Ex/PG/BPE/T/121A/2018

MASTER OF BIOPROCESS ENGINEERING EXAMINATION , 2018
(2nd Semester)

BIOSEPARATION ENGINEERING

Time : Three hours **Full Marks : 100**

Attempt any 4 questions. All questions carry equal marks.

1. (a) 100 cc of a fermentation broth pretreated with filter-aid may be filtered in 24 min in a 5 cm dia *Buchner funnel* attached to an aspirator, under ordinary atmospheric pressure. Find the time required to filter 3000 L of this broth in a plate-and-frame filter press consisting of 15 frames each of area 3520 cm^2 at 25 psi pressure. (Assume negligible filter medium resistance and cake compressibility = 0.67).
(b) A suspension of spherical particles of 0.1 mm diameter was allowed to settle in a column of 50 cm length. The density difference between the solid particles and the liquid was 0.05 g/cm^3 and the viscosity of the liquid was 1.1 cP.
(i) Calculate the settling time of the particles assuming that the particles reach their terminal velocity almost instantaneously.
(ii) Re-calculate the settling time in a centrifuge rotating at 400 rpm if the distance between the axis of rotation and the bottom of the centrifuge was 12 cm and the distance between the axis and the liquid surface was 3 cm. What is the G-factor of the centrifuge?

2 (i) A dextran-based adsorbent can adsorb a maximum of 8×10^{-8} mol of a protein immunoglobulin-G (from aqueous solution) per cm^3 of adsorbent. For a feed solution containing 2×10^{-8} mol/ litre of the protein it can adsorb at half the maximum value. Assuming Langmuir adsorption isotherm, what volume of adsorbent is required to adsorb 90% of protein initially present from 1.2 litres solution initially containing 4×10^{-6} mol/litre of protein?
(ii) Show under what conditions both Freundlich and Langmuir models reduce to a linear model.

3.(a) 1 L. water is used to 'strip' a certain amino acid from 4.7 L. of toluene containing 0.006M of this amino acid. The amino acid partitions between toluene and water as per the equilibrium relation $\mathbf{x^2 = Ky}$ ($K=0.001$ mol L^{-1}), where 'x' and 'y' are solute concentrations in organic and aqueous phases respectively. Find the % of amino acid originally present that is extracted.
(b)The partition coefficient value of an organic acid in organic solvent-water system is 2.7.
(i) Calculate the volume of organic solvent required to extract 99% of the acid from 50 ml of aqueous solution at one go.
(ii) How many repeated extractions each with 50 ml of organic solvent would be required to extract 99% of the acid.?

4 (a) A broth of 80 litres contains the desired protein, A, at 12.8 g/l as well as a contaminant protein, X, at 1.8 g/l . Calculate the ammonium sulphate concentration required to precipitate out 98% of the desired protein if the Cohn constants B and K_S of A are 9.33 and 1.1 respectively and that of X are 8.8 and 0.95 respectively. What will be the purity of the precipitated protein?
(b) How is the Juckes equation related to the Cohn equation?

5. (i) A chromatographic separation of a two component sample on a 50 cm column gave the retention times for the solutes A and B as 2.5 and 3.1 minutes with base widths of the two chromatographic peaks being 0.24 and 0.3 minutes respectively. Calculate the
(a) Number of theoretical plates
(b) Plate height and
(c) Resolution of the two peaks.
(d Re-calculate the resolution of the two peaks on an 80 cm column.
(ii) Obtain an expression for the optimum mobile phase velocity in column chromatography using the van Deemter model.

6.. (a) Express the permeate flux in ultrafiltration in driving force-resistance form. In this context, briefly explain the concepts of Concentration Polarization (C.P.) layer and Gel layer.
(b) Re-express the permeate flux in terms of C.P. layer thickness. What form does it reduce to for 100% solute rejection?
(c) State the commonly used correlations for estimating the mass transfer coefficient in ultrafiltration.
(d) Define the rejection coefficient and sieving coefficient in ultrafiltration. Obtain a relation between the apparent and intrinsic sieving coefficients.