國立臺北科技大學 111 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. Describe and explain the following briefly

   ① To write down the define of the Reynolds number and describe the laminar flow and turbulent flow. (4%)

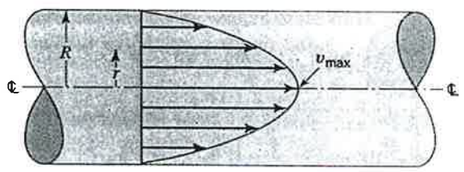
   ② To write down the define of hydraulic radius and equivalent diameter D_{eq}, and what is the hydraulic radius for annulus between two concentric pipes? (4%)

   ③ Define the reflux and the used reason in the operation, what are the minimum reflux ratio and optimum reflux ratio? (4%)

   ④ What is the effect of channeling? and to interpret the loading point and flooding point? (4%)

   ⑤ Interpret the leaching and liquid extraction, and their application. (4%)

2. A parabolic velocity profile of an incompressible fluid in a circular conduit, as figure. What is the average velocity (10%) and the sheer stress at the tube wall (10%)?



$$v = v_{max}\left[1 - \left(\frac{r}{R}\right)^2\right]$$

3. The heat loss from a boiler is to be held at a maximum of 1000 Btu/hr·ft^2 of wall area. ①What thickness of the asbestos (k = 0.1 Btu/h·ft·°F) is required if the inner and outer surfaces of the insulation are to be 1800°F and 500°F, respectively? (8%) If a 3-in-thick layer of kaolin brick (k = 0.07 Btu/h·ft·°F) is added to the outside of asbestos, ② what heat flux will result if the outside surface of the kaolin is 200 °F? (6%) ③ what will be the temperature at the interface between the asbestos and kaolin? (6%)

4. A sphere of naphthalene having a radius of 5.0 mm is suspended in a large volume of still air at 318 K and 101.32 kPa. The surface temperature of the naphthalene is 318 K and its vapor pressure at 318 K is 0.555 mmHg. The D_{AB} of naphthalene in air at 318 K is 6.92×10^{-6} m^2/s. ① Calculate the rate of evaporation of naphthalene from the surface. (10%) ② Calculate the time in seconds for complete evaporation. The density of naphthalene is 1.14 g/cm^3 and molecular weight is 128.2 g/mol) (10%)

5. A single-effect evaporator is concentrating a feed solution of organic solution from 10 to 60%. The boiling-point elevation of solution is negligible. The heat capacity of feed is Cp= 4.0 kJ/kg·K and the feed enter at 15.6 °C. Saturated steam (T = 100 °C, λs = 2257.1 kJ/kg) at 101.32 kPa is available for heating, and the pressure of vapor space of the evaporator is 15.3 kPa (T = 54.3 °C and Hv = 2372.4 kJ/kg). A total of 4500 kg/h of water is to be evaporated. The overall heat transfer coefficient is 2000 W/m^2·K. What is the required surface area in m^2 (8%), the steam consumption (8%) and the steam economy (4%)?