1. In a cake filtration controlled unstirred batch cell, the membrane resistance is negligible compared to the cake resistance.
2. Obtain an expression of variation of permeate flux (Vw) with the time (t) of filtration in terms of transmembrane pressure drop (), solution viscosity (), specific cake resistance

() and solute bilk concentration Cb.

1. If cake is compressible (), find how permeate flux varies with TMP?

What is the value of permeate flux if TMP is increased three folds at the same time point?

R2 R, CR

2. R1

F, C0

P, Cp=0

In a gel layer controlled cross flow, steady state UF system, the membrane is perfectly rejecting. The feed flow rate is F=50 kg/h and solute concentration in feed is 1 kg/m3. The gel layer concentration is 5 kg/m3. A fraction of the reject stream is recycled back. The cross flow system is assumed as a perfectly CSTR, i.e., the solute concentration in the flow channel is same as that at the retentate. Assume density of each stream is 1000 kg/m3.

1. Find the retentate flow rate R so that recovery ratio (P/F) is optimum. What are the optimum P and P/F? (10)
2. If the width and height of the flow channel are 30 cm and 1 mm, calculate the length of the flow channel required for optimum P. Consider solute diffusivity as 10-10 m2/s. The cross flow velocity in the flow channel is 1 m/s. The flow is laminar and hence use .
3. If the maximum solute concentration just at the inlet of filtration unit is 1.5 kg/m3, find out the recycle ratio Rc = R2/R1, under optimum condition.
4. The protein solution of feed concentration 2 kg/m3 is fed to a hollow fiber module with flow rate 100 L/h. The filtration is gel layer controlled with gel concentration 30 kg/m3. The internal diameter of each fiber is 650 micron and length 30 cm. Find the number of fibers required to have a permeate flow rate of 10 L/h. The protein diffusivity is 2x10-11 m2/s. The flow inside a fiber is laminar and .
5. A protein solution is ultrafiltered in a batch stirred cell with initial volume V0 and concentration C0. The filtration is gel layer controlled with gel concentration Cg. If the membrane area is A and the mass transfer coefficient is k, find an expression of time required to concentrate the feed solution so that the protein concentration becomes 2C0.