淡江大學九十一學年度碩士班招生考試試題

系別：化學工程學系　　科目：化工熱力學 50%

86-1

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Problem 1: 20 points

One kmole of ideal gas with a heat capacity of C_p = 29.3 kJ/kmol·K undergoes the following three-step process:

Step 1: The gas is heated at constant volume from 300K and 0.1 MPa until the pressure reaches 0.2 MPa.

Step 2: The gas is expanded adiabatically and reversibly to a pressure of 0.1 MPa.

Step 3: At a constant pressure of 0.1 MPa, the gas is cooled to 300K.

Determine the heat and work effects for <u>each step</u>.

(Gas constant **R** = 8.314 kJ/kmol·K = 0.008314 MPa·m^3/kmol·K)

Problem 2: 10 points

Calculate the ***fugacity*** of carbon dioxide at 100°F and 200 psia using the generalized property diagram as shown in Figure 1. The critical pressure and critical temperature of carbon dioxide are 72.9 atm and 304.2K, respectively.

Problem 3: 20 points

Assume benzene and toluene form an ideal solution, which follows the Raoult's Law. Calculate the phase equilibrium ***vapor composition*** and ***liquid composition*** for a benzene and toluene mixture at 90°C and 1 atm.

The Antoine equation is:

$\log P^{o} = A - \frac{B}{C+t}$, where P^{o} in mmHg and t in °C.

The parameters for Antoine equation are:

	A	B	C
benzene	6.90565	1211.033	220.790
toluene	6.95334	1343.943	219.377

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96-2

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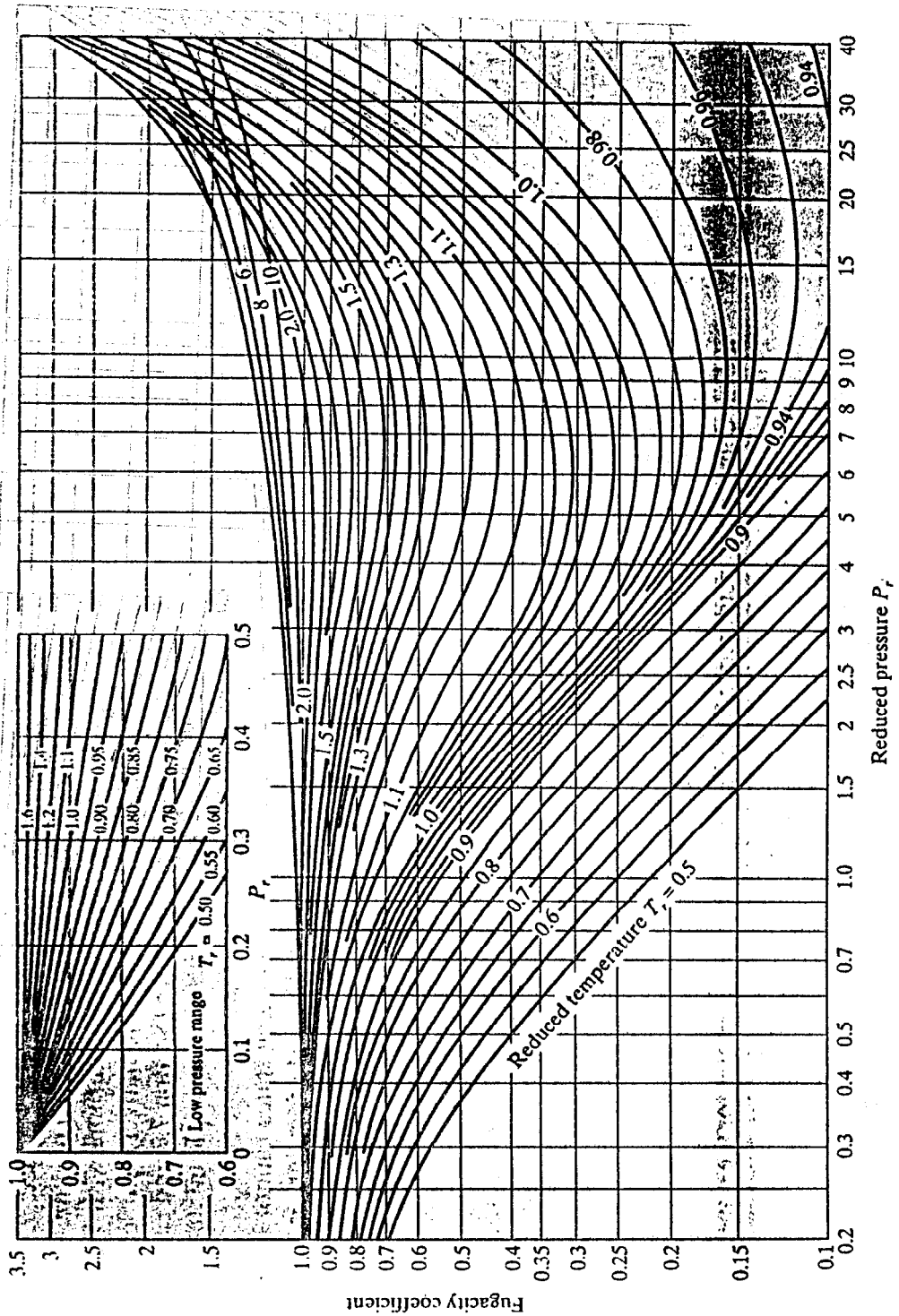
Figure 1



淡江大學九十一學年度碩士班招生考試試題

86-3

系別：化學工程學系　　科目：化學反應工程 50%

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1. How many types of industrial reactors do you remember? When are the reactors used? Describe the advantages and disadvantages of these reactors in detail. (20%)

2. A liquid-phase elementary reaction

$$A \rightarrow B + C$$

is irreversible and the rate law is

$$-r_A = kC_A$$

where the rate constant k is 0.01 s^{-1}.

Calculate the individual reactor volume and the total reactor volume for each scheme shown in the attached figure. The intermediate conversion, X_1, is 0.4, the final conversion, X_2, is 0.8, the entering volumetric flow rate, v_0, is 1 dm^3/s, and the entering molar flow rate of A, F_{A0}, is 0.5 mol/s. (30%)