high throughput required for industrial applications.

This study examines the expansion properties and protein binding characteristics of CHT Type I, 80 μm , in the STREAMLINE 25 column (2.5 x 100 cm).

Results

CHT Type I, 80 μm (75 ml; 17 cm gravity-settled bed), was added to a STREAMLINE 25 column filled with 10 mM sodium phosphate, pH 6.8. Flow was incrementally increased by 50 cm/hr and held for 30 min (Figure 1). The experiment was repeated using 500 mM sodium phosphate, pH 6.8. Due to the higher viscosity of 500 mM sodium phosphate, pH 6.8 ($\eta = 1.20$ cp), the degree of expansion (H/H_0 , expanded bed height/settled bed height) was higher than with 10 mM sodium phosphate ($\eta = 1.01$ cp). Typically, expanded bed systems require degrees of expansion values of 2–3 (Figure 2).¹ This requires a linear velocity range of 100–200 cm/hr for CHT Type I, 80 μm .

The 10% breakthrough binding capacity for purified bovine IgG and bovine serum albumin (BSA) was determined for CHT Type I, 80 μm , at 200 cm/hr in packed bed and expanded bed modes (Table 1). Only small differences were seen between packed and expanded beds, indicating that binding properties are similar. Total protein binding may be increased by increasing the amount of CHT Type I, 80 μm .

Recommendation

CHT is an ideal support for expanded bed systems. For initial studies, 17 cm of CHT Type I, 80 μm in 10 mM sodium phosphate, pH 6.8, should be fluidized in a STREAMLINE 25 column at 200 cm/hr.

Table 1. 10% breakthrough capacity for CHT Type I, 80 μm , for bovine IgG (1.1 mg/ml) and BSA (2 mg/ml) in 10 mM sodium phosphate, pH 6.8 at 200 cm/hr.

Mode	Protein	10% Breakthrough Capacity (mg/ml)*
Packed bed	Bovine IgG	38
Expanded bed	Bovine IgG	37
Packed bed	BSA	14
Expanded bed	BSA	11

* Packed bed column dimensions, 2.2 x 18.5 cm (70.3 ml).
Expanded bed height, 2.5 x 40 cm (73.6 ml settled bed volume).
Column void volume was subtracted from 10% breakthrough volume.

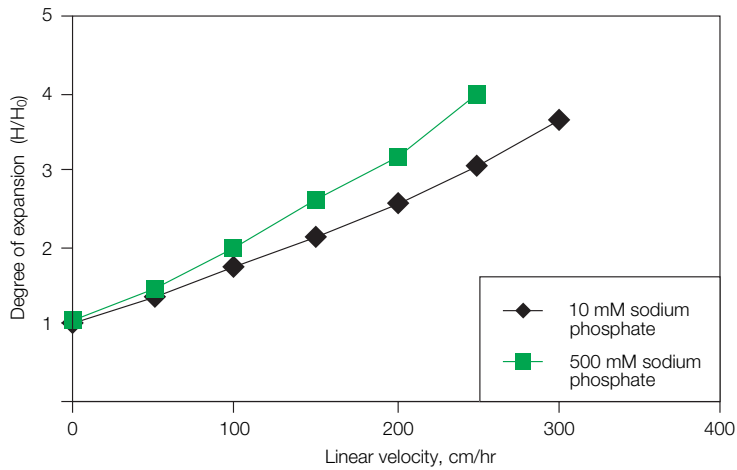


Fig. 1. Relative expansion at different flow velocities of CHT Type I, 80 μ m, with 10 mM and 500 mM sodium phosphate, pH 6.8.

References

- Expanded Bed Adsorption — Principles and Methods, Amersham Pharmacia Biotech 18, 1124–1126
- Ceramic Hydroxyapatite — A New Dimension in Chromatography of Biological Molecules, Bio-Rad Laboratories, bulletin 2156

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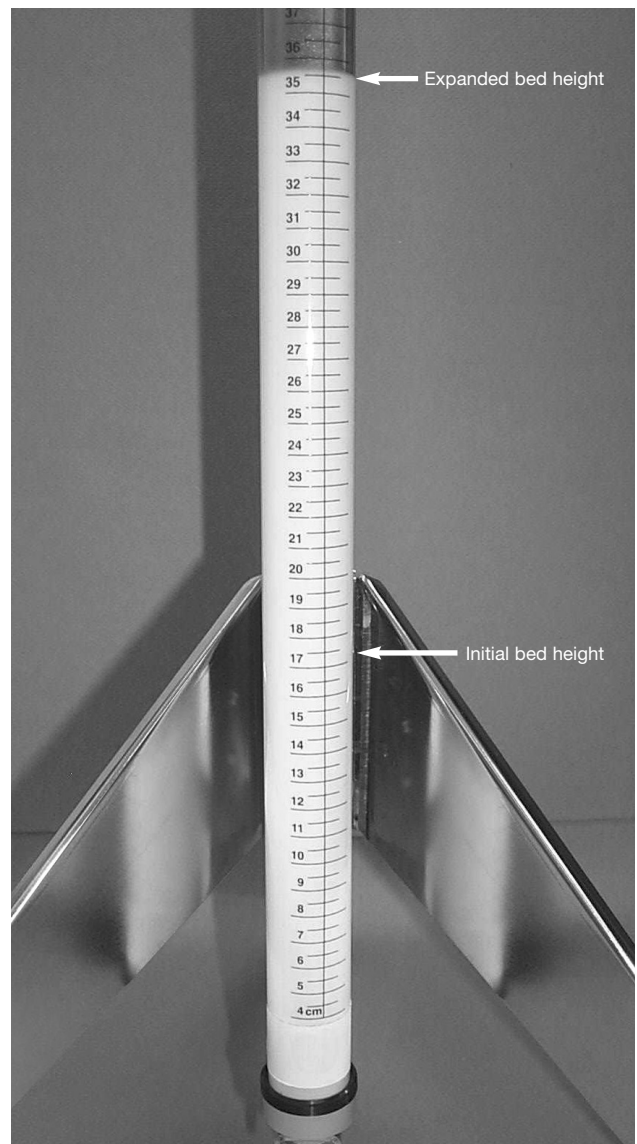


Fig. 2. Expanded CHT Type I, 80 μ m (17 cm settled bed height), in 10 mM sodium phosphate, pH 6.8, at 150 cm/hr in a STREAMLINE 25 column.

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