國立中正大學八十八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

1. Explain the following terms in detail: (16 分)
   (a) What are the physical meanings of $\nabla \cdot v$ and $\nabla \cdot v = 0$? (v: velocity of fluid)
   (b) What is the basic concept of boundary layer theory? Two-film theory? Penetration theory?
   (c) What is the non-Newtonian fluid?
   (d) What is the Bernoulli law?

2. Derive the equation of continuity in terms of cylindrical coordinates by shell momentum balance? (8 分)

3. A Newtonian fluid is falling downward as a film (film thickness δ) along a vertical plane at steady state. Suppose that the entrance and exit effects are both neglected. Please use the shell momentum balance to derive the governing equation. Also, obtain the velocity profile in using appropriate assumptions. Explain the boundary conditions why you use. (10 分)

4. (a) Much of the heat loss from residences in cold climates is through the glass windows (1/8 inch thick). We carry out an analysis here to provide some guidelines for reduction of this loss. We begin by considering the situation, in which a plane slab of solid glass material with a thermal conductivity k (0.0017 cal/s cm K) is exposed to two different temperatures. Suppose that the room temperature and outside temperature are T_h and T_c, respectively. We assume that the air on either side of the window plane is well mixed by convection, so that a good approximation is $T_h = T_1 = 60°F$ and $T_c = T_2 = 20°F$, where T_1 and T_2 are the glass temperature adjacent to the air at inside and outside of the room, respectively. Find the heat flux in terms of Btu/h ft^2 through the window at steady state. Derive the equation with appropriate assumptions before you make calculations. (8 分)
   (b) Suppose we have a room, insulated except for a glass window (thickness 1/8

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inch.) having an area of 6 ft^2. The room has dimensions 9x12x8=864 ft^3. How long will it take for the room to cool from 60°F to 45°F. Assume that the air in the room is well mixed and the outside temperature remains constant at 20°F. The thermal conductivity k of the glass window is 0.41 Btu/hr/ft/R. Be sure to derive the equation with appropriate assumptions before you make calculations. (8%)

5. Briefly explain the following dimensionless numbers and their physical meanings: Reynolds number, Schmidt number, Nusselt number and Grashof number. (15 分)

6. The following concentration profile has been proposed for the concentration boundary layer

$$C_A - C_{A,s} = 1 - a\cos(by)$$ (15 分)

(a) What boundary conditions are necessary for the evaluation of constants a and b?

(b) Solve $C_A - C_{A,s}$.

(c) Is the proposed concentration profile a good selection? Why?

7. A liquid mixture of A and B is being separated by a distillation operation. The more volatile component A is transferred from the liquid phase into the vapor phase, while B is transferred in the opposite direction. Both components are diffusing through a gas film of 1 inch thick. At the temperature of this system, the difference in the latent heats of vaporization for the two compounds predicts 2 moles of A will vaporize per mole of B that is condensing. The mole fraction of A is 0.8 at one side of the film and 0.3 on the other side. Solve y_A, the mole fraction of A, as a function of z, measured from the liquid surface. (20 分)