Department of Biochemical Engineering & Biotechnology
BEL 820: Downstream Processing
Major Test

November 29, 2006
Venue: I-336; Time: 2 hour
M.M: 40

1. (a) Draw a schematic of rotary vacuum filter showing the immersion, wash and dry region of the drum. Is the rate of filtration dV/dt in rotary vacuum filtration constant? Explain your answer. Write the formula for rotary vacuum filter and define the terms t_f, t_c, β, p_0 and V_f. How is cycle time t_c related to rpm of the drum? (3+2.5+0.5) = (6)

(b) A tubular centrifuge is used to concentrate a suspension of yeast before further processing for protein recovery. The unit has an inside radius of 12.5 cm and length of 100 cm. The speed of the bowl is 12,000 rpm and the volumetric capacity is 7.5 liter per minute. Under these conditions, this centrifuge removes cells completely. Calculate the settling velocity v_g for the cells. (3)

Or

1. (a) Describe briefly all the four industrial UF modules using appropriate sketches. (3)

(b) The solution of ovalbumin is concentrated & purified using appropriate ultrafiltration (UF) membrane module on a pilot scale. The initial concentration of protein is 1 g/l and needs to be concentrated to 10 g/l. The permeability of the UF membrane is $5.0 * 10^{-7}$ m/skPa and assumed to be constant during concentration. Calculate the pressure required to concentration $1 m^3$ of protein solution in 1 hour using 2 m^2 membrane area. The diffusion coefficient of ovalbumin at 25°C is $7.8 * 10^{-7}$ cm^2/s. During concentration, it is assumed that concentration polarization makes protein concentration at membrane surface twice that of bulk solution concentration. Determine the mass transfer coefficient of the UF module and boundary layer thickness. (6)

2. (a) Over 100 Craig extraction tubes are used to separate a mixture of proteins. Let us assume that the protein mixture has three proteins whose distribution coefficients are known for the heavy & light phase used in the system. Briefly list & explain all the steps for the collection of purified proteins keeping in view the requirement of a high yield & purity of each protein. (3)

(b) Briefly describe two-parameter model used for adsorption of a solute in a fixed bed. (3)

3. (a) Describe briefly all the points concerning scale up in elution chromatography. (2)

(b) An enzyme is being purified in a chromatographic column. At elution buffer velocity of 45cm/hr, the enzyme peak shows a residence time of 75 min with the standard deviation of 9 min. (i) How long must we purify for a yield of 95%? (ii) If elution buffer velocity is doubled, how long must column be run for the same yield if the process is controlled by internal diffusion and reaction? (iii) How long must one wait if the process is controlled by mass transfer? (iv) How long must one wait if Taylor dispersion controls? (v) How long must one wait if the column actually contains equilibrium stages? (2+2+2+1+1) = (8)

4. (a) Write down all the steps considered important for a large scale precipitation along with a short description of each of this step. (3)

(b) The solubility of ammonium sulfate in water at 20^0C is 533 g/l. Calculate the amount of water required to be added to 1 liter saturated solution of ammonium sulfate to make 2.0M solution. How much Bovine Serum Albumin (BSA) can be dissolved in 2.0 M salt solution prepared above? The solubility constants of BSA are A = 21.6 and m = 7.65. How much salt will be required to precipitate out 50% of the dissolved BSA? (5)

5. (a) Three proteins, namely, (i) Cytochrome C (ii) Myoglobin & (iii) Lactalbumin need to be separated on a large scale. The molecular weight and isoelectric point of the proteins are as follows:

	Cytochrome C	Myoglobin	Lactalbumin
M.W.	15,600	17,200	17,400
Isoelectric Point (I.P.)	9.7	7.0	5.1

What is the best method for separation of the above protein mixture? Briefly describe the proposed method of separation. (3)

Two proteins having electrophoretic mobilities of $2.5 * 10^{-5}$ and $3.0 * 10^{-5}$ cm^2/V sec are to be separated in the electric field of 2V/cm. What is the minimum time required to separate these proteins if the bandwidth of the load sample is 1 mm? Make appropriate & logical assumptions to solve the problem. (4)

or

Write briefly a short note highlighting the importance of the topic of your term paper and briefly describe the salient features of your topic using sketch wherever possible. (7)

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