New Problems Chapter 24

24.1-1 ***Discussion problem on filtration types.*** Create a table that distinguishes among microfiltration, ultrafiltration, nanofiltration, and reverse osmosis in terms of average pore size and their unique role in purification.

24.2-10 ***Dead- end filtration***. A suspension of cells is filtered under constant pressure for recovery of extracellular protease. A pilot-scale filter is used to measure the filtration properties. The filter area is 0.25 m^2, the pressure drop is 360 mmHg, and the filtration viscosity is 4.0 cp. The cell suspension deposits 22g of cake per liter of filtrate. The following data are measured.

Time (min)	2	3	6	10	15	20
Filtrate Volume (L)	9.8	12.1	18.0	23.8	29.9	37.5

a) Determine the specific cake resistance (α) and the filter medium resistance (R_m)

b) Based on the data obtained in the pilot-scale study, what size filter is required to process 4000L of cell suspension in 30 min at a pressure drop of 360mmHg?

24.3-1 ***Discussion problem on cross-flow filtration.*** Explain how gel permeation chromatography can be used to predict the molecular weight of polymers.

24.4-1 ***Microfiltration resistance calculation.*** During testing the flux of Micrococcus Bacteria through a microfiltration unit was $35\frac{kg}{m^2 \cdot s}$. If the membrane resistance was measured as 2.4 x 10^3 m^2/kg and the broth viscosity was 1.35 cP, what was the cake resistance (Rc) if the pressure drop across the membrane was 250 kPa.

24.5-3 ***Ultrafiltration flux calculation.*** A monoclonal antibody is produced using a hybridoma cell culture. A solution containing 150 mg/L of antibody is concentrated to 1500 mg/L using an ultrafiltration unit. The pressure drop across the column is 500kPa. The membrane resistance was determined using water and was found to be $R_m = 0.24\frac{kPa \cdot m^2 \cdot hr}{L}$ and the resistance to concentration polarization was equal to $R_g = 4.5\frac{kPa \cdot m^2 \cdot hr}{L}$ what is the flux across the membrane?

24.6-7 ***RO flux calculation.*** A reverse osmosis membrane is to be used at 20°C for a NaCl feed solution containing $\left(4.0\frac{kg\ \text{NaCl}}{m^3}, \rho = 1000\frac{kg}{m^3}\right)$ which is purified to $\left(0.1\frac{kg\ \text{NaCl}}{m^3}, \rho = 995\frac{kg}{m^3}\right)$. The membrane has a water permeability constant $A_w = 5.0\times10^{-4}\frac{kg}{s \cdot m^2 \cdot atm}$ and a solute permeability constant, $A_s = 4.5\times10^{-7}\frac{m}{s}$. Calculate the water flux, solute flux and the solute rejection if the ΔP = 50 bar.

24.7-3 ***Diffusion through a liquid and a membrane.*** A membrane process is being designed to recover solute *A* from a dilute solution where $c_1 = 0.3$M by dialysis through a membrane to a solution where $c_2 = 0.002$M The membrane thickness is 10 μm, the distribution coefficient $K' = 0.67$, $D_{AB} = 4.6\times10^{-11}$ m^2/s in the membrane, the mass-transfer coefficient in the dilute solution is $k_{c1} = 1.9\times10^{-5}$ m/s, and $k_{c2} = 0.8\times10^{-5}$. Calculate the flux at steady state and the total area in m^2 for a transfer of 10 mol solute/h.