淡江大學 106 學年度碩士班招生考試試題 40-1

系別： 化學工程與材料工程學系 A 組　科目：輸送現象與單元操作

考試日期：3 月 4 日(星期六) 第 2 節　本試題共 6 大題，3 頁

本試題雙面印刷

1. The inside diameter of a pipe is 25 cm. What is the hydraulic diameter when flowing half full? (10 points)

2. For the flow of liquid with density of ρ in a pipe of diameter D, length L and mean velocity u_m, as shown in Figure 1.

(1) Please derive the relationship between pressure drop (ΔP) and Fanning friction factor (f_F), which is $\Delta P = \frac{2\rho u_m^2 f_F L}{D}$. (Hint: use momentum balance for the pipe) (10 points)

(2) 40 L/s of 20°C water (density is 1000 kg/m^3 and viscosity is $1 \times 10^{-3}\ kg/(m \cdot s)$ flows through a pipe of 300 m long, 0.15 m diameter and 0.002 roughness ratio.

(a) What is the Reynolds number? Is the flow inside the pipe laminar or turbulent? (10 points)

(b) What is the frictional pressure drop in Pa (=$kg/(m \cdot s^2)$) of the flow? (Hint: Figure 2 can be used to obtain the value of Fanning friction factor.) (10 points)

3. A heat exchanger uses liquid ammonia refrigerant of -20°C to totally condense a saturated vapor at -15°C. The heat transfer loading is 3×10^6 W and the overall heat transfer coefficient is $850\ w/(m^2 \cdot K)$. What is the area of the heat exchanger? (20 points)

4. The forced convection heat transfer coefficient is commonly estimated by correlations. Which ones of the listed dimensionless numbers will appear in the correlations? (10 points)

(1) Reynolds number

(2) Sherwood number

(3) Nusselt number

(4) Prandtl number

5. For Figure 3, please answer the following two questions.

(1) Is the figure for an absorption operation or a stripping operation? (4 points)

(2) The meanings of lines $\overline{AB}$ and $\overline{AC}$. (6 points)

6. Based on the two-film theory, using the notations shown in Figure 4, please derive the following equation. (20 points)

$$\frac{1}{K_y} = \frac{m}{k_x} + \frac{1}{k_y}$$

where K_y, k_x and k_y are the overall gas phase, liquid film and gas film mass transfer coefficients, respectively. The slope of the equilibrium curve is m.

背面尚有試題

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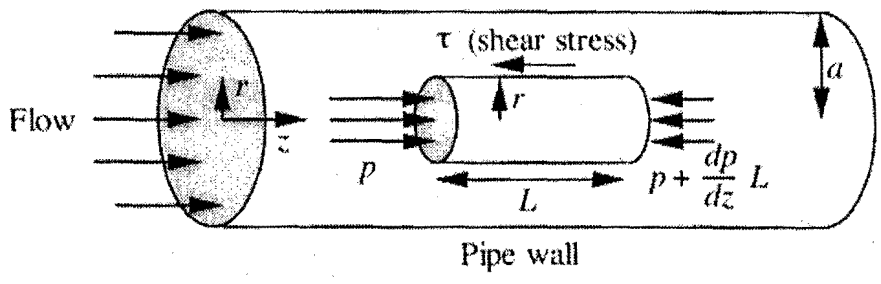

Figure 1. A pipe flow

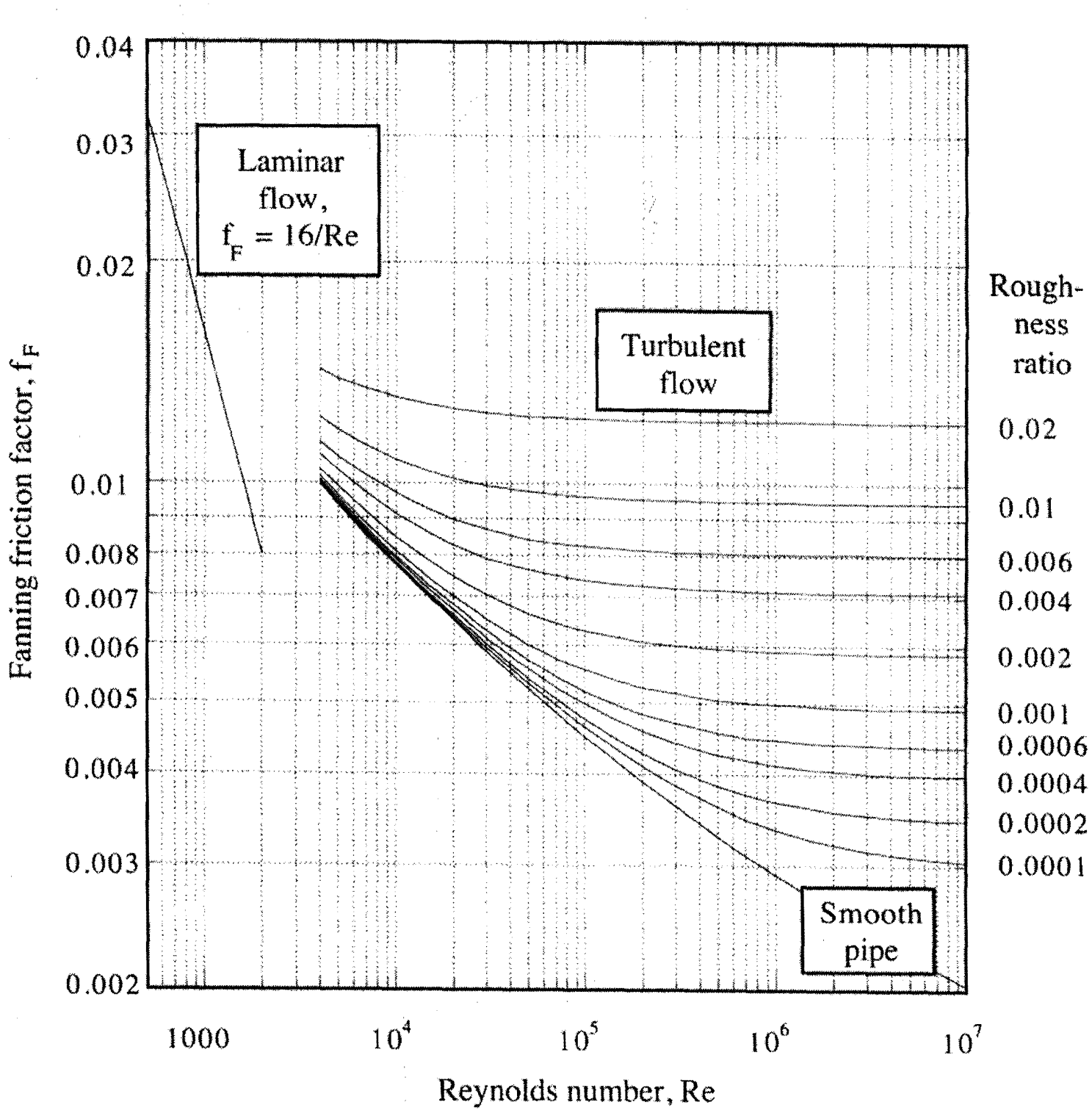

Figure 2. Fanning friction factor vs. Reynolds number

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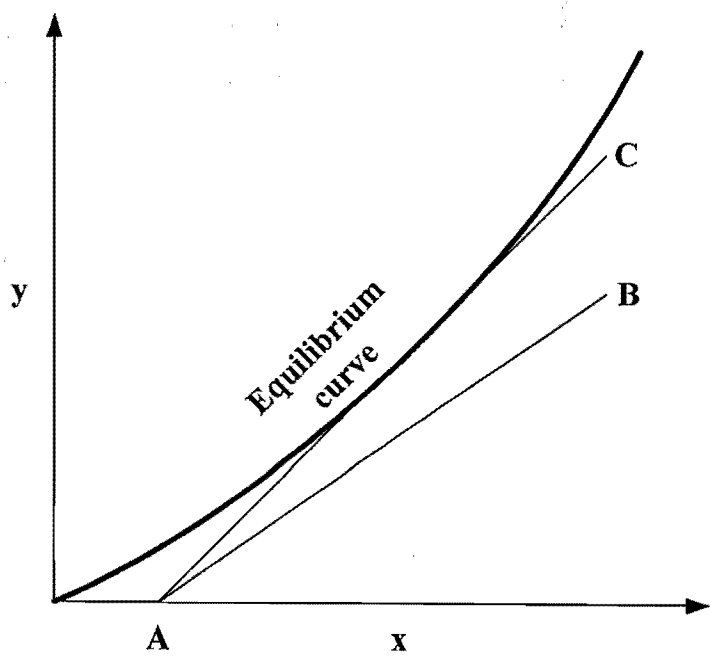

Figure 3. y-x diagram for a separation column

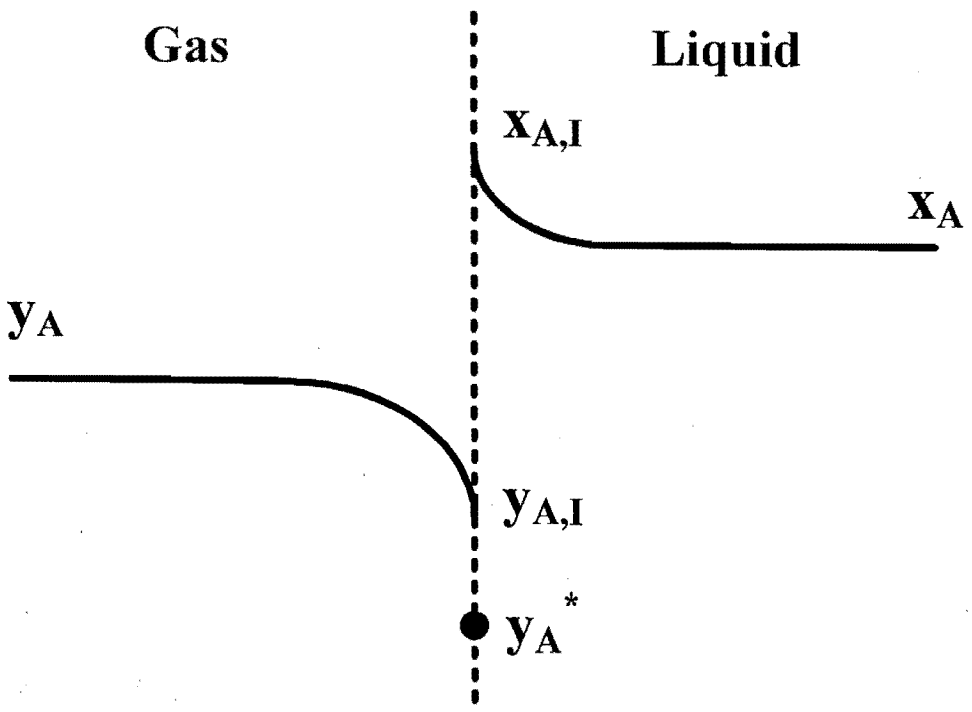

Figure 4. Concentration gradients near a gas-liquid interface