淡江大學 101 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

考試日期：2 月 26 日(星期日) 第 2 節　　　本試題共 4 大題， 1 頁

1. Answer the following:
   (a) (5%) Distinguish the normal stresses (σ_{ii}) and shear stresses (τ_{ij}).
   (b) (8%) Define the thermal diffusivity of a solid and state its physical significance.
   (c) (12%) Give the physical significance of the three derivatives $\partial T/\partial t$, dT/dt and DT/Dt, in which T is the local fluid temperature and t is time.

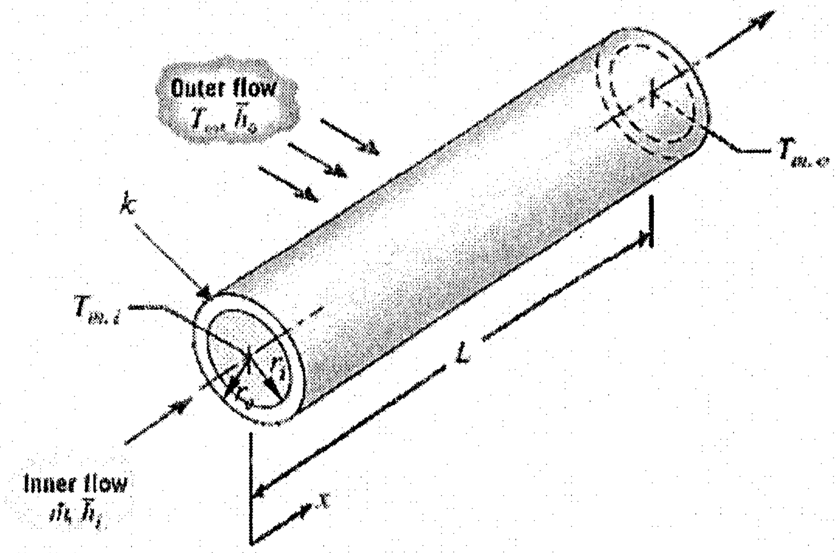
2. (25%) A fluid flows at steady state in a vertical tube under the action of an applied pressure gradient and gravity. The density of the fluid is ρ. The tube has a length L and a diameter D. The inlet and outlet pressures of the fluid are P_o and P_L, respectively. Use a shell balance to develop the axial z-component of the linear momentum equation.

3. (25%) The most useful concept to describe the process of gas absorption is given by the two-film theory. In the two-film theory, the transfer of solutes in the gas film is by means of diffusion. Show that for a binary system (the solute A and insoluble gas B), the molar flux of solute A (N''_A) in the gas film can be described by the following equation

$$N''_A = -D_v \frac{C_T}{C_B}\frac{dC_A}{dz}$$

where D_v is the diffusivity of A and z is the transfer direction of solute A. C_T, C_A, and C_B are the molar concentrations of the gas mixture, solute A, and insoluble gas B in the gas film, respectively.

4. (25%) For the following conditions



show that the heat transfer rate (q) between the outer fluid and inner fluid is

$$q = \bar{U} A_s \Delta T_{lm}, \quad \text{where} \quad A_s = 2\pi r_i L$$

$$\bar{U} = \frac{1}{\frac{r_i}{r_o}\frac{1}{\bar{h}_o} + \frac{r_i}{k}\ln\left(\frac{r_o}{r_i}\right) + \frac{1}{\bar{h}_i}}$$

$$\Delta T_{lm} = \frac{\Delta T_o - \Delta T_i}{\ln\left(\frac{\Delta T_o}{\Delta T_i}\right)}; \Delta T_o = T_\infty - T_{m,o}$$

$$\Delta T_i = T_\infty - T_{m,i}$$