

# 淡江大學 102 學年度碩士班招生考試試題

系別：化學工程與材料工程學系

科目：輸送現象與單元操作

考試日期：3月10日(星期日) 第2節

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1. For a Newtonian fluid flowing in a horizontal pipe, answer the following questions:
  - (a) Describe the difference between laminar and turbulent flows including the velocity profiles and flow characteristics. (10%)
  - (b) Describe the definitions of Fanning friction factor and Reynolds number including their physical meaning and all variables. (10%)
  - (c) Sketch a plot of Fanning friction factor versus Reynolds number. What's the effect of pipe wall roughness? (10%)
  - (d) A liquid having a density of  $800 \text{ kg/m}^3$  and a viscosity of  $1 \times 10^{-3} \text{ Pa}\cdot\text{s}$  is flowing through a horizontal straight pipe at a velocity of  $0.45 \text{ m/s}$ . The pipe diameter is  $2 \text{ mm}$ . For a length of pipe of  $50 \text{ m}$ , calculate the friction loss. (10%)
  
2. For a fluid flowing over an isothermal flat plate, answer the following questions:
  - (a) Describe the developments of velocity and thermal boundary layers from the leading edge in the flowing direction. (5%)
  - (b) What's the boundary layer separation? Why does it occur? (5%)
  - (c) Sketch a plot to show the variations of average heat transfer coefficient, local heat transfer coefficient and velocity boundary layer thickness in the flowing direction. (5%)
  - (d) Air at a pressure of  $6 \text{ kN/m}^2$  and a temperature of  $300^\circ\text{C}$  (kinematic viscosity =  $5.21 \times 10^{-4} \text{ m}^2/\text{s}$ , thermal conductivity =  $36.4 \times 10^{-3} \text{ W/m}\cdot\text{K}$ , Prandtl number ( $\text{Pr}$ ) =  $0.687$ ) flows with a velocity of  $10 \text{ m/s}$  over a flat plate  $0.5 \text{ m}$  long. Estimate the cooling rate per unit width of the plate needed to maintain it at a surface temperature of  $27^\circ\text{C}$ . [Empirical equation: the average Nusselt number  $\overline{Nu} = 0.664 \text{Re}_x^{1/2} \text{Pr}^{1/3}$  for  $\text{Pr} \geq 0.6$ ] (15%)
  
3. Answer the following questions for distillation operations:
  - (a) Describe the tray types for plate columns and the factors determining column performances. (10%)
  - (b) Sketch a plot to show the T-xy diagram for a binary mixture under a given pressure. Describe the saturation curves for liquid and vapor phases and the tie lines. Describe how to separate the components in the binary mixture using distillation. (10%)
  - (c) What are azeotrope and azeotropic distillation? (10%)