Department of Biochemical Engineering & Biotechnology

BEL 703: Downstream Processing in Biotechnology

Major Test

May 5, 2007
Time: 2 hour
M.M: 30

1. A In a constant pressure filtration of microbial broth in the laboratory, the following filtration data is obtained: (i) Weight of microbial cell = 60 g; (ii) Pressure of filtration is 1 bar (iii) Filter diameter is 5 cm; (iv) Cake depth is 10cm; (v) Filtration time is 150 min. The cake is assumed to be incompressible. On the basis of the laboratory test, calculate the number of frames needed for filtering 50kg of microbial cells, if the size of one frame is 45cm x 45cm x 2cm. Also estimate the time required to complete this filtration, if the pressure drop across the filter press is 0.50 bar. (2+2) = (4)

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 15 cm and length of 75 cm. The speed of the bowl is 12,000 rpm and the volumetric capacity is 4.5 liter per minute: Under these conditions, this centrifuge removes cells completely. Calculate the settling velocity v_g for the cells. (2)

2. Four batch extractions in sequential order are performed with equal amount of pure 200 liter organic phase. The initial feed for the extraction is 250 liter of aqueous phase containing 10g/l of antibiotic. The distribution coefficient of the antibiotic in the organic phase (i.e. K) is 1.5. Find the concentration of antibiotic in the spent feed after the four consecutive extractions as described above. Also determine the total amount of antibiotic extracted in organic phase. (4)

3. 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?
(1+1+2) = (4)

4. 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 10 min. (i) How long must we purify for a yield of 95%? (ii) If elution buffer velocity is trebled, 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? (2+2+1) = (5)

5A. A protein solution is ultrafiltered through 10KDa membrane at the rate of 36 liter/m^2 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 x 10^{-7}

cm^2/s and thc boundary layer thiekness is estimated to be 1.5µm. Calculate the coneentration of protein at the membrane surfaee. **(4)**

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

6. The following screen analysis of a modified lincomycin prepared during the pilot plant study of continous cryatllization is as follows:

S. No.	Product size, Mesh	Sieve Opening, mm	Cumulative %
1	+14	1.190	11
2	+20	0.841	30
3	+28	0.595	53
4	+35	0.420	70
5	+48	0.297	93

The magma density and retention time in this experiment are 98g/liter and 1.66 hr, respectively. The product has a density of 1.59 g/cm^3. Determinc the crystal growth rate in mm/hr for this experiment. **(5)**

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