

# 淡江大學 98 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

准帶項目請打「V」	
✓	簡單型計算機

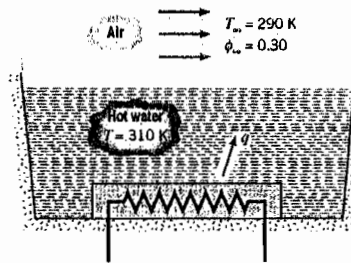
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1. Answer the following questions:

- (a) Describe the Dalton's law, the Raoult's law, and the Henry's law. Also, state the limitations of each law. [10%]
- (b) What is the major difference in operation condition between a flash distillation and a differential distillation? [5%]
- (c) When will a liquid be boiled? [5%]
- (d) Translate the following text, in meaning, into Chinese: [10%]

*Fins are used to increase the heat transfer from a surface by increasing the effective surface area. However, the fin itself represents a conduction resistance to the heat transfer from the original surface. For this reason, there is no assurance that the heat transfer rate will be increased through the use of fins. An assessment of this matter may be made by evaluating the fin effectiveness  $\epsilon_f$ . It is defined as the ratio of the fin heat transfer rate to the heat transfer rate that would exist without the fin.*

2. You have installed a circular hot tub in the back yard and find that for the typical operating conditions as described in the figure, water must be added at a rate of 0.001 kg/s in order to maintain a fixed water level in the tub. The tub is well insulated on its sides and bottom, and the temperature of the makeup water is equal to that of the tub water. At what rate must electrical heaters supply energy to maintain the tub water at 310 K? [25%]



Note: The following data may be required in calculation:

Air ( $T = 300\text{K}$ , 1 atm):  
 $\rho = 1.161 \text{ kg/m}^3$ ,  
 $c_p = 1007 \text{ J/(kg} \cdot \text{K)}$ ,  
 $\alpha = 22.5 \times 10^{-6} \text{ m}^2/\text{s}$ ;

Sat. water vapor ( $T = 310\text{K}$ ):  
 $\lambda = 2414 \text{ kJ/kg}$ ,  
 $\rho_{A,sat}(T) = 0.0436 \text{ kg/m}^3$ ,

Air-water vapor (298K):  
 $D_{AB} = 26 \times 10^{-6} \text{ m}^2/\text{s}$

Sat. water vapor ( $T = 290\text{K}$ ):  
 $\rho_{A,sat}(T) = 0.0143 \text{ kg/m}^3$ .

3. In the two-film theory, the transfer of solutes in the gas film is by means of diffusion. Show that for a binary system (the solute  $A$  and insoluble gas  $B$ ), the molar flux of solute  $A$  ( $N_A^*$ ) in the gas film can be described by the following equation

$$N_A^* = -D_v \frac{C_T}{C_B} \frac{dC_A}{dx}$$

where  $D_v$  is the diffusivity of  $A$  and  $x$  is the transfer direction of solute  $A$ .  $C_T$ ,  $C_A$ , and  $C_B$  are the molar concentrations of the gas mixture, solute  $A$ , and insoluble gas  $B$  in the gas film, respectively. [15%]

4. A horizontal annulus is 27 ft long. The outside radius of the inner cylinder is 0.495 in.; the inside radius of the inner cylinder is 1.1 in. A 60% aqueous solution of sucrose ( $C_{12}H_{22}O_{11}$ ) is to be pumped through the annulus at  $20^\circ\text{C}$ . At this temperature the fluid density is  $80.3 \text{ lb}_m/\text{ft}^3$  and its viscosity is  $136.8 \text{ lb}_m/\text{ft} \cdot \text{h}$ . What is the volume rate of flow when the impressed pressure drop is 5.39 psi? [30%]