國立成功大學

110學年度碩士班招生考試試題

編　號：75

系　所：化學工程學系

科　目：化工熱力學

日　期：0203

節　次：第 2 節

備　註：可使用計算機

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※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

Problem 1　(15%)

In a steady-flow compressor, 40 kmol per hour of a gas at 1.0 bar and 300 K with a velocity of 10 m/s is compressed to 6.0 bar and 500 K with a velocity of 4.0 m/s. Assume for the gas that enthalpy is independent of pressure and that the constant-pressure heat capacity is (7/2) R with R = 8.314 J/mol-K. What is the rate of heat transfer from the compressor if the delivered mechanical power is 100.0 kW?

Problem 2　(18%)

In a closed system, a gas, initially at 300 K and 1 bar, is first compressed adiabatically to 5 bar, then cooled at constant pressure condition to 300 K, and finally expanded isothermally to its original pressure. Assume that the gas is ideal with a constant-pressure heat capacity of (7/2) R. What are the values of Q and W for each step of the processes if the cycle is irreversible and each step has an efficiency of 80% compared with the corresponding mechanically reversible processes?

Problem 3　(20%)

Considering a fluid, of which *PVT* behavior can be well predicted by the Redlich-Kwong-Soave Equation of State: $P = \frac{RT}{V-b} - \frac{a}{V\cdot(V+b)}$, where b is a constant and a is a temperature-dependent attracting term and a function of Pitzer acentric factor ω,

(1) please estimate the residual internal energy of this fluid, U^R, under an isothermal operation. (15%)

(2) If the parameter a is specifically equal to $k\cdot T^{-0.5}$, namely $a = \frac{k}{\sqrt{T}}$, where k is a constant, please calculate the residual internal energy of this fluid, U^R, under an isothermal operation. (5%)

Problem 4　(13%)

Two 100-liter gas storage tanks each contain air at 2 bar. They are connected across a small reversible compressor. The compressor will take up gas from one tank, compress it, and discharge it into the other tank. If tanks, connecting line and compressor are placed in an environmental/thermostatic chamber at 280 K. Heat transfer between the components and the chamber is so excellent. Furthermore, the air is assumed to be in ideal gas with C_P = 29.30 J/mol·K. Please estimate the work required to compress the gas in one tank to 3 bar?

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Problem 5　(20%)

Please answer "True" or "False". You MUST provide the right answer once your answer is "False". 5% of each.

(1) $\sum_i x_i d\ln\phi_i = 0$

(2) $V_i^{ig}(T,P) = V^{ig}(T,P)$

(3) $\overline{H}_i^{ig}(T,P) = H_i^{ig}(T,P) = H_i^{ig}(T,p_i)$

(4) $d\left(\frac{nG^R}{RT}\right) = \frac{nV^R}{RT}dP - \frac{nS^R}{RT}dT + \sum_i \frac{\overline{G}_i^R}{RT}dn_i$

Problem 6　(14%)

Please use mainly two particular equations (please write down the names of these two equations, with specified conditions **(6%)**) to derive and solve for $\overline{M}_1 = M + x_2\frac{dM}{dx_1}$ and $\overline{M}_2 = M - x_1\frac{dM}{dx_1}$ **(8%)**