國立中央大學九十一學年度碩士班研究生入學試題卷

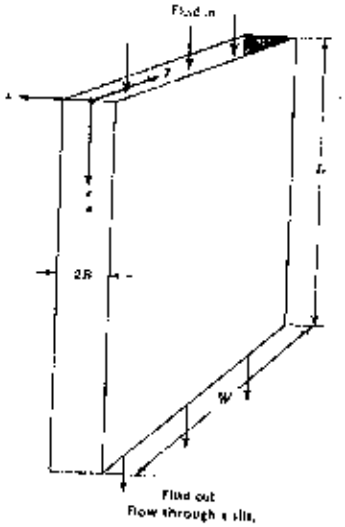
所別：化學工程與材料工程學系不分組　科目：輸送現象與單元操作　共 2 頁 第 1 頁

1. (25%) **Laminar Flow in a Narrow Slit**

A viscous fluid is in laminar flow in a slit formed by two parallel walls a distance 2B apart. (a) Obtain the velocity distribution $v_z(x)$ by solving the N-S equation. (10%) (b) Obtain the expression for the distribution of momentum flux. (10%) (c) What is the ratio of average to maximum velocity in the slit? (5%)

Hint: z-momentum:

$$\rho(v_x \partial v_z/\partial x + v_y \partial v_z/\partial y + v_z \partial v_z/\partial z) = -\partial p/\partial z + \mu(\partial^2 v_z/\partial x^2 + \partial^2 v_z/\partial y^2 + \partial^2 v_z/\partial z^2) + \rho g_z$$



2. (10%) **Determination of Viscosity (μ) from Terminal Velocity (v_t) of a Falling Sphere (radius R)**

Derive a relation that enables one to get the viscosity of a fluid by measuring the steady-state rate of fall of a sphere in the fluid. What is the range of applicability of Stokes law?

3. (15%) A steel tube (k=50 W/m K) of inner and outer diameter $D_i = 20mm$ and $D_o = 26mm$, respectively, is used to transfer heat from hot gases flowing over the tube ($h_o = 200W/m^2 \cdot K$) to cold water flowing through the tube ($h_i = 8000W/m^2 \cdot K$). For radial conduction in a cylindrical wall, the heat transfer rate is $q = 2\pi Lk(T_o - T_i)/\ln(D_o/D_i)$.

(a) What is the conduction resistance of the tube wall? (5%)

(b) What is the cold side overall heat transfer coefficient U_i? (10%)

注意：背面有試題

4. (20%) Forced air at 25°C and 10 m/s is used to cool electronic elements mounted on a circuit board. Consider a chip of length 4 mm and width 4 mm located 120 mm from the leading edge. Because the board surface is irregular, the flow is disturbed and the appropriate convection correlation is of the form $Nu_x = 0.04\,\mathrm{Re}_x^{0.9}\,\mathrm{Pr}^{1/3}$. Estimate the surface temperature of the chip, if the heat dissipation rate is 30 mW.
The properties of air (at 310 K):
$k = 27.0\times10^{-3} W/m\cdot K, \nu = 16.9\times10^{-6} m^2/s, \alpha = 24.0\times10^{-6} m^2/s$

5. (15%) The slow reaction A---> B + 2C takes place on the surface of a flat catalyst. The reaction is first order in A. Obtain (a) the concentration profile of A in the film surrounding the surface and (b) an expression for the flux of A at Z=δ.

6. (15%) The theoretical models for mass transfer at a fluid-fluid interface are flim theory, penmetration theory, surface renewal theory and etc....., please select one of the model and modify the model as there is reaction (interaction) between solutes.