國立成功大學

114學年度碩士班招生考試試題

編　號：95

系　所：工程科學系

科　目：熱力學

日　期：0211

節　次：第 1 節

注　意：1.可使用計算機
2.請於答案卷(卡)作答，於試題上作答，不予計分。

Notice: All questions **must be answered with detailed solution steps**. Otherwise, even if the chosen option is correct, no points will be awarded. 所有題目都要以詳細解題過程作答，否則即使選項正確也不算分數。

1. As Fig. 1, a rigid tank is divided into two equal parts by a partition. Initially, one side of the tank contains 10 kg of water at 300 kPa and 35°C, and the other side is evacuated. The partition is then removed, and the water expands into the entire tank. The water is allowed to exchange heat with its surroundings until the temperature in the tank returns to the initial value of 35°C. Determine: (20%)
   (1) the volume of the tank (m^3) (A) 0.01, (B) 0.02, (C) 0.03, (D) 0.04, (E) 0.05, (F) 0.06
   (2) the final pressure (kPa) (A) 5.01, (B) 5.28, (C) 5.46, (D) 5.63, (E) 5.72, (F) 5.85
   (3) the heat transfer for this process (kJ) (A) 1.7, (B) 1.5, (C) 1.3, (D)1.1., (E) 0.9, (F) 0.7
   (4) please show the process on a P-v diagram with respect to saturation lines.

2. As Fig. 2, a heat pump with R-134a as the working fluid is used to keep a space at 25°C by absorbing heat from geothermal water that enters the evaporator at 60°C at a rate of 0.1 kg/s and leaves at 40°C. Refrigeratant enters the evaporator at 12.5°C with a quality of 20% and leaves at the same pressure as satuated vapor. If the compressure comsumes 1.5 kW of the power. Determine: (20%)
   (1) the mass flow rate of refigerant (kg/s) (A) 0.055, (B) 0.050, (C) 0.045, (D) 0.040, (E) 0.035, (F) 0.030
   (2) the rate of heat supply (kW) (A) 11.8, (B) 10.7, (C) 9.9, (D) 8.7, (E) 7.6, (F) 6.5
   (3) the coefficint of performace (COP) (A) 1.8, (B) 2.2, (C) 3.3, (D) 4.4, (E) 5.5, (F) 6.6
   (4) the minimum power input to the compressor for the same rate of heat supply (kW) (A) 1.04, (B) 2.10, (C) 3.15, (D) 4.21, (E) 5.32, (F) 6.51.

3. As Fig. 3, a rigid, insulated tank that is initially evacuated is connected through a valve to a supply line that carries helium at 200 kPa and 120°C. Now the valve is opened, and helium is allowed to flow into the tank until the pressure reaches 200 kPa, at which point the valve is closed. The properties of the helium are R = 2.0769 kJ/kg•K, C_p = 5.1926 kJ/kg•K, C_v = 3.1156 kJ/kg•K. Determine: (20%)
   (1) the flow work of helium in the supply line (kJ/kg) (A) 758, (B) 765, (C) 779, (D) 791, (E) 804, (F) 816.
   (2) final temperature of helium in the tank (K) (A) 564, (B)592, (C) 621, (D) 655, (E) 681, (F) 692.

4. As Fig. 4, steam enters a turbine steadily at 3 MPa and 425°C and leaves at 50 kPa and 125°C. If the heat loss of the turbine is 50 kJ/kg. Determine: (20%)
   (1) the isentropic efficiency of turbine (%) (A) 60.1, (B) 65.4, (C) 68.2, (D) 70.2, (E) 72.5, (F) 75.2.
   (2) power output of turbine (kJ/kg) (A) 420, (B) 443, (C) 461, (D) 486, (E) 507, (F) 520.

5. As Fig. 5, a refrigerator uses refrigerant-134a as the working fluid and operates on an ideal vapor-compression refrigeration cycle between 0.14 MPa and 0.8 MPa. If the mass flow rate of the refrigerant is 0.05 kg/s. Determine: (20%)
   (1) the rate of heat removal from refrigerated space (kW) (A) 6.4, (B) 7.2, (C) 8.0, (D) 8.8, (E) 9.4, (F) 10.0.
   (2) the power input to the compressor (kW) (A)0.6, (B) 1.0, (C) 1.4, (D) 1.8, (E) 2.2, (F) 2.6.
   (3) the rate of heat rejection to environment (kW) (A)7.0, (B) 7.5, (C) 8.0, (D) 8.5, (E) 9.0, (F) 9.5.
   (4) the COP of the refrigerator (A)2.15, (B) 3.06, (C) 3.97, (D) 4.78, (E) 5.11, (F) 5.50.

Figures and Tables

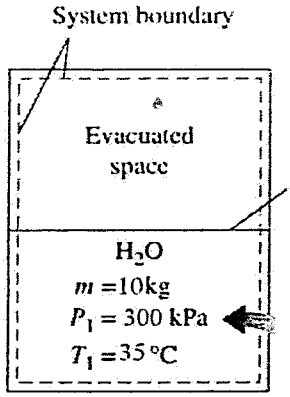

Fig. 1

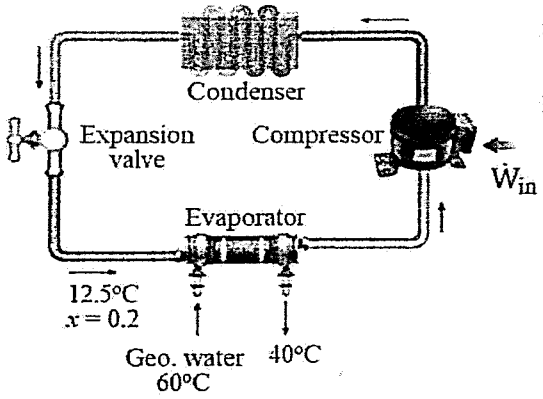

Fig.2

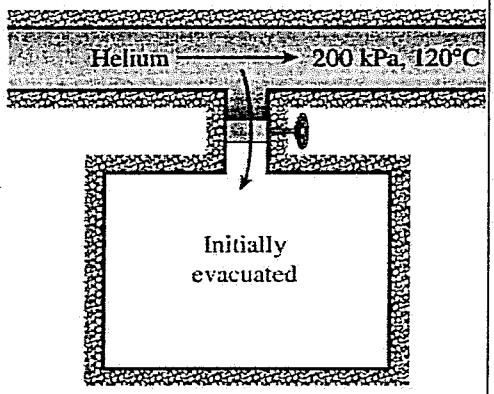

Fig. 3

Fig. 4

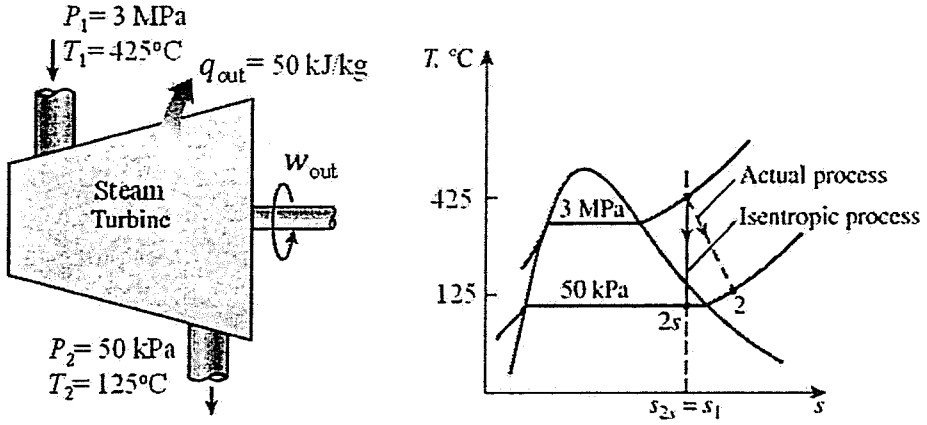

Fig. 5

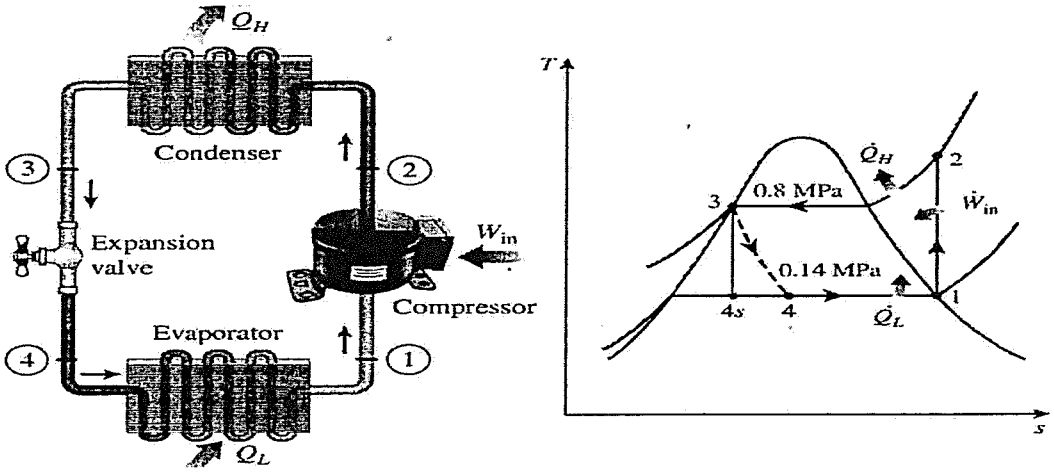

TABLE A–6

Superheated water (*Concluded*)

T °C	*v* m³/kg	*u* kJ/kg	*h* kJ/kg	*s* kJ/kg·K
	P = 3.00 MPa (233.85°C)			
Sat.	0.06667	2603.2	2803.2	6.1856
400	0.09938	2933.6	3231.7	6.9235
450	0.10789	3021.2	3344.9	7.0856
	P = 0.05 MPa (81.32°C)			
Sat.'	3.2403	2483.2	2645.2	7.5931
100	3.4187	2511.5	2682.4	7.6953
150	3.8897	2585.7	2780.2	7.9413
	P = 8.0 MPa (295.01°C)			
Sat.	0.023525	2570.5	2758.7	5.7450
600	0.048463	3254.7	3642.4	7.0221
700	0.054829	3443.6	3882.2	7.2822

TABLE A–13

Superheated refrigerant-134a (*Concluded*)

T °C	*v* m³/kg	*u* kJ/kg	*h* kJ/kg	*s* kJ/kg·K
	P = 0.80 MPa (T_{sat} = 31.31°C)			
Sat.	0.025645	246.82	267.34	0.9185
40	0.027035	254.84	276.46	0.9481
50	0.028547	263.87	286.71	0.9803
60	0.029973	272.85	296.82	1.0111
70	0.031340	281.83	306.90	1.0409
80	0.032659	290.86	316.99	1.0699

TABLE A–4

Saturated water—Temperature table

Temp., T °C	Sat. press., P_{sat} kPa	Specific volume, m³/kg: Sat. liquid, v_f	Specific volume, m³/kg: Sat. vapor, v_g	Internal energy, kJ/kg: Sat. liquid, u_f	Internal energy, kJ/kg: Evap., u_{fg}	Internal energy, kJ/kg: Sat. vapor, u_g	Enthalpy, kJ/kg: Sat. liquid, h_f	Enthalpy, kJ/kg: Evap., h_{fg}	Enthalpy, kJ/kg: Sat. vapor, h_g	Entropy, kJ/kg·K: Sat. liquid, s_f	Entropy, kJ/kg·K: Evap., s_{fg}	Entropy, kJ/kg·K: Sat. vapor, s_g
25	3.1698	0.001003	43.340	104.83	2304.3	2409.1	104.83	2441.7	2546.5	0.3672	8.1895	8.5567
30	4.2469	0.001004	32.879	125.73	2290.2	2415.9	125.74	2429.8	2555.6	0.4368	8.0152	8.4520
35	5.6291	0.001006	25.205	146.63	2276.0	2422.7	146.64	2417.9	2564.6	0.5051	7.8466	8.3517
40	7.3851	0.001008	19.515	167.53	2261.9	2429.4	167.53	2406.0	2573.5	0.5724	7.6832	8.2556
45	9.5953	0.001010	15.251	188.43	2247.7	2436.1	188.44	2394.0	2582.4	0.6386	7.5247	8.1633
50	12.352	0.001012	12.026	209.33	2233.4	2442.7	209.34	2382.0	2591.3	0.7038	7.3710	8.0748
55	15.763	0.001015	9.5639	230.24	2219.1	2449.3	230.26	2369.8	2600.1	0.7680	7.2218	7.9898
60	19.947	0.001017	7.6670	251.16	2204.7	2455.9	251.18	2357.7	2608.8	0.8313	7.0769	7.9082
65	25.043	0.001020	6.1935	272.09	2190.3	2462.4	272.12	2345.4	2617.5	0.8937	6.9360	7.8296
70	31.202	0.001023	5.0396	293.04	2175.8	2468.9	293.07	2333.0	2626.1	0.9551	6.7989	7.7540

TABLE A–5

Saturated water—Pressure table

Press., P kPa	Sat. temp., T_{sat} °C	Specific volume, m³/kg: Sat. liquid, v_f	Specific volume, m³/kg: Sat. vapor, v_g	Internal energy, kJ/kg: Sat. liquid, u_f	Internal energy, kJ/kg: Evap., u_{fg}	Internal energy, kJ/kg: Sat. vapor, u_g	Enthalpy, kJ/kg: Sat. liquid, h_f	Enthalpy, kJ/kg: Evap., h_{fg}	Enthalpy, kJ/kg: Sat. vapor, h_g	Entropy, kJ/kg·K: Sat. liquid, s_f	Entropy, kJ/kg·K: Evap., s_{fg}	Entropy, kJ/kg·K: Sat. vapor, s_g
20	60.06	0.001017	7.6481	251.40	2204.6	2456.0	251.42	2357.5	2608.9	0.8320	7.0752	7.9073
25	64.96	0.001020	6.2034	271.93	2190.4	2462.4	271.96	2345.5	2617.5	0.8932	6.9370	7.8302
30	69.09	0.001022	5.2287	289.24	2178.5	2467.7	289.27	2335.3	2624.6	0.9441	6.8234	7.7675
40	75.86	0.001026	3.9933	317.58	2158.8	2476.3	317.62	2318.4	2636.1	1.0261	6.6430	7.6691
50	81.32	0.001030	3.2403	340.49	2142.7	2483.2	340.54	2304.7	2645.2	1.0912	6.5019	7.5931

TABLE A–12

Saturated refrigerant-134a—Pressure table

Press., P kPa	Sat. temp., T_{sat} °C	Specific volume, m³/kg: Sat. liquid, v_f	Specific volume, m³/kg: Sat. vapor, v_g	Internal energy, kJ/kg: Sat. liquid, u_f	Internal energy, kJ/kg: Evap., u_{fg}	Internal energy, kJ/kg: Sat. vapor, u_g	Enthalpy, kJ/kg: Sat. liquid, h_f	Enthalpy, kJ/kg: Evap., h_{fg}	Enthalpy, kJ/kg: Sat. vapor, h_g	Entropy, kJ/kg·K: Sat. liquid, s_f	Entropy, kJ/kg·K: Evap., s_{fg}	Entropy, kJ/kg·K: Sat. vapor, s_g
120	−22.32	0.0007323	0.16216	22.38	195.15	217.53	22.47	214.52	236.99	0.09269	0.85520	0.94789
140	−18.77	0.0007381	0.14020	26.96	192.60	219.56	27.06	212.13	239.19	0.11080	0.83387	0.94467
160	−15.60	0.0007435	0.12355	31.06	190.31	221.37	31.18	209.96	241.14	0.12686	0.81517	0.94202
400	8.91	0.0007905	0.051266	63.61	171.49	235.10	63.92	191.68	255.61	0.24757	0.67954	0.92711
450	12.46	0.0007983	0.045677	68.44	168.58	237.03	68.80	188.78	257.58	0.26462	0.66093	0.92555
500	15.71	0.0008058	0.041168	72.92	165.86	238.77	73.32	186.04	259.36	0.28021	0.64399	0.92420
750	29.06	0.0008395	0.027398	91.59	154.11	245.70	92.22	174.03	266.25	0.34348	0.57582	0.91930
800	31.31	0.0008457	0.025645	94.80	152.02	246.82	95.48	171.86	267.34	0.35408	0.56445	0.91853
850	33.45	0.0008519	0.024091	97.88	150.00	247.88	98.61	169.75	268.36	0.36417	0.55362	0.91779