國立中央大學九十學年度碩士班研究生入學試題卷

所別: 化學工程與材料工程系 科目: 化工熱力學及化學反應工程 共 2 頁 第 1 頁

A. 化工熱力學 (50%)

A 1. The following equation (3% for each correct answer)

$$PV^{\delta} = K$$

is usually used to describe a process by given a specific parameter δ, for instance, the process is isochoric for $\delta = \infty$.
Please tell what are the processes for a) $\delta = 0$ b) $\delta = 1$ c) $\delta = \gamma$ ($\gamma = C_p/C_v$).

A 2. Describe a) how the fugacity is defined and b) describe a vapor liquid equilibrium of a mixture of n components by fugacity besides the criteria of equal temperature and pressure of vapor and liquid phases. (6%)
Hint: dU=TdS-PdV, dH=TdS+VdP, dA=-SdT-PdV, dG=-SdT+VdP

A 3. Propane is burned with sufficient oxygen initially at 298 K. What could be the maximum temperature for this combustion system without any leakage of heat. (You do not have to do numerical calculations, but please clearly write down every computation step and the thermodynamic properties you need in detail (**equations are not needed**)) (10%)

A4 能動量、能量及質量傳送各為一不可逆程序，並証明其不可逆。 (9%)

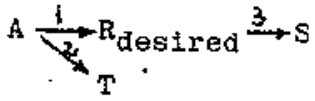
A5 寫出 entropy balance 並敘述導致 "entropy generation" 之各項因素。 (6%)

A6 Nitrogen flows at steady state through a horizontal, insulated pipe with inside diameter of 3.81 cm. A pressure drop results from flow through a partially opened valve. Just upstream from the valve the pressure is 689.5 kPa, the temperature is 120(°F), and the average velocity is 6.09 ms^{-1}. If the pressure just downstream from the valve is 20 psia, what is the temperature? Assume for nitrogen that PV/T is constant, $C_v = 2.5R$, and $C_p = 3.5R$. (10%)

注：背面有試題

B. 化學反應工程：(50%)

B1. Determine the conditions such as temperature T, concentration C_A (high, low, intermediate, etc.) and reactor type (plug, mixed) which will favor the formation of the desired product indicated. Also, give the reasons.



n_1, E_1	n_2, E_2	n_3, E_3
2, 20	1, 30	1, 40

where n_i: reaction order of ith step
E_i: activation energy of ith step

(12%)

B2. Pure gas A (reaction $A \longrightarrow 3R$; $-r_A = (5/\text{min})C_A$) with volumetric flow rate 0.2 m^3/min is fed into a steady mixed flow reactor. Find the final conversion of A if the reactor volume needed is 0.2 m^3.

<Hint>: for any const. ε_A, $C_A/C_{A0} = (1-x_A)/(1+\varepsilon_A x_A)$ (13%)

B3 (10%) The following data are obtained at 0°C in a constant-volume batch reactor using pure gaseous A:

Time, min	0	2	4	6	8	10	12	14	∞
Partial pressure of A, mm	760	600	475	390	320	275	240	215	150

The stoichiometry of the decomposition is A → 2.5 R. Find a rate equation which satisfactorily represents this decomposition.

B4 (15%) Consider the autocatalytic reaction A → R, with $-r_A = 0.001 * C_A C_R$ mol/liter.s. We wish to process 1.5 liters/ s of a C_{A0} = 10 mol/liter feed to the highest conversion possible in the reactor system consisting of four 100-liter mixed flow reactors connected as you wish and any feed arrangement. Sketch your recommended design and feed arrangement and determine C_{Af} (final outlet) from this system.