B.E. CHEMICAL ENGINEERING FOURTH YEAR FIRST SEMESTER SUPPLEMENTARY EXAM 2018 (OLD)

Bioprocess Engineering

Time: 3 hours **Total Marks:100**

Answer any four questions.

Use graph paper if required. Assume any missing data.

All symbols have usual significance

1.	Glucose is converted to ethanol by immobilized yeast cells entrapped in gel beads. The specific rate of ethanol production, q_p =0.2g ethanol/g cell-h. The effectiveness factor for an average bead is 0.8. Each bead contains 50g/L of cells. The voidage of the bed is 40%. Assume growth to be negligible (all glucose is converted to ethanol). The feed flow rate is 400L/h and the feed concentration of glucose is 150g/L. The diameter and the height f the column are 1m and 4m respectively and the yield coefficient is 0.49g ethanol/g glucose. What is the exit concentration of glucose? What is the concentration of ethanol in the exit stream? Show all relevant derivations.	25
2.	An industrial waste water stream is fed to a stirred tank reactor continuously and the cells are recycled back to the reactor from the bottom of the sedimentation tank placed after the reactor. The following information are given: F=100L/h; S0=5000mg/L; μ_m =0.25h^{-1}; Ks=200mg/L; Recycle ratio=0.6; Degree of concentration in the sedimentation tank=2; $Y_{X/S}$=0.4. The effluent substrate concentration is desired to be 100mg/L. Showing all derivations, a) Determine the reactor volume; (b) Determine the cell concentration in the reactor and in the recycle stream. (c) If the residence time in the sedimentation tank be 2h, determine the volume of the tank and cell concentration in the effluent of the sedimentation tank.	25
3.	Penicillin is produced by *P. chrysogenum* in a fed batch reactor with the intermittent addition of glucose solution to the culture medium. The initial culture volume at quasi-steady state is 500L and glucose containing nutrient solution is added with a flow rate F=50L/h. Glucose concentration in the feed solution and initial biomass concentration are 300g/L and 20g/L respectively. The kinetic constants and yield coefficient of the organism are μ_m=0.2h^{-1}, K_s=0.5g/L and $Y_{X/S}$=0.3g /g glucose.Showing all derivations a) Determine the concentration and total amount of cells and products at t=10h if q_P=0.05 g product/g cell-h and C_{P0}=0.1g/L.	25
4.a)	Clarified bioreactor broth contains a protein at a concentration of 15g/L. Product is harvested from the broth using ultrafiltration at a fluid velocity of 0.34m/s in open membrane tubes of diameter 24mm and length of 2m. Deriving the necessary equation, estimate the permeate flux if the filter is operated under gel polarization condition and protein concentration in the gel is 25 g/L. The properties of bioreactor broth: ρ=1020kg/m^3; μ=1.8cP; D=3.6x$10^{-11}$$m^2$/s .[$N_{Sh}$=0.023($N_{Re}$)$^{0.89}$($N_{Sc}$)$^{0.3}$]	15
4.b).	A protein solution contains 1.95M KCl. Constant volume diafiltration using a membrane with retention coecfficient R=0 for KCl and R=1 for protein is used to desalt 2000L of the protein solution. The filter is operated so that the permeate flux is 20L/m^2-h. The total membrane	

4.b). (Contd.)	area is 65m^2. Water is added until KCl concentration reduces to 0.01M. Derive the governing equation and determine the time required for this process and volume of permeate generated.	10
5.	Carbohydrate A decomposes in the presence of enzyme E. We also suspect that carbohydrate B in some way influences this decomposition. To study this phenomenon various concentrations of A, B, and E flow into and out of a mixed flow reactor (V = 240 cm^3). **(a)** From the following data find a rate equation for the decomposition. **(b)** What can you say about the role of B in the decomposition? **(c)** Can you suggest a mechanism for this reaction?	25

C_{A0}, mol/m^3	C_A, mol/m^3	C_{B0}, mol/m^3	C_{E0}, mol/m^3	v, cm^3/min
200	50	0	12.5	80
900	300	0	5	24
1200	800	0	5	48
700	33.3	33.3	33.3	24
200	80	33.3	10	80
900	500	33.3	20	120