

淡江大學 100 學年度碩士班招生考試試題

56

系別：化學工程與材料工程學系

科目：輸送現象與單元操作

考試日期：2月28日(星期一) 第2節

本試題共 3 大題，1 頁

1. Oil is flowing at a flow rate of $45 \text{ cm}^3/\text{s}$, through a pipe of 1.27 cm inside diameter and 30.48 m. The density and kinematic viscosity of oil are 0.9 g/cm^3 and $0.465 \text{ cm}^2/\text{s}$, respectively. (30%)
 - (1) Determine the **Fanning friction factor**.
 - (2) Determine the **pressure drop** over the length of pipe if the inlet and exit losses are neglected.
 - (3) Determine the **velocity** at the center of the pipe.

2. In a heat exchanger, an oil with flow rate of 0.6 kg/s is to be cooled from 240°F to 178°F . Water is used as the cooling media, with a flow rate of 0.3 kg/s and an initial temperature of 46°F . The specific heat of oil and water are $1880 \text{ J/kg}\cdot^\circ\text{C}$ and $4177 \text{ J/kg}\cdot^\circ\text{C}$, respectively. The overall heat transfer coefficient is $275 \text{ W/m}^2\cdot^\circ\text{C}$. (30%)
 - (1) Calculate the required **heat transfer surface area** for counter-current arrangement.
 - (2) Calculate the required **heat transfer surface area** for co-current arrangement.

3. Sulfur dioxide (A) is absorbed into water in a packed column. The equilibrium relation at 50°C in terms of mole fractions can be expressed as $y_A^* = 29.74 x_A^* + 6733 (x_A^*)^2$. The mass transfer coefficients for the liquid phase and gas phase are $k_x = 9.9 \frac{\text{kmol}}{\text{h}\cdot\text{m}^2}$ and $k_y = 8.1 \frac{\text{kmol}}{\text{h}\cdot\text{m}^2}$, respectively. At a certain location, the bulk conditions are 50°C , 2 atm, $y_{A_b} = 0.085$ and $x_{A_b} = 0.001$. The mass transfer flux can be expressed as:

$$N_A = k_y(y_{A_b} - y_{A_i}) = K_y(y_{A_b} - y_A^*) = k_x(x_{A_i} - x_{A_b}) = K_x(x_A^* - x_{A_b})$$
 where y_{A_i} and x_{A_i} are mole fractions at the gas-liquid interface. (40%)
 - (1) Please determine K_x and N_A by assuming the gas-phase resistance is negligible.
 - (2) Use the results from (1) to check if the assumption is acceptable.