

國立中正大學九十二學年度碩士班招生考試試題

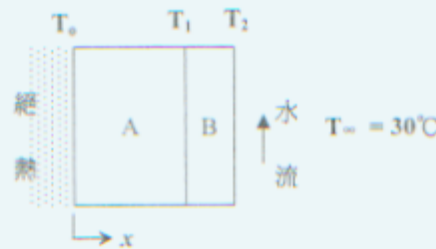
系所別：化學工程學系

科目：輸送現象與單元操作

第 1 頁，共 3 頁

1. (25 points)

有一輪壁由 A 與 B 兩種材料組成（如下圖），其中材料 A 厚度為 50mm, $k_A = 75 \text{ W/m} \cdot \text{K}$ 且均勻放熱 $1.5 \times 10^6 \text{ W/m}^3$ ；另一材料 B 厚度為 20mm, $k_B = 150 \text{ W/m} \cdot \text{K}$ ，且沒有放熱。已知材料 A 的一面為絕熱，而材料 B 的另一面使用 30°C 的水流冷卻且其 $h = 1000 \text{ W/m}^2 \cdot \text{K}$ 。（假設 AB 之間無熱傳阻力）



- 在 steady state 下，請計算出 T_0 、 T_1 與 T_2
- 並請畫出溫度之可能分佈圖

2. (25 points)

水上遊樂園內有一滑梯水道（寬度為 50cm），為了減少表面摩擦力，利用水流在滑梯表面形成一流動水膜。此水膜是經由滑梯頂端自然溢流產生，溜滑梯與地面角度為 45° 。假設此水膜在 fully developed、steady-state 下厚度為 2.5mm，且水膜與滑梯表面為 non-slip，請問

- 最大流速為多少？
- 平均流速為多少？
- 體積流量為多少？
- 作用在平行於滑梯面上（z 方向）之力為多少？

（註：水密度為 1 g/cm^3 ， μ 為 $10^{-2} \text{ g/cm} \cdot \text{s}$ ，重力加速度為 980 cm/sec^2 ）

（Hint: 利用 shell momentum balance）



國立中正大學九十二學年度碩士班招生考試試題

系所別：化學工程學系

科 目：輸送現象與單元操作

第 2 頁，共 3 頁

3. (20 points)

For each of the following 10 terms, select a **proper definition** from the pool of definitions (a) to (j) and a **proper short feature** from the pool of features from (k) to (p). (不要抄題，依序寫出配對即可)

- (1) Absorption
- (2) Adsorption
- (3) Crystallization
- (4) Dehumidification
- (5) Distillation
- (6) Drying
- (7) Filtration
- (8) Humidification
- (9) Leaching
- (10) Liquid extraction

Definitions:

- (a) The removal of solid particles from a fluid by passing the fluid through a porous medium.
- (b) The formation of solid particles within a homogeneous phase.
- (c) Soluble material is dissolved from its mixture with an inert solid by means of a liquid solvent.
- (d) A solute is removed from either a liquid or gas through contact with a solid adsorbent, the surface of which has a special affinity for the solute.
- (e) A pure liquid is partially removed from an inert or carrier gas by condensation. Usually, the carrier gas is virtually insoluble in the liquid.
- (f) A soluble vapor is removed from its mixture with an inert gas by means of a liquid.
- (g) A mixture of liquid is treated by a solvent that preferentially dissolves one or more of the components in the mixture.
- (h) A liquid, usually water, is separated by the use of hot gas.
- (i) To separate, by vaporization, a liquid mixture of miscible and volatile substances into individual components or, in some cases, into groups of component
- (j) Warm liquid is brought into contact with unsaturated gas, part of the liquid is vaporized and the liquid temperature drops.

Features:

- (k) The transfer of a solute from the gas phase into the liquid phase.
- (l) The transfer of a solute from the liquid phase into the gas phase.
- (m) The transfer of a solute from one liquid phase into a second immiscible liquid phase.
- (n) The transfer of a solute from a solid into a fluid (liquid or gas) phase.
- (o) The transfer of a solute from a fluid (liquid or gas) onto the surface of a solid.
- (p) The unit operation involving particulate solids.

4. (30 points)

A packed tower is designed to strip component A from an aqueous stream into a countercurrent flowing air stream. The packed tower having a cross-sectional area of 1 m^2 is operated at the conditions of 293 K and 1 atm. The inlet aqueous stream contains 2 mol % A and outlet 0.5 %. The inlet liquid flow is 100 kg mol water/h. The A-free air flow is 500 kg mol/h. At the tower's operating conditions, the system satisfies Henry's law with a Henry's constant of 0.3 atm/(kg mol fraction of A). Under the given flow conditions, the individual mass-transfer liquid coefficient, k_L , is equal to $1.0 \text{ kg mol}/(\text{h m}^2)$. Assume that 50% of the resistance to mass transfer is encountered in the liquid phase. The interfacial surface area per unit volume of this packed tower, a , is $200 \text{ m}^2/\text{m}^3$. Determine

- The overall mass-transfer coefficient based on the liquid-phase molar fraction gradient, K_L .
- The overall and individual mass-transfer coefficients based on the gas-phase molar fraction gradient, K_G and k_G .
- The volumetric overall mass-transfer coefficient, $K_G a$.
- The height of the packed tower based on $K_G a$.
- You have to draw a plot of y versus x for solving this problem and indicate the equilibrium curve and operating line on the plot. Here y and x are mass fractions of A in gas and liquid phases, respectively.