淡江大學九十三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「○」否則打「x」
簡單型計算機

P.1

本試題共 2 頁

1. Compute the horsepower needed to pump water in the piping system shown in Figure 1. Water to be delivered to the upper tank at a rate of $5.7\times10^{-3}\ \mathrm{m^3/s}$. All of the piping is 10.16 cm I.D. smooth circular pipe. The pump efficiency is unity. The friction-factor-Reynolds-number correlation can be expressed for smooth pipe as $f=0.0791\,\mathrm{Re}^{-1/4}$. (Note: 1 hp=0.7457 kW). (20%)

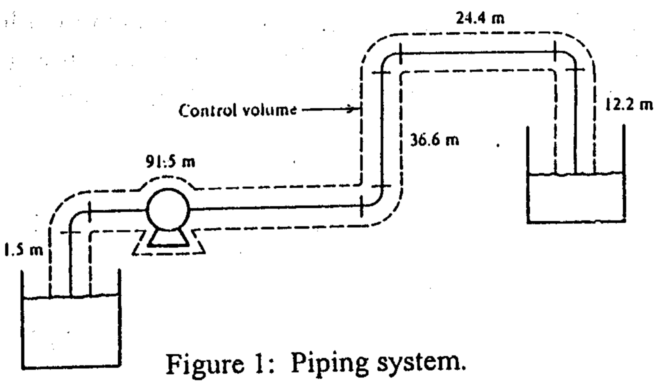

Figure 1: Piping system.

2. It is desired to develop the steady-state tray composition for a six-plate absorption column. It can be assumed that a linear equilibrium relation holds between liquid (x_m) and vapor (y_m) on each plate;

$$y_m = ax_m + b$$

The inlet composition to the column x_0 and y_7 are specified along with the Liquid (L) and gas (G) phase flow rates. The system is shown schematically in Fig. 2. To solve the problem by computing the tray compositions with $x_0=0$ and $y_7=0.2$. A typical set of parameters for this problem is $a=0.72$, $b=0$, $G=66.7$ kgmole/min, and $L=40.8$ kgmole/min. (20%)

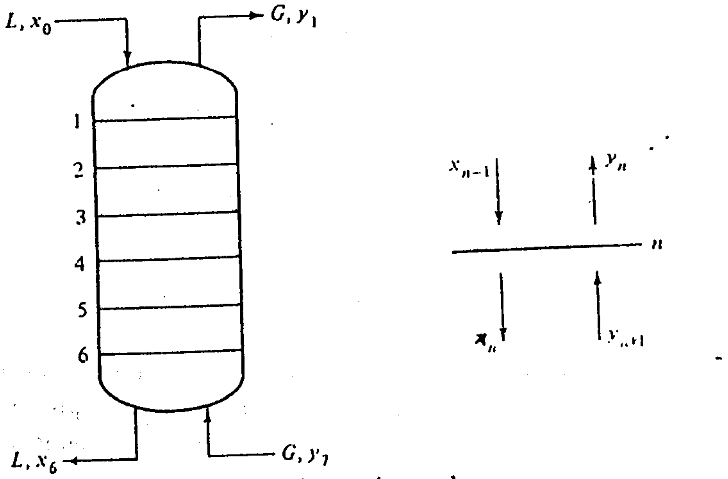

Figure 2: Absorption column.

3. The double pipe heat exchanger shown in Figure 3 is an example of the application of microscopic energy balances to heat transfer problems. In a general derivation of a model for the heat exchanger of Figure 3, energy balances will be written separately for both fluids, the tube wall, and the shell wall. Each will be

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written for the differential slice shown. The following assumptions will be made: (1) Both fluids are in plug flow with velocities independent of z. (2) In each of the four media the average temperatures in the radial direction are representative of the enthalpy. (3) properties such as densities and heat capacities are constant. (4) There is no heat conduction axially. (5) The shell is completely insulated. (6) Heat transfer in a radial direction can be represented by a lumped relation of the form of Newton's law of cooling with a constant heat transfer coefficient. Set up the energy balance equations with these assumptions. (20%)

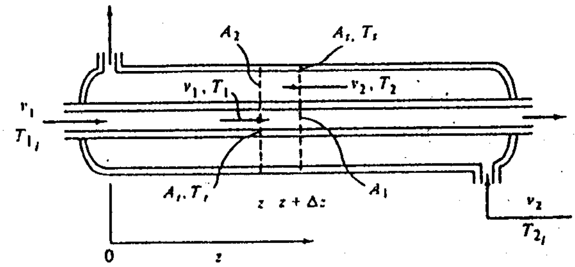

Figure 3: Double pipe heat exchanger in countercurrent flow.

4. A batch (or more precisely, semi-batch) distillation unit is charged with 100 mole of a 60 mole% benzene-40 mole% toluene mixture. At any given instant the vapor leaving the still may be considered to be in equilibrium with the remaining liquid. The benzene mole fraction in the exit vapor, y, and the benzene mole fraction in the remaining liquid, x, are related by the expression $y = \dfrac{2.6x}{1+1.6x}$.
Derive an equation relating the amount of liquid remaining in the still to the mole fraction of benzene in the liquid. (20%)

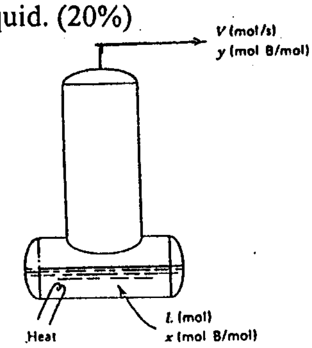

Figure 4: Distillation unit.

5. A gas stream containing 60 wt% ethane and 40wt% butane is to be heated from 150 to 250 K at a pressure of 5 bars. Calculate the required heat input per kg of the mixture, neglecting potential and kinetic energy changes and using the given enthalpy data for C_2H_6 and C_4H_{10}. (20%)

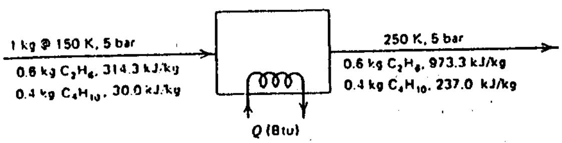

Figure 5: A two-component process.