九十三學年度___工程與系統科學___系（所）_____乙_____組碩士班入學考試

科目 _熱力學___ 科號__3902 _共__三__頁第__一__頁 *請在試卷【答案卷】內作答

1. In mathematics, for a differential equation F=M(x,y)dx+N(x,y)dy.

   We call F is an exact differential equation if:

   $$(\frac{\partial M}{\partial y})_x = (\frac{\partial N}{\partial x})_y$$

   We call F is an inexact differential equation if:

   $$(\frac{\partial M}{\partial y})_x \neq (\frac{\partial N}{\partial x})_y$$

(a) Write down the function of state in Thermodynamics (4%) and give two thermo properties as the examples for each of the thermodynamic state (8%).

(b) Explain what is that means in Physics? (8%)

Mathematics: [F=M(x,y)dx+N(x,y)dy]	Thermodynamics	Physics means
Exact differential equation	(a-1) Write down the function of state and give two examples	(b-1) Explain
Inexact differential equation	(a-2) Write down the function of state and give two examples	(b-2) Explain

2. (a) The polytropic process is happened under the condition of ideal gas and adiabatic process, please prove and write down the pressure P as the function of the V and k, where V is the volume and k=Cp/Cv. (10%)

   (b) Please prove Cp=Cv+R for an ideal gas (5%)

   (c) Try to evaluate the value of the work done from state 1 to state 2 as the function of the (R, T_2, T_1, k) (5%)

3. A heat engine receives 600 KJ of heat from a high-temperature source at 1000K during a cycle. It converts 150 KJ of this heat to net work and rejects the remaining 450 KJ to a low-temperature sink at 300K. Determine if this heat engine violates the second law of thermodynamics on the basis of

   (a) The Clausis inequality (5%)

   (b) The Carnot principle (5%)

4. We wish to produce refrigeration at -40^0C. A reservoir is available at a temperature of 200^0C and the ambient temperature is 25^0C. Thus, work can be done by a cyclic heat engine operating between the 200^0C reservoir and the ambient. This work can be used to drive the refrigerator. Determine the ratio of the heat transferred from the high temperature reservoir to the heat transfer from the refrigerated space, assuming that all processes are reversible. (10%)

5. Please give the three methods to increase the Rankine cycle efficiency?(6%) for which is the best way to increase the efficiency (2%) and why(2%)

6. A pressure cooker is a pan that cooks food much faster than ordinary pans by maintaining a higher pressure and temperature during cooking. The pressure inside the pan is controlled by a pressure regulator (the petcock), which keeps the pressure at a constant level by periodically allowing some steam to escape. Thus preventing any excess pressure buildup. A certain pressure cooker has a volume of 6 lit and an operating pressure of 75 KPa(gage). Initially, It contains 1 Kg of water. Heat is supplied to the pressure cooker at a rate of 500 W for 30 min. After the operating pressure is reached. Assumed an atmospheric pressure of 100Kpa. Determine:

(a) The absolute pressure within the cooker (2%)

(b) The temperature at which cooking takes place (2%)

(c) Write down the Energy Balance Equation with function of Q, m_e, m_1, m_2, h_e, u_1, u_2 (5%)

Where Q : the amount of heat transfer

m_e: the amount of steam exit

m_1: the mass of steam at initial state

m_2: the mass of steam at final state

u_1: the internal energy at initial state

u_2: the internal energy at final state

h_e: the enthalpy of exit steam

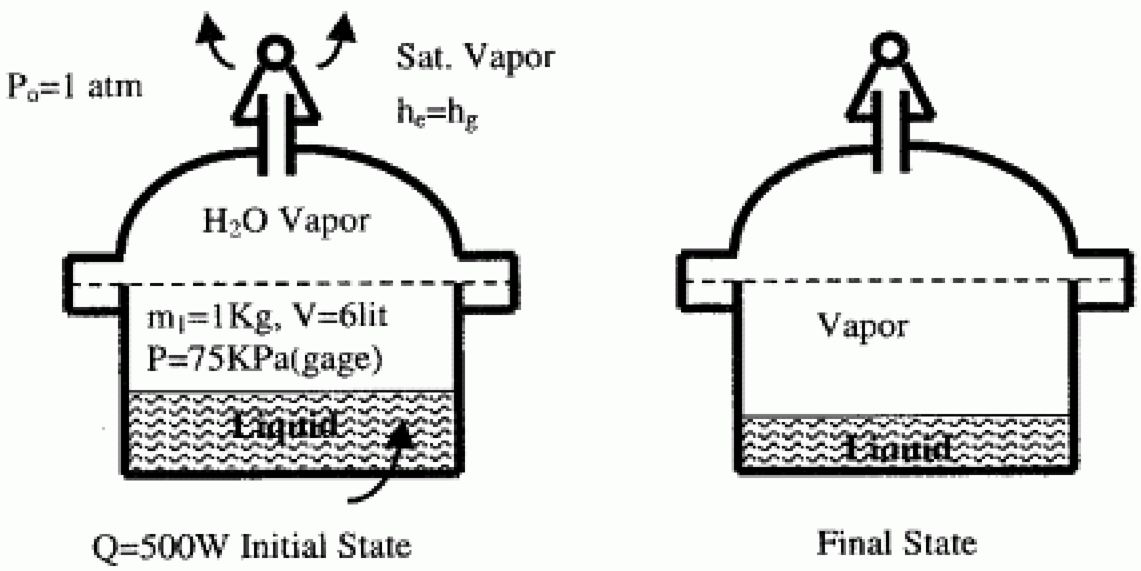
(d) Write down the mass balance with function of m_e, m_1, m_2, (2%)

(e) Determine the values of X_1, X_2 at each state (6%) and calculate the amount of water left (m_2) in the pressure cooker at the end of the process (4%)

(f) Determine the internal energy U_1 and U_2 in KJ (6%)

(g) Draw the T-V diagram from the initial state to final state and mark the values of T and P for each state (3%)

Hint: there is no work, $1\text{lit}=10^{-3}\text{m}^3$



State (Unit)	T (^{0}C)	P (Mpa)	V_f (m^3/Kg)	V_g (m^3/Kg)	U_f (KJ/Kg)	U_g (KJ/Kg)	h_f (KJ/Kg)	h_g (KJ/Kg)	S_f (KJ/Kg,^{0}K)	S_g (KJ/Kg,^{0}K)
Superheat	380	3.8		0.0741		2877.3		3158		6.7159
Superheat	400	4.0		0.07341		2919.6		3213.6		6.769
Saturated	40	7.38×10^{-3}	0.001008	19.52	167.56	2430.1	167.57	2574.3	0.5725	8.257
Saturated	45	9.59×10^{-3}	0.001010	15.26	188.48	2436.8	188.45	2583.2	0.6387	8.1648
Saturated	50	12.34×10^{-3}	0.001012	12.03	209.32	2443.5	209.33	2592.1	0.7038	8.0763
Saturated	55	15.75×10^{-3}	0.001015	9.568	230.21	2450.1	230.23	2600.9	0.7679	7.9913
Saturated	60	19.94×10^{-3}	0.001017	7.670	251.11	2456.6	251.13	2609.6	0.8312	7.9096
Saturated	65	25.03×10^{-3}	0.001020	6.197	272.02	2463.1	272.06	2618.3	0.8935	7.8310
Saturated	70	31.19×10^{-3}	0.001023	5.042	292.95	2469.6	292.98	2626.8	0.9549	7.7553
Saturated	75	38.58×10^{-3}	0.001026	4.131	313.9	2475.9	313.93	2635.3	1.0155	7.6824
Saturated	80	47.39×10^{-3}	0.001029	3.407	334.86	2482.2	334.91	2643.7	1.0753	7.6122
Saturated	85	57.83×10^{-3}	0.001033	2.828	355.84	2488.4	355.9	2651.9	1.1343	7.5445
Saturated	90	70.14×10^{-3}	0.001036	2.361	376.85	2494.5	376.92	2660.1	1.1925	7.4791
Saturated	95	84.55×10^{-3}	0.001040	1.982	397.88	2500.6	397.96	2668.1	1.2500	7.4159
Saturated	100	0.10135	0.001044	1.6729	418.94	2506.5	419.04	2676.1	1.3069	7.3549
Saturated	105	0.12	0.001048	1.4194	440.02	2512.4	440.15	2683.8	1.3630	7.2958
Saturated	110	0.14	0.001052	1.2102	461.14	2518.1	461.3	2691.5	1.4185	7.2387
Saturated	115	0.169	0.001056	1.0366	482.3	2523.7	482.48	2699.0	1.4734	7.1833
Saturated	120	0.198	0.001060	0.8919	503.5	2529.3	503.71	2706.3	1.5276	7.1296
Saturated	262	4.8	0.00128	0.04	1138.2	2597.86	1146.5	2795.3	2.9	5.987
Subcooled	40	5	0.001		166.95		171.97		0.5705	
Subcooled	60	5	0.00101		250.23		255.3		0.8285	