BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI, PILANI CAMPUS
DEPARTMENT OF CHEMICAL ENGINEERING
First Semester 2017-18
Course Title: Advanced Separation Techniques (CHE G551)
Mid Semester Test (Closed Book)
Marks: 50   Date: 14/10/17   Time: 04:00 – 05:30 p.m.   Room No. 2204

Note: Make the necessary assumptions, if required.

1. **(4 × 6 = 24 Marks)**
    (a) The degree of separation in a separation operation is often specified in terms of component recoveries and/or product purities. How do these two differ?
    (b) What is a mass-transfer zone (MTZ) and what causes it? Is it desirable? If not, why not?
    (c) Discuss the effect of unused bed length, shape of adsorption isotherm, and external & intraparticle resistances in the steepness of breakthrough curve.
    (d) How do microfiltration and ultrafiltration differ from reverse osmosis with respect to pore size, pressure drop, and the nature of the permeate?
    (e) Discuss the different types of liquid chromatography.
    (f) If a binary gaseous mixture is to be separated through a porous membrane and the pressure on feed and permeate side is same then how will you achieve separation?

2. **(4 × 3 = 12 Marks)**
    (a) How will you utilize the simulated moving bed adsorption process to obtain the highly pure hydrogen from steam reforming process?
    (b) Discuss the operation of Reverse Osmosis (RO)-Nano filtration Hybrid process and its advantages over conventional RO process.
    (c) How the performance of pervaporation process to separate or dehydrate organic mixtures can be improved using sulfonation and cross-linking methods?

3. **(7 Marks)**
    Adsorption on fresh activated carbon is being considered to recover methyl ethyl ketone (MEK) from an air stream at 25^0C and 1 atm. The air flow rate is 12,000 std ft^3/min and the air has 0.04 lb MEK/1000 std ft^3. If the superficial velocity is 0.5 ft/s, and an adsorption cycle of at least 8 h is desired, about what bed dimension should be used? Assume the bulk density and adsorption capacity of the activated carbon are 30 lb/ft^3 and 18 lb MEK/100 lb of activated carbon, respectively.

4. **(7 Marks)**
    A cellulose-acetate membrane with an area of 4.0×10^{-3} m^2 is used at 25^oC to determine the permeability constants for reverse osmosis of a feed salt solution containing 12.0 kg NaCl/m^3 (density = 1005.5 kg/m^3). The product solution has a concentration of 0.468 kg NaCl/m^3 (density = 997.3 kg/m^3). The measured product flow rate is 3.84×10^{-8} m^3/s and pressure difference used is 56.0 atm. Calculate the permeability constants and the solute rejection R.

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