國立中正大學
113學年度碩士班招生考試
試題
[第1節]

科目名稱	輸送現象與單元操作
系所組別	化學工程學系

—作答注意事項—

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
3. 入場後於考試開始40分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

1. There is a vertical falling liquid film along an immovable solid surface, with the following information: The film length and width are L and W, respectively, the fluid density and viscosity are ρ and μ, respectively, and the flow and shear directions are along the z- and x-axis, respectively.

(a) Use **shell balance** to set up the steady-state momentum equation. 【10 分】

(b) If the fluid is Newtonian, solve the velocity profile $v_z(x)$. 【10 分】

(c) If the mass flow rate w is known, find an expression that can be used to determine the film thickness δ. 【10 分】

2. For the following macroscopic mechanical energy balance equation, provide the physical meaning of **each term**, where 1 and 2 denote the entrance and exit locations, respectively. 【20 分】

$$\frac{1}{2}(v_2^2 - v_1^2) + g(h_2 - h_1) + \int_{p1}^{p2} \frac{1}{\rho} dp = \widehat{W}_m - \sum_i \left(\frac{1}{2} v^2 \frac{L}{R_h} f\right)_i - \sum_i \left(\frac{1}{2} v^2 e_v\right)_i$$

3. A single pass heat exchanger is used for the heating of oil from 25 to 35°C; the oil flow rate is 12 kg/s (C_{po}= 2.5 KJ/kg · K). Hot water (C_{pw}= 4.5 KJ/kg · K) enters the shell at 80°C and leaves the shell at 55°C. The overall heat transfer coefficient based on the outside surface of the tube is estimated to be 1280 W/m^2 · K. If it is in a counter-flow type, please determine (a) the corrected logarithmic-mean temperature difference (LMTD) 【15 分】; (b) the required surface area in the exchanger. 【10 分】

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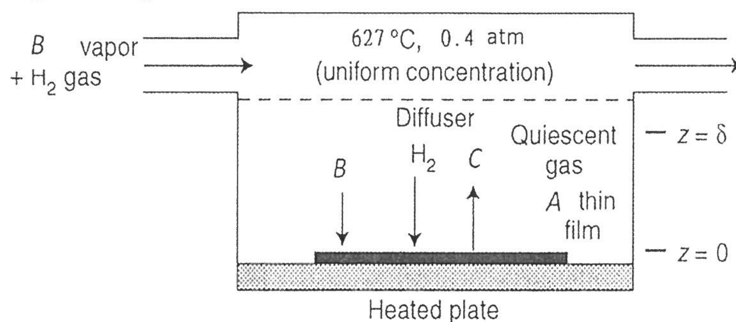
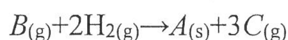
4. Consider the low-pressure chemical vapor deposition (LPVCD) diffusion reactor as show blew. It is desired to lay a thin film of the semiconductor *A*, onto a silicon wafer surface. *A* metal is not volatile, but its precursor (*B*, 114.72 g/gmol) is volatile. In the presence of an H_2 gas, at high temperature, *B* will decompose to solid *A* on a surface by the following reacting:





$$B_{(g)} + 2H_{2(g)} \rightarrow A_{(s)} + 3C_{(g)}$$

At 627°C, this surface reaction is diffusion limited.

a. Develop an integral model to predict the flux of *B* to the wafer surface. Keep your final model in algebraic form. Provide appropriate assumptions and boundary condition. At this point, you may not assume that the process is dilute. 【15 分】

For the part (b), consider a process where the feed gas consists of 99.98 mol% H_2 and 0.02 mol% *B*. The temperature and total system pressure are 627°C and 0.4 atm, respectively. The binary diffusion coefficient of *B* in H_2 at 727°C and 1 atm is known to be 2.0 cm^2/s.

b. What is the simplified form of the model previously developed in part (a)? 【10 分】

Hint: $D_{AB_{T2,P2}} = D_{AB_{T1,P1}} \left(\frac{P_1}{P_2}\right)\left(\frac{T_2}{T_1}\right)$