Department of Biochemical Engineering & Biotechnology
BBL 445: Membrane Applications in Biotechnology
Minor I

February 6, 2018
M.M.: 20
Time: 1 hour

1. A. What was the milestone for the development of industrially viable membrane technology? Was this development planned? Why osmotic pressure is expected to be nil or very low in case of MF & UF processes and high or very high in case of NF & RO processes? Explain quantitatively taking one solute each as an example for each process. **(1 + 2)**

B. What is the osmotic pressure of sugar solution of 1.8% glucose and 1.5% xylose at 27^0C? If this solution was made in tap water containing 585mg/l equivalent NaCl, what would be the osmotic pressure? **(3)**

2. Classify the pressure driven membrane processes on the basis of transmembrane pressure (TMP) usually applied across the membrane, corresponding pore size range of the membrane & the expected flux in these processes at 1 bar. The range of numerical value of TMP, pore size & flux should be given in bar, nm & LMH respectively for each kind of these pressure driven membrane processes. **(4)**

3. A. Could you please very briefly highlight the relevance of concentration polarization (CP) as a concept/model? How is CP Model helpful in explaining experimental observations regarding flux decrease with increasing pressure for different cross flow velocities and temperatures? Use schematics for your answer as much as possible. **(2)**

B. Consider the series of experiments for UF of a protein solution at room temperature. The experiments are carried out on a totally retentive membrane in a tubular module for different feed concentration of the protein and the limiting volumetric flux measured as given below. Using the following data, find out the mass transfer coefficient (k) and the maximum membrane protein concentration (C_m or C_w): **(3)**

Feed concentration of Protein (g/l)		1	2	5	10	20
Limiting Volumetric Flux (cm/s) x 10^{-4}		11	9	6.5	5.5	4.5

4. Mixture of three proteins X (MW: 3000), Y (MW: 40, 000) and Z (MW: 500,000) are separated using 20K and 100K UF membranes in series. The rejections of these proteins for the two membranes are as follows:

Protein	Rejection (20K)	Rejection (100K)
X	10	5
Y	95	10
Z	99	98

One hundred liter (L) of solution containing 1.0% (w/v) of each protein is first ultrafiltered through 20K membrane to give 10L retentate and after adding 90L water to 10L retentate, it is filtered through 100K membrane to 10L retentate, calculate the composition of proteins in the permeate of 100K membrane. **(5)**

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