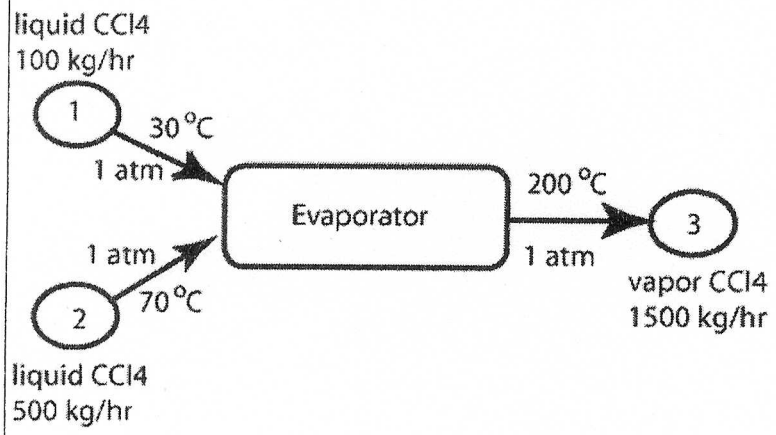
94 學年度_ 生命科學院，生命科學院結構生物學程_系（所）_丙組，乙組___碩士班入學考試

科目__輸送現象及單元操作_科目代碼 1004,1204 共___3_頁第__1__頁 *請在試卷【答案卷】內作答

Total Points: 100 分, 第 3 題 20 分, 其他各題 (1, 2, 4, 5, 6) 各 16 分

1. An evaporator vaporizes 1500 kg of carbon tetrachloride per hour at atmospheric pressure. There are two feed streams: 1000 kg/hr of liquid at 30 °C and 500 kg/hr of liquid at 70 °C. The product is superheated vapor at 200 °C. Calculate the heat load for the evaporator. (16 points)



* molal heat capacity of CCl4 $Cp=12.24 + 3.4\times10^{-2}\,T - 2.995\times10^{-5}\,T^2 + 8.828\times10^{-9}\,T^3$
* At 50 °C, the heat capacity of liquid CCl4 is 0.207 cal/gK
* Boiling point of CCl4 is at 76.7 °C. And the heat of evaporation is 46.42 cal/g.

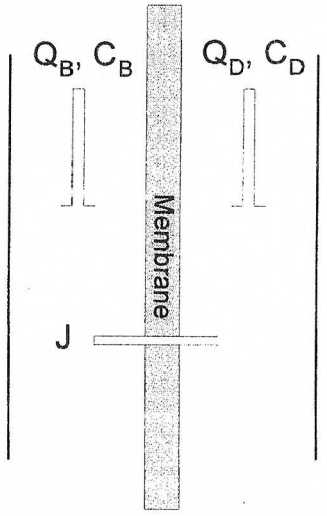
2. In a countercurrent-flow heat exchanger, 1.25 kg/s of benzene (specific heat 1.9 kJ/kg-K and specific gravity 0.88) is to be cooled from 350 K to 300 K with water, which is available at 290 K. In the heat exchanger, tubes of 25 mm external and 22 mm internal diameter are employed and the water passes through the tubes. If the film coefficients for the water and benzene are 0.85 and 1.70 kW/m^2-K, respectively, and the scale resistance can be neglected, what total length of tube will be required if the minimum quantity of water is to be used and its temperature is not to be allowed to rise above 320 K? (16 points)

3: Dialysis is a method of removing toxic substances (impurities or wastes) from the blood when the kidneys are unable to do so. The dialyzer shown below operates in a concurrent flow configuration. In this case, the blood and the dialysate have the same direction of flow on both sides of the membrane. Q_B and Q_D are the rates of blood flow and dialysate flow, respectively, into the dialyzer. C_B and C_D are the concentrations of solute in the blood and dialysate, respectively, at the inlet of the dialyzer. (20 points)

A) Derive an expression for the flux of solute J across the membrane.

B) What are the major effects of counter current dialysate flow?

Note: Clearly state all your assumptions in your derivations.



4: Assume that $CuSO_4.5H_2O$ is to be crystallized in an ideal product-classifying crystallizer. A 1.4-mm product is desired. The growth rate is estimated to be 0.2 μm/s. The geometric constant a is 0.20, and the density of the crystal is 2,300 kg/m^3. A magma consistency of 0.35 m^3 of crystals per cubic meter of mother liquor is to be used. *(This problem is taken from Unit Operation by McCabe, Smith, and Harriott.)(16 points)*

A) What is the production rate, in kilograms of crystals per hour per cubic meter of mother liquor?

B) What rate of nucleation, in number per hour per cubic meter of mother liquor, is needed?

Note: You may want to reference the following equations:

$$Mc = \frac{a\rho_c B^\circ L_T^4}{4G} \quad \text{and} \quad \tau = \frac{L_T}{4G}$$

5. What are the physical meanings of (A) shear stress (B) Newton's Law of viscosity (C) Reynold's number (D) Prandtl number. (16 points)

6. Consider the steady state axial flow of an incompressible Newtonian fluid in an annular region between two coaxial cylinders of radii kR and R as shown below. The fluid is flowing upward in the tube. Let $P=p+\rho gz$ being the modified pressure. Consider a control volume of a tube of length L. (16 points)

(a) Derive the momentum flux and velocity distribution.

(b) At what location will the velocity reaches a maximum and at what location will the momentum flux becomes zero. Are the two locations the same? Explain why they are or are not the same.