# 明新科技大學九十五學年度研究所 ☑ 碩 士 班 ☐ 碩士在職專班 招生考試試題卷

| 所別 | 科目 | 准考證號碼(請考生填入) | 考試日期 | 節次 | 第1頁/共1頁 |
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| 化學工程研究所 | 輸送現象與單元操作 | | 95年5月7日 | 第一節 | |

一、 A fluid flowing in laminar flow in the x direction between two parallel plates has a velocity profile given by the following: $v_x = v_{x,max}(1-(y/y_0)^2)$ where $2y_0$ is the distance between the plates, y is the distance from the center line, and $v_x$ is the velocity in the x direction at position y. Derive an expression for the average velocity $v_{x,av}$. (20%)

二、 A liquid mixture containing 15 mol% n-heptane and 85 mol% n-octane is fed at its boiling point to the top of a stripping tower at 101.32 kPa abs. The bottom product is to contain 97 mol% n-octane. For every 5 mol of feed, 4 mol of vapor is withdrawn as top product. Calculate the number of theoretical plates required. The equilibrium data below are given as mole fraction of n-heptane. (20%)

| | | | | | |
|---|---|---|---|---|---|
| x | 0.284 | 0.097 | 0.067 | 0.039 | 0.012 |
| y | 0.459 | 0.184 | 0.131 | 0.078 | 0.025 |

三、 Ammonia gas is diffusing through $N_2$ under steady state conditions with $N_2$ nondiffusing since it is insoluble in one boundary. The total pressure is 1.0 atm and the temperature is 298 K. The partial pressure of $NH_3$ at one point is 13000 Pa, and at other point 20 mm away it is 6000 Pa. The $D_{AB}$ for the mixture at 1.0 atm and 298 K is $2.30\times10^{-5}$ $m^2/s$. Calculate the flux of $NH_3$ in $kgmol/m^2.s$. (20%)

四、 The velocity profile of a fluid flowing upward through an annulus is

$$v_z = \frac{(P_0 - P_L)R^2}{4\mu L}\left[1-\left(\frac{r}{R}\right)^2+\left(\frac{1-\kappa^2}{\ln(1/\kappa)}\right)\ln\left(\frac{r}{R}\right)\right],$$

(a) Show that the average velocity is $\langle v_z \rangle = \frac{(P_0 - P_L)R^2}{8\mu L}\left[\frac{1-\kappa^4}{1-\kappa^2}-\frac{1-\kappa^2}{\ln(1/\kappa)}\right]$. (15%)

(b) Derive the volumetric flow rate of this fluid. (5%)
(R is the radius of the outer pipe, κR is the radius of the inner pipe)

五、 In a process producing $KNO_3$ salt, 1000 kg/h of a feed solution containing 20 wt% $KNO_3$ is fed to an evaporator, which evaporates some water at 422 K to produce a 50 wt% $KNO_3$ solution. This is then fed to a crystallizer at 311 K, where crystals containing 96 wt% $KNO_3$ are removed. The saturated solution containing 37.5 wt% $KNO_3$ is recycled to the evaporator. Calculate the rates of recycle stream and the product stream of crystals in kg/h. (20%)