

國立臺北科技大學 114 學年度碩士班招生考試

系所組別：3510 化學工程與生物科技系化學工程碩士班甲組

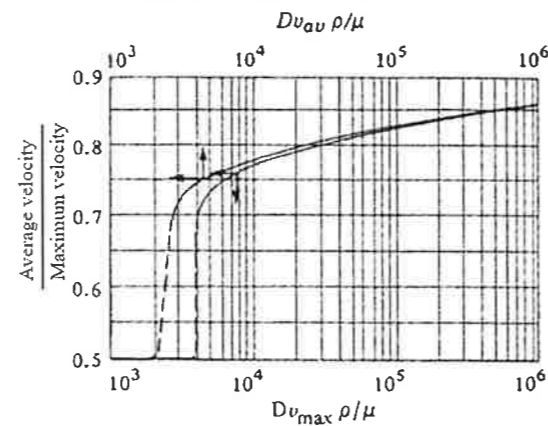
第一節 單元操作與輸送現象 試題

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注意事項：

1. 本試題共 6 題，每題 20 或 10 分，共 100 分。
2. 不必抄題，作答時請將試題題號及答案依照順序寫在答案卷上。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

1. A pitot tube is used to measure the flow rate of water at 20°C in the center of a pipe having an inside diameter of 80 mm. The manometer reading is 150 mm of carbon tetrachloride at 20°C. The pitot tube coefficient C_p is 0.98. (a) Calculate the velocity at the center and the average velocity. (10%) (b) Calculate the volumetric flow rate of the water. (10%) ($\mu = 1.0 \times 10^{-3}$ Pa·s, $\rho = 1000$ kg/m³ for water; ρ of carbon tetrachloride is 1600 kg/m³)



2. Pure water at 20°C is flowing down a vertical wetted-wall column at a rate (Γ) 0.1 kg/s·m. Calculate the film thickness (10%) and the average velocity (10%). ($\rho = 1000$ kg/m³ and $\mu = 1.0 \times 10^{-3}$ Pa·s for water)

$$\Gamma = \rho \delta v_{z,av} = \frac{(\rho \delta) \rho g \delta^2}{3\mu} = \frac{\rho^2 \delta^3 g}{3\mu}$$

3. The Fourier field equation in cylindrical coordinates is

$$\frac{\partial T}{\partial t} = \alpha \left[\frac{\partial^2 T}{\partial r^2} + \frac{1}{r} \frac{\partial T}{\partial r} + \frac{1}{r^2} \frac{\partial^2 T}{\partial \theta^2} + \frac{\partial^2 T}{\partial z^2} \right]$$

- (a). What form does this equation reduce to for the case of steady state, radial heat transfer? (10%)
- (b). What is the temperature distribution for given the boundary condition; $T = T_i$ at $r = r_i$; $T = T_o$ at $r = r_o$. (5%)
- (c). Generate an expression for the heat flow rate, q_r , using the result from part (b). (5%)

4. The solute HCl (A) is diffusing through a thin film of water (B) 5 mm thick at 283 K. The concentration of HCl at point 1 at one boundary of film is 15 wt% HCl (density $\rho_1 = 1060.7$ kg/m³), and at the other boundary at point 2 it is 8 wt% HCl (density $\rho_2 = 1030.3$ kg/m³). The diffusion coefficient of HCl in water is 2.5×10^{-9} m²/s. Assuming steady state and one boundary impermeable to water, calculate the flux of HCl in kg mol/s·m². (20%) (molecular weight of HCl and water are 36.5 and 18.0, respectively)

5. What is the driving force for (a) momentum transfer? (4%) (b) heat transfer? (3%) (c) mass transfer? (3%)

6. What is the pressure P_A in the figure? The specific gravity of the Hg and oil are 13.6 and 0.8, respectively. (10%)

