

國立成功大學

115學年度碩士班招生考試試題

編號：81

系所：工程科學系

科目：熱力學

日期：0204

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。

- As Fig. 1, a piston-cylinder device contains 25g of saturated water vapor that is maintained at a constant pressure of 300 kPa. A resistance heater within the cylinder is turned on and passes a current of 0.2 A for 5 min from a 120V source. At the same time, a heat loss of 3.7 kJ occurs. (20%)
Determine the
 - Input work of a resistance heater (kJ). (a) 3.6, (b) 4.5, (c) 5.4, (d) 6.3, (e) 7.2, (f) 8.1
 - Final enthalpy (kJ/kg). (a) 2905, (b) 2885, (c) 2865, (d) 2845, (e) 2825, (f) 2795
 - Final temperature (°C). (a) 150, (b) 200, (c) 250, (d) 300, (e) 350, (f) 400
 - Draw the process on a P-v diagram with respect to saturation lines.
- As Fig. 2, a 10 kg mass of superheated refrigerant R-134a at 0.8 MPa and 95°C is cooling at constant pressure until it exists as a compressed liquid at 25°C. (20%)
 - Determine the change in volume (m³). (a) -0.34, (b) -0.45, (c) -0.54, (d) -0.63, (e) -0.72, (f) -0.81
 - Find the change of total internal energy (kJ).
(a) -2127, (b) -2147, (c) -2167, (d) -2187, (e) -2207, (f) -2227
 - Show the process on a T-v diagram with respect to saturation lines.
- As Fig. 3, R-134a is to be cooled by water in a condenser. The R-134a enters the condenser with a mass flow rate at 2 kg/s at 1 MPa and 140°C and leaves at 40°C. The cooling water enters at 10 kPa and 40°C and leaves to produce **saturated liquid-vapor mixture state** at 10 kPa and quality $x = 0.3$. The heat lost is 100 kW. Neglect any pressure drops. (20%)
Determine
 - Mass flow rate of the cooling water (kg/s). (a) 0.24, (b) 0.22, (c) 0.20, (d) 0.18, (e) 0.16, (f) 0.14
 - Heat transfer rate from the R-134a to water (kW). (a) 60, (b) 70, (c) 80, (d) 90, (e) 100, (f) 110
- As Fig. 4, determine the compressor work input required to compress steam isentropically from 50 kPa to 1.2 Mpa, assuming that the steam exists as (20%)
 - Saturated liquid at the inlet state. (kJ/kg) (a) 1.0, (b) 1.2, (c) 1.4, (d) 1.6, (e) 1.8, (f) 2.0
 - Saturated vapor at the inlet state. (kJ/kg) (a) 620, (b) 670, (c) 720, (d) 770, (e) 820, (f) 870
- Consider a steam power plant operating on the simple ideal Rankine cycle. Steam enters the turbine at 3 MPa and 350 °C and is condensed in the condenser at a pressure of 75 kPa. (20%)
Determine
 - The work of pump ($w_{\text{pump,in}}$) (kJ/kg). (a) 3.0, (b) 3.3, (c) 3.6, (d) 3.9, (e) 4.2, (f) 4.5
 - Enthalpy of state 4 (h_4) (kJ/kg) (a) 2201, (b) 2302, (c) 2403, (d) 2504, (e) 2605, (f) 2706
 - Thermal efficiency of this cycle. (a) 0.36, (b) 0.34, (c) 0.32, (d) 0.30, (e) 0.28, (f) 0.26

Figures and Tables

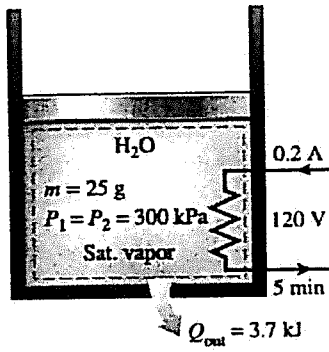


Fig. 1

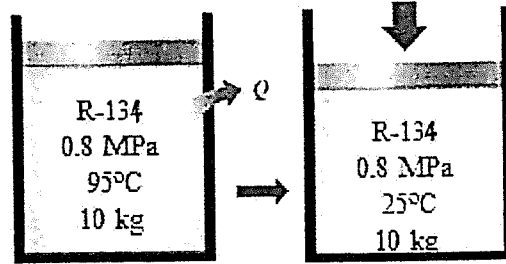


Fig. 2

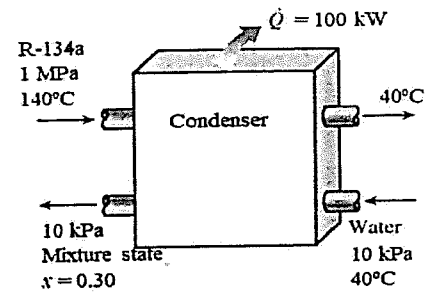


Fig. 3

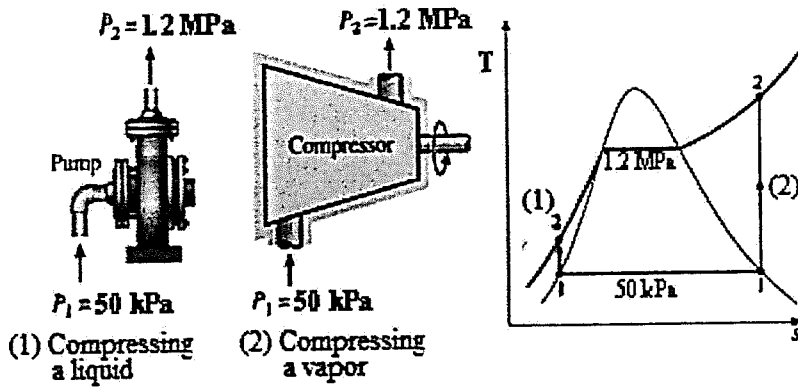


Fig. 4

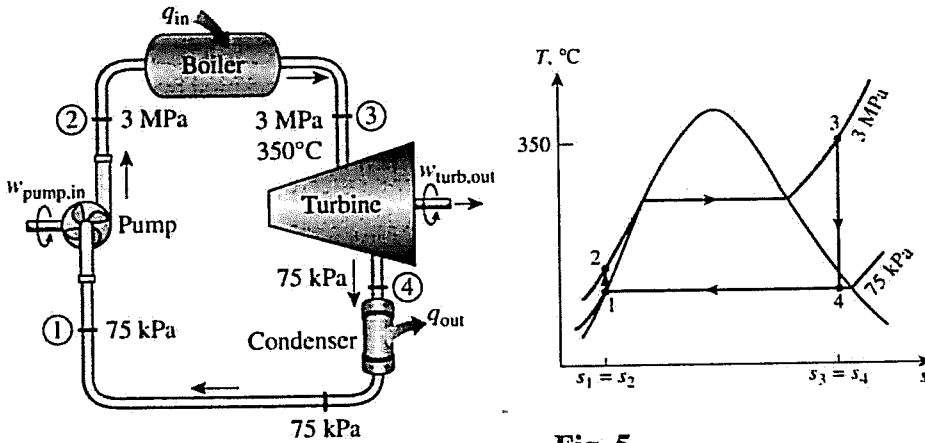


Fig. 5

TABLE A-4

Saturated water—Temperature table

Temp., T , °C	Sat. press., P_{sat} , kPa	Specific volume, m^3/kg		Internal energy, kJ/kg			Enthalpy, kJ/kg			Entropy, kJ/kg·K		
		Sat. liquid, v_f	Sat. vapor, v_g	Sat. liquid, u_f	Evap., u_{fg}	Sat. vapor, u_g	Sat. liquid, h_f	Evap., h_{fg}	Sat. vapor, h_g	Sat. liquid, s_f	Evap., s_{fg}	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

TABLE A-5

Saturated water—Pressure table

Press., <i>P</i> kPa	Sat. temp., <i>T</i> _{sat} °C	Specific volume, m ³ /kg		Internal energy, kJ/kg			Enthalpy, kJ/kg			Entropy, kJ/kg·K		
		Sat. liquid, <i>v</i> _l	Sat. vapor, <i>v</i> _g	Sat. liquid, <i>u</i> _l	Evap., <i>u</i> _{fg}	Sat. vapor, <i>u</i> _g	Sat. liquid, <i>h</i> _l	Evap., <i>h</i> _{fg}	Sat. vapor, <i>h</i> _g	Sat. liquid, <i>s</i> _l	Evap., <i>s</i> _{fg}	Sat. vapor, <i>s</i> _g
7.5	40.29	0.001008	19.233	168.74	2261.1	2429.8	168.75	2405.3	2574.0	0.5763	7.6738	8.2501
10	45.81	0.001010	14.670	191.79	2245.4	2437.2	191.81	2392.1	2583.9	0.6492	7.4996	8.1488
15	53.97	0.001014	10.020	225.93	2222.1	2448.0	225.94	2372.3	2598.3	0.7549	7.2522	8.0071
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
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
75	91.76	0.001037	2.2172	384.36	2111.8	2496.1	384.44	2278.0	2662.4	1.2132	6.2426	7.4558
100	99.61	0.001043	1.6941	417.40	2088.2	2505.6	417.51	2257.5	2675.0	1.3028	6.0562	7.3589
275	130.58	0.001070	0.65732	548.57	1991.6	2540.1	548.86	2172.0	2720.9	1.6408	5.3800	7.0207
300	133.52	0.001073	0.60582	561.11	1982.1	2543.2	561.43	2163.5	2724.9	1.6717	5.3200	6.9917
325	136.27	0.001076	0.56199	572.84	1973.1	2545.9	573.19	2155.4	2728.6	1.7005	5.2645	6.9650

TABLE A-6

Superheated water

TABLE A-6

Superheated water (Concluded)

<i>T</i> °C	<i>v</i> m ³ /kg	<i>u</i> kJ/kg	<i>h</i> kJ/kg	<i>s</i> kJ/kg·K	<i>T</i> °C	<i>v</i> m ³ /kg	<i>u</i> kJ/kg	<i>h</i> kJ/kg	<i>s</i> kJ/kg·K	<i>v</i> m ³ /kg	<i>u</i> kJ/kg	<i>h</i> kJ/kg	<i>s</i> kJ/kg·K
<i>P</i> = 0.30 MPa (133.52°C)					<i>P</i> = 1.00 MPa (179.88°C)					<i>P</i> = 1.20 MPa (187.96°C)			
Sat.	0.60582	2543.2	2724.9	6.9917	250	0.23275	2710.4	2943.1	6.9265	0.19241	2704.7	2935.6	6.8313
150	0.63402	2571.0	2761.2	7.0792	300	0.25799	2793.7	3051.6	7.1246	0.21386	2789.7	3046.3	7.0335
200	0.71643	2651.0	2865.9	7.3132	350	0.28250	2875.7	3158.2	7.3029	0.23455	2872.7	3154.2	7.2139
250	0.79645	2728.9	2967.9	7.5180	400	0.30661	2957.9	3264.5	7.4670	0.25482	2955.5	3261.3	7.3793
300	0.87535	2807.0	3069.6	7.7037	500	0.35411	3125.0	3479.1	7.7642	0.29464	3123.4	3477.0	7.6779
400	1.03155	2966.0	3275.5	8.0347	600	0.40111	3297.5	3698.6	8.0311	0.33395	3296.3	3697.0	7.9456
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TABLE A-6

Superheated water (Concluded)

TABLE A-11

Saturated refrigerant-134a—Temperature table

<i>T</i> °C	<i>v</i> m ³ /kg	<i>u</i> kJ/kg	<i>h</i> kJ/kg	<i>s</i> kJ/kg·K	Specific volume, m ³ /kg			Internal energy, kJ/kg			
					Sat. liquid, <i>v</i> _l	Sat. vapor, <i>v</i> _g	Sat. liquid, <i>u</i> _l	Evap., <i>u</i> _{fg}	Sat. vapor, <i>u</i> _g		
<i>P</i> = 3.00 MPa (233.85°C)					Temp., <i>T</i> °C	Sat. press., <i>P</i> _{sat} kPa	Sat. liquid, <i>v</i> _l	Sat. vapor, <i>v</i> _g	Sat. liquid, <i>u</i> _l	Evap., <i>u</i> _{fg}	Sat. vapor, <i>u</i> _g
Sat.	0.06667	2603.2	2803.2	6.1856	16	504.58	0.0008064	0.040798	73.31	165.62	238.93
225	0.07063	2644.7	2856.5	6.2893	18	537.52	0.0008112	0.038317	76.07	163.92	239.99
250	0.08118	2750.8	2994.3	6.5412	20	572.07	0.0008160	0.036012	78.85	162.19	241.04
300	0.09056	2844.4	3116.1	6.7450	22	608.27	0.0008209	0.033867	81.64	160.45	242.09
350	0.09938	2933.6	3231.7	6.9235	24	646.18	0.0008260	0.031869	84.44	158.68	243.13
400	0.10789	3021.2	3344.9	7.0856	26	685.84	0.0008312	0.030008	87.26	156.89	244.15

TABLE A-13

Superheated refrigerant-134a (Concluded)

TABLE A-13

Superheated refrigerant-134a (Concluded)

<i>T</i> °C	<i>v</i> m ³ /kg	<i>u</i> kJ/kg	<i>h</i> kJ/kg	<i>s</i> kJ/kg·K	<i>T</i> °C	<i>v</i> m ³ /kg	<i>u</i> kJ/kg	<i>h</i> kJ/kg	<i>s</i> kJ/kg·K
<i>P</i> = 0.80 MPa (<i>T</i> _{sat} = 31.31°C)					<i>P</i> = 1.00 MPa (<i>T</i> _{sat} = 39.37°C)				
Sat.	0.025645	246.82	267.34	0.9185	Sat.	0.020319	250.71	271.04	0.9157
60	0.029973	272.85	296.82	1.0111	40	0.020406	251.32	271.73	0.9180
70	0.031340	281.83	306.90	1.0409	50	0.021796	260.96	282.76	0.9526
80	0.032659	290.86	316.99	1.0699	60	0.023068	270.33	293.40	0.9851
90	0.033941	299.97	327.12	1.0982	130	0.030581	336.12	366.70	1.1847
100	0.035193	309.17	337.32	1.1259	140	0.031554	345.87	377.42	1.2110
					150	0.032512	355.73	388.24	1.2369