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國立臺北科技大學 115 學年度碩士班招生考試

系所組別：3510 化學工程與生物科技系化學工程碩士班甲組

第一節　單元操作與輸送現象　試題

注意事項：

1. 本試題共 5 題，每題 20 分，共 100 分。
2. 不必抄題，作答時請將試題題號及答案依照順序寫在答案卷上。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

1. An incompressible Newtonian fluid in steady flow that is flowing continuously at 250°F along 2500 ft pipe with a constant diameter of 4 in and a volumetric flow rate of 2.5 ft^3/s. The fluid properties are the kinematic viscosity -7.41×10^{-6} ft^2/s and surface tension -0.0435 N/m. Assuming that flow is laminar and fully developed with a pressure drop of 256 lb_f/ft^2. Calculate the density of fluid if no slip boundary condition applies (20%).
2. Equimolar counter diffusion is occurring at steady state in a tube 0.11 m long containing N_2 (A) and CO (B) gases at a total pressure of 1.0 atm abs, and 298 K. The partial pressure of N_2 is 80 mmHg at one end and 10 mmHg at the other end. Calculate (a) molecular diffusivity D_{AB} of the N_2 into CO (10%), ($\Sigma\upsilon_A$=17.9; $\Sigma\upsilon_B$=18.9) (b) the flux in kg mol/s·m^2 at 298 K for N_2 (10%).

$$D_{AB}=\frac{1.00\times10^{-7}T^{1.75}(1/M_A+1/M_B)^{1/2}}{P[(\Sigma\upsilon_A)^{1/3}+(\Sigma\upsilon_B)^{1/3}]^2}$$

3. A feed of 4535 kg/h of a 2.0 wt% salt solution at 311 K enters continuously a single effect evaporator and is being concentrated to 3.0 wt%. The evaporation is at atmospheric pressure and the area of the evaporator is 69.7 m^2. Saturated steam at 383.2 K is supplied for heating. Since the solution is dilute, it can be assumed to have the same boiling point as water. The hear capacity of the feed is Cp=4.10 kJ/kg·K. Calculate the amounts of vapor and liquid product (10%), and the overall heat-transfer coefficient (10%). (the latent heat of steam at 383.2 K is 2230.2 kJ/kg; and enthalpy of vapor is 2257.06 kJ/kg at 273.2 K)
4. At the end of water pipe of 3 in diameter is a nozzle which discharges a jet having a diameter of 1.5 in into the open atmosphere. The pressure in pipe is 60 psig (pounds per square inch gage), and the rate of discharge is 400 gal/min. What are the magnitude and the direction of the force necessary to hold the nozzle to the pipe (20%). (1 gal=7.48 ft^3)
5. A steel pipeline 52.5 mm inner diameter and 3.91 mm thickness, contains saturated steam at 121.1°C. The line is covered with 25.4 mm of insulation. Assuming that the inside surface temperature of the metal wall is 121.1°C and the outer surface of the insulation is at 26.7°C. Calculate the heat loss for 30.5 m of pipe (10%), and the kg of steam condensed per hour in the pipe due to the heat loss (10%). (thermal conductivity of the steel is 45 W/m·K and 0.182 for insulation, the latent heat of steam is 2199.5 kJ/kg)