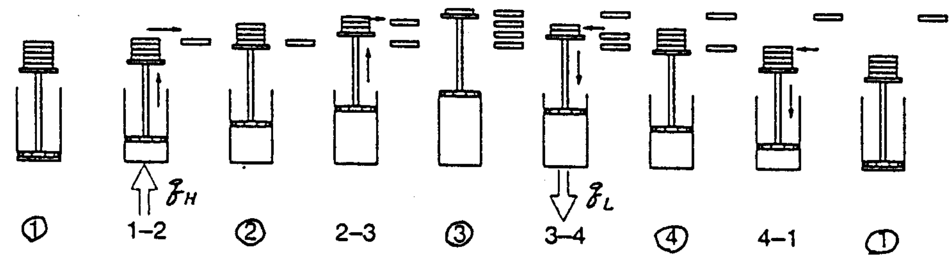
(1) 考慮一由活塞和汽缸所構成的系統(control mass),裡面充滿理想氣
(20%) 體,經由四個過程形成一卡諾循環(Carnot cycle),並視為一熱機(heat engine),如下圖所示。(假設理想氣體之比熱為定值)

(a) 描述此一卡諾循環中的四個過程,並示於P-v圖和T-s圖上。

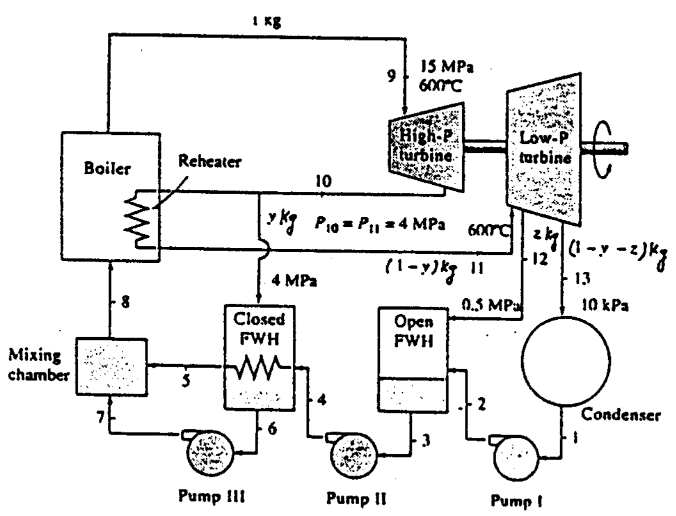
(b) 推導每一個過程中所產生的功和熱,並示於P-v圖或T-s圖上。

(c) 推導此一卡諾循環淨輸出功的表示式,並示於P-v圖和T-s圖上。

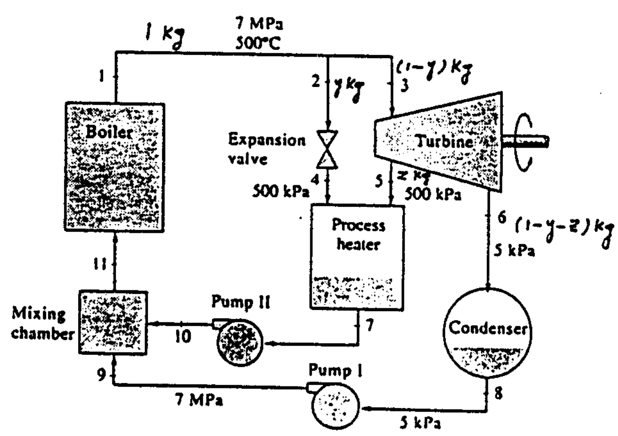
(d) 推導此一卡諾循環熱效率的表示式。



(2) 下圖(a)之Rankine循環包含一Reheater,一Closed Feedwater Heater (Closed FWH)
(14%) 和一Open Feedwater Heater (Open FWH);而圖(b)為汽電共生循環(Cogeneration)。
請仔細繪出其所對應的T-s圖,並標示各個狀態的位置。



圖(a)



圖(b)

(3) (a) 何謂絕熱飽和過程(adiabatic saturation process)?吾人如何利用此一
(8%) 原理設計一具有濕球(wet-bulb)和乾球(dry-bulb)的濕度計(psychrometer)。

(4%) (b) 何謂絕熱火焰溫度?

(4%) (c) 何謂熱力學第三定律?

1. 1 kg of saturated water at 6 MPa is contained in a cylinder and piston apparatus. Consider process 1→2 in which the water system expands adiabatically to atmospheric pressure (0.1 MPa) and a final volume of 0.7 m^3.

   a) Based on the given information, in what domain of the property surface (superheated vapor, two-phase, subcooled liquid) is state 2 located? (4%)

   b) Using the steam tables, determine the exact position of state 2 on the T-s chart (T_2 = ? K, s_2 = ? $\frac{KJ}{Kg \cdot K}$). (7%)

   c) Calculate the net work transfer interaction experienced by the water system during expansion (W_{12} = ? KJ). (7%)

   d) Is 1→2 an irreversible process? Base your answer on an appropriate test. (7%)

2. Consider an empty household refrigerator whose contents (air) are to be kept at 275K. The volume of air present in the refrigerating chamber is 0.2 m^3 and its temperature 275K.

Suppose now that if the door is kept open for a short period of time, all 0.2 m^3 of cold air are replaced by warm air at ambient temperature (295K). Assume that the air can be modeled as an ideal gas with c_v = 0.7165 kJ/kg·K and R = 0.287 kJ/kg·K.

   a) If the refrigerator is reversible and performs in an integral number of cycles, calculate the total work input required to lower the air temperature back to 275K. (13%)

   b). Consider now the case where the refrigerator does not function reversibly and its COP is given by

$$COP_{actual} = \frac{T}{T_H} COP_{reversible}, \qquad (12\%)$$

where T_H is the ambient temperature and T the instantaneous air temperature inside the refrigerator. Calculate the work input required to lower the inside air temperature from 295K to 275K.

TABLE A.1.2SI (Continued) *Saturated Water: Pressure Table (SI Units)*

		Specific Volume, m^3/kg		Internal Energy, kJ/kg			Enthalpy, kJ/kg			Entropy, kJ/kg K		
Press. MPa P	Temp. °C T	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
0.100	99.62	0.001043	1.6940	417.33	2088.7	2506.1	417.44	2258.0	2675.5	1.3025	6.0568	7.3593
0.125	105.99	0.001048	1.3749	444.16	2069.3	2513.5	444.30	2241.1	2685.3	1.3739	5.9104	7.2843
0.150	111.37	0.001053	1.1593	466.92	2052.7	2519.6	467.08	2226.5	2693.5	1.4335	5.7897	7.2232
0.175	116.06	0.001057	1.0036	486.78	2038.1	2524.9	486.97	2213.6	2700.5	1.4848	5.6868	7.1717
0.200	120.23	0.001061	0.8857	504.47	2025.0	2529.5	504.68	2202.0	2706.6	1.5300	5.5970	7.1271
4.0	250.40	0.001252	0.049778	1082.28	1520.0	2602.3	1087.29	1714.1	2801.4	2.7963	3.2737	6.0700
5.0	263.99	0.001286	0.039441	1147.78	1449.3	2597.1	1154.21	1640.1	2794.3	2.9201	3.0532	5.9733
6.0	275.64	0.001319	0.032440	1205.41	1384.3	2589.7	1213.32	1571.0	2784.3	3.0266	2.8625	5.8891
7.0	285.88	0.001351	0.027370	1257.51	1323.0	2580.5	1266.97	1505.1	2772.1	3.1210	2.6922	5.8132
8.0	295.06	0.001384	0.023518	1305.54	1264.3	2569.8	1316.61	1441.3	2757.9	3.2067	2.5365	5.7431