107CH01

國立臺北科技大學 107 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.本試題共六題，共 100 分。
2.請標明大題、子題編號作答，不必抄題。
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. Describe and explain the following briefly
   ① What are the types and used effect of extended surface heat change equipment. 4%
   ② Net positive suction head (NPSH) and cavitation. 4%
   ③ Duhring's rule for boiling-point elevation. 4%
   ④ Higbie's penetration theory model of mass transfer. 4%
   ⑤ What are the total moisture content and drying rate, and plot the figure of drying rate vs free moisture. 4%
2. Water in an open cylindrical tank 15 ft in diameter discharge into the atmosphere through a nozzle 2 in. in diameter. Neglecting friction and the unsteadiness of the flow, find the time required for the water in the tank to drop from a level of 28 ft above the nizzle to the 4 ft level. 10%
3. A slightly soluble component in a gas stream is absorbed by water, using a packed tower. The equilibrium relationship for the soluble component is y = 5x. The terminal condition of the tower are

	Top	Bottom
x	0	xb
y	0.01	0.03

   ① Calculate the minimum water rate (mol water/ mol gas). 5%
   ② For a water rate twice as the minimum, how many overall gas phase transfer units are needed? What is xb in this case? 10%
   ③ If Hx = 0.5 m and Hy = 0.2 m, what is the height of the packed section?(Hx and Hy are the heights of transfer unit based on the liquid and gas films). 5%
4. Helium gas at 293 K is separated from other components of a gas mixture by its selective diffusion through the wall of a Pyrex glass tube. Under steady-state conditions, the partial pressure of helium at the inner and outer surfaces of the Pyrex tube are 1.5 bar and 1 bar, respectively. If the wall of the Pyrex tubing is 3 mm, determine ① the flux of He through a tube having an inside diameter of 1 cm (10%), and ② the concentration profile $C_A(r)$ of helium within the wall (10%). ($D_{AB} = 4.49\times10^{-15}$ m^2/s at 293 K)
5. The double –pipe heat exchanger is essentially a set of concentric pipes. One fluid flows within the smaller pipe and the other in the annulus. For such an exchanger (inside pipe outer diameter is 2 cm; outside pipe inner diameter is 4 cm), water flows in the annular space at an average velocity of 1.5 m/sec. The water, which cools an organic flowing in the central pipe, has a temperature change from 16 ℃ to 28 ℃. Calculate the heat transfer coefficient for the water assuming that the exchanger is heavily insulated and that the wall temperature on the inside of the annulus is 30℃. (Cp = 4186 J/Kg·℃; k = 0.599 W/m·℃; water viscosity $\mu = 10.54\times10^{-4}$ kg/m·s (16℃); $\mu = 9.67\times10^{-4}$ kg/m·s (22℃); $\mu = 8.80\times10^{-4}$ kg/m·s (28℃); $\mu = 8.516\times10^{-4}$ kg/m·s (30℃)). 20%
6. Find the temperature profile for the laminar flow of a Newtonian fluid (constant density and thermal conductivity) if there is a constant energy flux at the wall. Flow is along the tube axis (z direction). This means that the only velocity is Vz. The viscous dissipation is neglected. 10%