國立中央大學 111 學年度碩士班考試入學試題

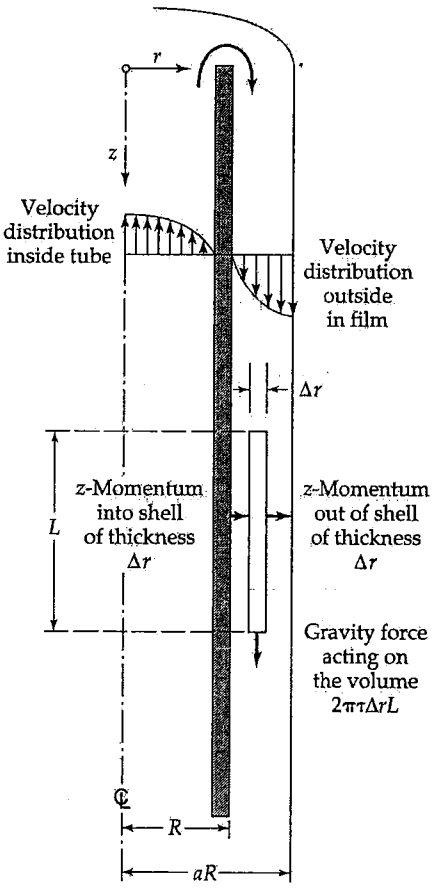
所別： 化學工程與材料工程學系 碩士班 甲組(一般生)　　共 2 頁　第 1 頁

科目： 輸送現象與單元操作

1. (15%) Please answer the following questions:
   (a) (5%) What's the physical meaning of net positive suction head (NPSH)? Why do we need a sufficient NPSH?
   (b) (10%) Please name three devices which can measure the volumetric flow rate of pipe directly or indirectly. You also have to explain the theory why the devices can measure the volumetric flow rate.

2. (20%) In a gas absorption experiment a viscous Newtonian fluid flows upward through a small circular tube and then downward in laminar flow on the outside (see the figure below). Please find the velocity distribution and the mass rate of flow in the falling film (neglecting end effects).

   Note: $\int x^p \ln(ax)\, dx = \frac{x^{p+1}}{p+1}\ln(ax) - \frac{x^{p+1}}{(p+1)^2} \quad (x \text{ and } a > 0,\ p \neq -1)$



注意:背面有試題

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3. (30%) A standard 2 inch steel pipe is insulated with 1.25 inches of a molded high-temperature covering made of earth and asbestos (k = 0.058 BTU/(hr·ft·°F)). The covering is insulated with 2.5 inches of laminated asbestos felt (k = 0.042 BTU/(hr·ft·°F)). In a test, the temperature of the surroundings was 86°F, the temperature of the steam was 900°F, and the temperature of the outer surface of the lagging was 122°F.
   (a) (10%) Calculate the heat loss in BTU/hr for 1 foot of length of pipe,
   (b) (10%) Calculate the temperature at the interface between the two layers of insulation, and
   (c) (10%) Calculate the, h, in BTU/(hr·ft^2·°F) which is the heat transfer coefficient between the outer surface of the lagging and the room.

   Data: Internal Diameter of pipe: 2.07 inches
   Outside Diameter of pipe: 2.37 inches
   k of steel: 23.5 BTU/(hr·ft·°F)

4. (35%) A dye in an industrial process stream needs to be removed to conform to environmental regulations. The stream is introduced at the top of a unit process tower where it flows countercurrent to a stream of air. A measurement at one point in the tower indicates that the process stream contained 1 x 10^{-3} g mol of dye per cubic meter, whereas the air stream contains virtually no dye. Under the operating conditions of the tower, the film mass-transfer coefficients are k_L = 5 x 10^{-4} kg mol/m^2·s·(kg mol/m^3) and k_G = 0.01 kg mol/m^2·s·atm. Assume the concentrations are in the Henry's law regime, where Henry's constant is 10 atm/(kg mol/m^3).
   (a) (10%) What is the **overall mass flux** of the dye in the tower?
   (b) (10%) What are the **overall mass-transfer coefficients**, K_L and K_G?
   (c) (5%) What type of unit operation is this tower?
   (d) (10%) What theory is used to describe the mass transfer between phases in this case? Name the two principal assumptions of this theory.

注意:背面有試題