92-1

淡江大學九十四學年度碩士班招生考試試題

系別：化學工程與材料工程學系　科目：輸送現象與單元操作

准帶項目請打「V」	
✓	簡單型計算機

本試題共 2 頁

本試題雙面印製

The following problems can be answered in Chinese (prefer) or in English.

Problem 1 (10%)

Please draw the general performance curve (head vs. discharge) for a centrifugal pump (Fig. 1(i)). How about the performance curves when two identical such pumps are connected together either in series (Fig. 1(ii)) or in parallel (Fig. 1(iii))?

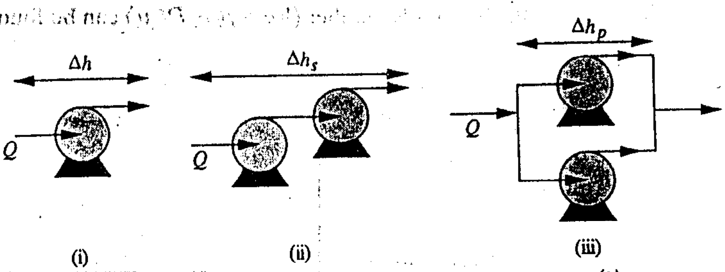

Fig.1 *Centrifugal pump arrangements: (i) a single pump, (ii) two in series, (iii) two in parallel.*

Problem 2 (10%)

What is the definition of Biot number (Bi) in heat transfer? What assumption can be stated when the heat transfer system with Bi << 0.1?

Problem 3 (10%)

What is the definition of heat-exchanger effectiveness? What is the definition of fin efficiency in finned heat exchanger?

Problem 4 (10%)

Consider a small heated horizontal tube immersed in a vessel containing water boiling at T_b. Please draw and describe the boiling curve of heat flux (q) vs. $\Delta T = T_w - T_b$, where T_w is the tube wall temperature.

Problem 5 (10%)

Describe the procedure of a method that can be applied to determine the molecular diffusivity for binary gas mixtures.

Problem 6 (10%)

What is the definition of permeability of a gas diffusing through a solid? And what is the effective diffusivity of a component diffusing through a porous solid?

Problem 7 (20%)

A stainless steel sphere of diameter D = 1 mm and density ρ_s = 7870 kg/m^3 falls steadily under gravity through a polymeric fluid of density $\rho_f = 1052$ kg/m^3. The downwards- terminal velocity, u_t, of the sphere is 0.035 m/s. What is the viscosity of the polymeric fluid (μ_f) in kg/m-s (or Pa-s)?

Hint: The relation of drag coefficient C_D and drag force F_D is $C_D = \dfrac{F_D/(\pi D^2/4)}{\rho_f u_t^2/2}$

and the relation of drag coefficient C_D and the Reynolds number (Re = $\rho_f u_t D/\mu_f$) can be found in following figure (**Fig. 2**).

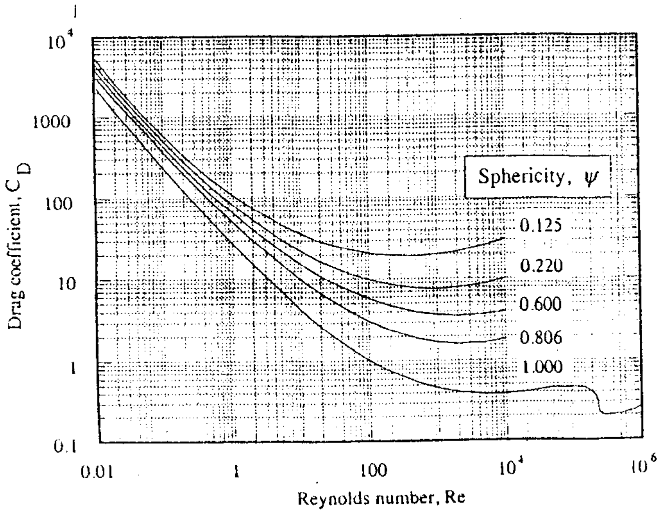

Fig. 2 *Drag coefficients for objects with different values of the sphericity ψ; the curve for ψ = 1 corresponds to a sphere.*†

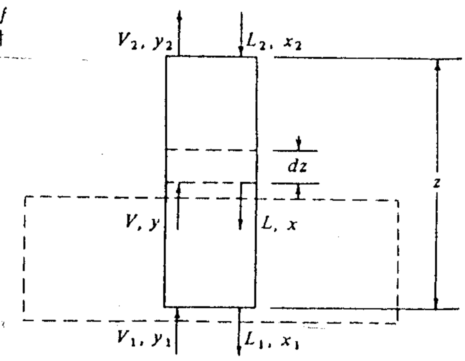

Fig. 3

Material balance for a countercurrent packed absorption tower.

Problem 8 (20%)

A soluble gas A is absorbed from a dilute gas-air mixture by countercurrent scrubbing with a solvent in a packed tower. The flow diagram can be shown in **Fig. 3** where V and L [mol/s-m^2] are flow rates of the gas mixture and liquid, y_1 and y_2 are the mol fraction of the gas A in gas-phase at the inlet and outlet of the tower, x_2 and x_1 are the mol fraction of gas A in liquid-phase at the inlet and outlet of the tower. As the height of the tower required z is expressed as z = $N_{OG}\,H_{OG}$, please **prove**

$$N_{OG} = \int_{y_1}^{y_2} \frac{dy}{y_e - y}, \quad H_{OG} = \frac{V'}{K_G a P}$$

where $K_G a$ [mol/s-m^3-kPa] is the overall gas-phase absorption coefficient, P [kPa] is the total pressure, V' is the flow rate of inert gas, and y_e is the mol fraction of A in gas-phase in equilibrium with mol fraction x of A in liquid-phase ($y_e = mx$).