國立雲林科技大學 108 學年度 碩士班招生考試試題

系所：化材系

科目：單元操作與輸送現象

1. Please explain the following terms:
   (a) incompressible fluid (3%)
   (b) hydraulic radius (3%)
   (c) kinematic viscosity (3%)
   (d) Newtonian fluid (3%)
   (e) friction factor (3%)

2. A packed bed is composed of cylinders having a radius R = 0.01 m and a length h = 0.02 m. The bulk density of the overall packed bed is 950 kg/m^3 and the density of the solid cylinders is 1600 kg/m^3.
   (a) What is the void fraction? (3%)
   (b) What is the effective diameter of the particles? (6%)
   (c) What is the ratio of total surface area in the bed to total volume of bed (void volume plus particle volume)? (6%)

3. In a process in which A is used as a solvent, it is evaporated into dry nitrogen. At 300 K and 101.3 kPa, the resulting mixture has a percentage relative humidity of 50. It is required to recover 85 % of the A present by cooling to 285 K and compressing to a suitable pressure. What should this pressure be? (20%)
   Vapor pressure of A at 300 K = 12.3 kPa; at 285 K = 6 kPa
   Molecular weight of A = 80 g/mole

4. A copper sphere of radius R and thermal conductivity k is initially in equilibrium at 500 K in a hot oil bath. It is suddenly removed from the bath and cooling in air at 300 K. The convection heat transfer coefficient for this cooling process is h.
   (a) Write the conservation equation of the transient conduction occurs in the sphere. (6%)
   (b) What are the initial condition and the boundary conditions of this system? (3%)
   (c) Under what physical condition the temperature in the sphere can be regarded as uniform? (5%)
   (d) Write the approximate energy balance equation for the transient conduction in this solid sphere if the lumped capacitance method can be applied. (6%)

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5. Gas A diffuses through a stagnant film of gas surrounding a catalyst particle. A undergoes the following reaction $2A \rightarrow B$ at the particle surface, instantaneously, B diffuses back through the stagnant film into the bulk. The catalytic surface is considered as a flat surface. Assuming isothermal conditions,
   (a) obtain an expression for the local reaction rate in terms of the effective gas-film thickness (δ) and the bulk gas stream compositions X_{Ao} and X_{Bo} (7%)
   (b) evaluate the concentration profiles of A in the stagnant film. (8%)

6. Please give the SI units of the following terms:
   (a) thermal conductivity (3%)
   (b) heat transfer coefficient (3%)
   (c) thermal diffusivity (3%)
   (d) mass transfer coefficient (3%)
   (e) Nusselt number (3%)