

Department of Biochemical Engineering & Biotechnology
BEL 703: Downstream Processing in Biotechnology
Major Test

April 30, 2008

Time: 2 hour

M.M: (40)

1. On the same diagram, sketch V vs. t in constant pressure filtration for (a) incompressible flow and (b) compressible flow. (5)

2A. What is the significance of the sigma factor in centrifugation? (5)

B. Find the capacity of a tubular sedimenting and clarifying centrifuge with the following operating parameters: bowl diameter = 50 cm; bowl depth = 30 cm; liquid layer thickness = 10 cm; liquid density = 1.1 g/cm³; liquid viscosity = 2 cP; solid density = 1.3 g/cm³; cut diameter of particles = 30 microns; speed of rotation = 800 rpm. (5)

3. Sepharose based affinity matrix can adsorb upto 7.5×10^{-6} mole of protein per ml of adsorbent matrix. The adsorption on this matrix follows a Langmuir isotherm with a constant K of 2.0×10^{-5} mol/liter. The volume of the matrix is 100ml and feed solution is 1.5 liter, what concentration of protein in the feed will exhaust 90% of the adsorbent capacity and what will be the recovery of protein for it? (4)

4. A Craig extraction containing many tubes gives a Gaussian concentration profile which is analogous to that in elution chromatography. Two proteins are being separated in a Craig Extraction using an aqueous buffer as the mobile phase and an isooctane solution containing inverted micelles as immobile phase. The ratio of solution volumes in any given stage (i.e. tube) is 1; the extraction contains 40 such tubes, enough so the concentration profiles are roughly Gaussian. The desired protein, to be used as a herpes vaccine, has an equilibrium constant of 1.8; the impurity, actually a mixture of compounds, has an equilibrium constant of 0.8. The desired proteins has 9.3 times the concentration of the impurity. (a) For 90% yield of the product, after how many transfers one begins to collect the mobile phase? (b) What purity will this material have? (8)

5A. Briefly describe all the categories of pressure driven membrane based operations. (2)

B. A protein solution is ultrafiltered through 10KDa membrane at the rate of 36 liter/m² h (LMH) at the transmembrane pressure of 4 bar. The protein concentration in solution is 2.5 g/liter. The diffusion coefficient at operating condition of the process is 6.5×10^{-7} cm²/s and the boundary layer thickness is estimated to be 1.5µm. Calculate the concentration of protein at the membrane surface. (2)

6A. Draw a sketch of multi-stack electrodialysis unit with identifications of all parts. (1.5)

B. An electrodialysis stack is used to remove 2 M ammonium sulphate from a dilute solution of an enzyme. If the current of 200 ampere is passed through the stack, how much should the feed to the compartments of electrodialysis unit to remove 95% salt? (2.5)

7. Show that single crystal growth rate is independent of crystal dimensions. For crystal size distribution, define all four moments and their physical significance. (5)
