

淡江大學 99 學年度碩士班招生考試試題

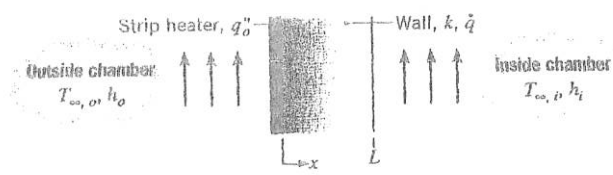
系別：化學工程與材料工程學系

科目：輸送現象與單元操作

准帶項目請打「V」	
V	計算機

本試題共 1 頁，4 大題

- (1) The air *inside* a chamber at $T_{\infty,i} = 60^\circ\text{C}$ is heated convectively with $h_i = 20 \text{ W/m}^2 \cdot \text{K}$ by a 200-mm-thick wall having a thermal conductivity k of $4 \text{ W/m} \cdot \text{K}$ and a uniform heat generation \dot{q} of 1000 W/m^3 . To prevent any heat generated within the wall from being lost to the *outside* of the chamber at $T_{\infty,o} = 25^\circ\text{C}$ with $h_o = 5 \text{ W/m}^2 \cdot \text{K}$, a very thin electrical strip heater is placed on the outer wall to provide a uniform heat flux, q_o'' .



- (a) What are the temperatures at the wall boundaries, $T(0)$ (10%) and $T(L)$ (5%), for the conditions where no heat generated within the wall is lost to the *outside* of the chamber?
- (b) Determine the value of q_o'' that must be supplied by the strip heater so that all heat generated within the wall is transferred to the *inside* of the chamber. (10%)
- (c) If the heat generation in the wall were switched off while the heat flux to the strip heater remained constant, what would be the steady-state temperature, $T(0)$, of the outer wall surface? (10%)

- (2) Helium gas at 25°C and 4 bars is stored in a spherical Pyrex container of 400-mm inside diameter and 50-mm thickness. What is the rate of mass loss (kg/s) from the container? (15%)

$$(D_{AB} = \frac{1}{\pi} \times 10^{-13} \frac{m^2}{s}; S = 10^{-3} \text{ kmol/m}^3\text{-bar})$$

- (3) A tray tower is absorbing ethyl alcohol from an inert gas stream using pure water at 303 K and 101.3 kPa. The inlet gas stream flow rate is 100 kg mol/h and it contains 2.5 mol % alcohol. It is desired to recover 96% of the alcohol. The equilibrium relationship is $y = 0.7x$ for this dilute stream. Using 1.5 times the minimum liquid flow rate, determine the number of trays needed (5%) and mole fractions of alcohol inlet and outlet liquid/gas streams. (20%)

- (4) In the equipment shown in the following figure, a pump draws a solution of specific gravity 1.64 from a storage tank through a 3-in. Schedule 40 ($A = 0.0513 \text{ ft}^2$) steel pipe. The efficiency of the pump is 75%. The velocity in the suction line is 3 ft/s. The pump discharges through a 2-in. Schedule 40 ($A = 0.0233 \text{ ft}^2$) pipe to an overhead tank. The end of the discharge pipe is 50 ft above the level of the solution in the feed tank. Friction losses in the entire piping system are $10 \text{ ft}\cdot\text{lb}_f/\text{lb}_m$. What pressure must the pump develop (lb_f/ft^2)? (15%) What is the power delivered to the fluid by the pump (hp)? (10%) (Please use American engineering system of units)

(hint: 1 hp = 550 ft·lb_f/s)

