淡江大學八十七學年度碩士班入學考試試題

系別： 化學工程學系　　科目： 輸送現象與單元操作

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Problem 1. [20 pts]

The space between two parallel plates 0.5 cm apart is filled with a Newtonian fluid of viscosity 0.0177 g/cm-s. The upper plate is at rest and the lower plate velocity is 10 cm/s. Calculate the shear stress and the shear rate using SI units.

Problem 2. [20 pts]

A continuous rectifying column with total condenser, treats a mixture consisting of 45 mole% of benzene and 55 mole% of toluene at the rate of 4000 kg mole/hr, and separates it into a overhead product containing 97 mole % of benzene and a bottoms product containing 98 mole% of toluene. The feed enters as an equilibrium mixture of 75% liquid and 25% vapor. The mole latent heats of benzene and of toluene are taken as 7500 kcal/kg mole.

(a) Calculate the mole flow rate of the overhead product and the bottom product,

(b) If the reflux ratio R = 3.5 is employed, calculate

(1) The heat removed in the condenser, q_c

(2) The heat required in the reboiler, q_r

Problem 3. [20 pts]

A solution of 1 kg of Nicotine in 100 kg of water is to be extracted with a solvent of kerosene at 20 ℃. Water and kerosene are immiscible. Determine the percentage of extraction for nicotine if 101 kg of feed solution is extracted with

(a) 150 kg solvent in a ideal extractor

(b) three ideal extractors in co-current contact and using 50 kg solvent for each extractor.

The equilibrium curve is given as $Y = 0.85X$, where X is kg nicotine/kg water and Y is kg nicotine/kg kerosene

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Problem 4. [20 pts]

An electric wire having a diameter of 10 mm and covered with a plastic insulation (thickness = 3 mm) is exposed to air at 300 K and the convective heat transfer coefficient (h) is 20 W/m^2-K. The thermal conductivity (k) of the insulation is 0.4 W/m-K. It is assumed that the wire surface temperature is constant at 400 K.

(a) Calculate the heat loss per m of wire length with no insulation.

(b) Repeat (a) for the insulation present.

(c) What is the thickness of the insulation when the heat loss is a maximum?

Problem 5. [20 pts]

The diffusion coefficient for a gas may be experimentally measured in an Arnold diffusion cell. This cell is illustrated schematically in the following figure. The narrow tube, which is partially filled with pure liquid A, is maintained at a constant temperature and pressure. Gas B, which flows across the open end of the tube, has a negligible solubility in liquid A and is also chemically inert to A. Component A vaporizes and diffuses into the gas phase; the rate of vaporization may be physically measured.

(a) Derive the steady-state diffusion of component A in terms of the molar mass flux.

(b) An experiment was conducted by an Arnold cell to measure the diffusion coefficient of chloroform (molecular weight = 119.39 g/mole) in air at 298 K and one atmosphere pressure. The liquid density of chloroform at 298 K is 1.485 g/cm^3, and its vapor pressure at 298 K is 200 mmHg. At time t = 0, the liquid chloroform surface was 7.40 cm from the top of the tube, and after 10 hours the liquid surface had dropped 0.44 cm. If the concentration of chloroform is zero at the top of the tube, what would be the gas diffusion coefficient of chloroform in air? The gas constant, R, is 82.06 atm-cm^3/mol-K.