

國立中正大學八十六學年度碩士班考試試題

所 別：化學工程研究所

科 目：輸送現象與單元操作

每大題25分，共100分

1. Briefly define the following terms and when there is more than one, compare and contrast their general characteristic with those of others in the same groups:
 - (a) natural convection, molecular diffusion.
 - (b) Biot number, Nusselt number, Sherwood number.
 - (c) leaching, liquid extraction
 - (d) gray body, blackbody, greenhouse effect.
 - (e) spray dryer, tray dryer.
2. Water (with $\rho = 1000 \text{ kg/m}^3$, $\mu = 0.001 \text{ kg/m} \cdot \text{s}$) is flowing in a horizontal tube having a diameter of 1 m. The temperature of water is 25°C and the flow rate is determined to be $0.001 \text{ m}^3/\text{s}$ by a U-tube manometer. Please derive step by step the equations you need for the following calculations, and then
 - (a) Calculate the maximum velocity in the tube.
 - (b) Calculate the friction drag on the wall of 1-m long tube by the water,
 - (c) Calculate the Fanning friction factor.
 - (d) What is the principle of a U-tube manometer for the determination of flow rate ?
3. Steam is condensed on the outer surface of a **thin-wall** circular tube of 5-cm diameter and 6-m length. The outer surface of the tube is maintained at a uniform temperature of 100°C . Water (with $c_p = 4200 \text{ J/kg} \cdot \text{K}$) flows through the tube at a rate of 0.25 kg/s , and its inlet and outlet temperatures are 15°C and 60°C .
 - (a) Obtain the expression relating the total heat transfer rate, Q , to the average convection heat-transfer coefficient associated with the water flow, \bar{h} .
 - (b) Calculate the values of Q and \bar{h} .
 - (c) What exit water temperature will result if the water flow rate is decreased to 0.1 kg/s ?
 - (d) If a thick-walled tube of small thermal conductivity, rather than the thin-walled tube, is used, is the equation you have derived in part (a) still useful?

4. A distillation column is fed 200 kg mol/h of a mixture of 50 mol % benzene and 50 mol % toluene at 1 atm. The feed is liquid at the boiling point. The distillate (overhead product) is to contain 95 mol % benzene and the bottom product 10 mol % benzene. The reflux ratio is 4:1. The equilibrium data are shown in Table 1.
- (a) Calculate the kg mol/h distillate, kg mol/h bottom product, and the number of theoretical trays needed.
- (b) If the feed is at a temperature of 320 K, what will happen to the feed-plate position?
- (c) What are the operating lines in rectifying and stripping sections when the distillation is operated under the condition of total reflux?
- (d) There is a liquid side stream for the removal of liquid product above the feed inlet. Making a mass balance to obtain the operating line between the side stream and the feed.

(回答本大題，若有任何作圖，即使不很精確，也務必畫在答案卷上，否則不予計分。)

Table 1. Vapor-pressure and equilibrium-mole-fraction data for benzene-toluene system

Temperature (K)	Vapor Pressure (mm Hg)		Mole fraction of benzene at 1 atm	
	benzene	toluene	x_A	y_A
353	760		1	1
358	877	345	0.78	0.90
363	1016	405	0.58	0.78
368	1168	475	0.41	0.63
373	1344	557	0.26	0.46
378	1532	645	0.13	0.26
384	1800	760	0	0

P. 2
(共2頁)