大同大學 100 學年度研究所碩士班入學考試試題

考試科目：單操與輸送　　所別:化學工程研究所　　

註:本次考試 不可以參考自己的書籍及筆記； 不可以使用字典； 可以使用計算器。

1. Give the units of the following terms:
   (a) viscosity (b) volume flow rate (c) mass flux
   (d) thermal diffusivity (e) heat transfer coefficient. (15%)

2. Define and exlpain the following terms:
   (a) Newtonian fluid and non-Newtonian fluid.
   (b) potential flow (c) Prandtl mixing length (15%)

3. Water flows from the bottom of a large tank where the pressure is 105 psig through a pipe to a turbine which produces 6.35 hp. The pipe leading from the turbine is 60 ft below the bottom of the tank. In this pipe the pressure is 55 psig, the velocity 70 ft/s, and the flow rate 100 lb/s. If the friction loss in the system, excluding the turbine, is 40 $(ft)(lb_f)/lb$, find the efficiency of the turbine.(Given: The density of the water is 62.4 lb_m/ft^3. And, 1 hp = 550 $ft\text{-}lb_f/sec$.) (10%)

4. Derive and find the Nusselt number for the heat conduction and convection from a sphere to a stagnant fluid. (10%)

5. The wall of a house has an average thermal conductivity of 0.1 Btu/(h-ft-°F). The bulk outside air temperature is 0 °F and the bulk inside air temperature is 70 °F. If the wall thickness is 3.68 in., what is the inside wall surface temperature in °R ? Assume that the heat transfer coefficient on each surface can be represented by the empirical equation, $h = 0.18(\triangle t)^{1/3}$, where h is in $Btu/(h\text{-}ft^2\text{-}°F)$, and $\triangle t$ is in °F. (10%)

6. It is desired to estimate the time required to evaporate the water into the surrounding quiescent air. The water layer is 0.04 in. thick and may be assumed to remain at a constant temperature of 75 °F. The air is also at 75°F, 1.0 atmosphere with an absolute humidity of 0.002 lb H_2O/lb dry air (the saturated humidity is 0.0189 lb H_2O/lb dry air). The evaporation is assumed to take place by molecular diffusion through a gas film 0.2 in. thick.(Note: the diffusion coefficient of water vapor in air is 0.259 cm^2/s) (15%)

7. The correlating equation for the heat transfer coefficient for turbulent flow in a pipe is $Nu = 0.023\ Re^{0.8}\ Pr^{1/3}$. What should be the corresponding equation for the mass transfer coefficient when the transfer is to a turbulent fluid flowing in a pipe based on the Chilton-Colburn relationship (derive it). (10%)

8. An absorber is to be designed to remove a VOC pollutant from an exhaust gas stream. Fifteen cubic meters per minute of gas at 289 K and 1.013×10^5 Pa containing 5.0 mol% VOC is fed to the bottom of the absorption tower. By feeding a VOC-free solvent stream to the top of the tower, the VOC concentration is reduced to 0.3 mol%. The solvent stream leaves the tower containing 3.65 mol% VOC. With the specified stream flow rates, the overall mass transfer coefficient, K_Ya equals 52.0 $mol/(s\text{-}m^2\text{-}\triangle Y_A)$. The cross-sectional area of the tower is 0.2 m^2. At 289 K, the equilibrium for the VOC-solvent system is $Y_A = 0.8\ X_A$. Determine the height of the tower. (Note: Y_A = mol VOC / mol VOC-free gas, X_A = mol VOC / mol VOC-free solvent) (15%)