國 立 臺 北 科 技 大 學 九十八學年第二學期
能源與冷凍空調工程研究所
博士班資格考試
冷凍原理（能源/冷凍組）試題

填 學 生 證 號 碼

Attentions：

1. There are【6】problems on this exam, of which you are instructed to work only【5】. If you work all【6】problems, only the first【5】will be graded. Each problem gets【20】points.

2. Please answer the problems by order. Don't need to copy the problems on the answer sheet. Write all your answers on the answer sheet.

3. Do not write your name on the answer sheet.

4. ( )open book (x)close book

(1) In the desorber of a NH_3/H_2O absorption system the rich solution enters at a temperature of 150℃ and a mass fraction of 0.3. The vapor produced in this desorber is in equilibrium with the incoming liquid. (Please refer to Fig.1)

(a) Determine the mass fraction of the vapor in equilibrium with this liquid.

(b) Assume that saturated liquid of the same mass fraction as the vapor enters the evaporator (T_{evap} = 0℃). What is the mass fraction of the vapor in equilibrium with this liquid ?

(c) Assume further that the entire liquid is evaporated at constant pressure. What is the size of the temperature glide?

(d) Comment on the obtained evaporator inlet/outlet conditions and explain the reason why this happens.

(e) How to correct the problem in (d) to ensure the normal running of this machine?

(2) Prove that on a graph of the performance of a water-chilling evaporator with the coordinates of Fig. 2 a curve for a given entering water temperature is a straight line if the heat-transfer coefficients are constant.

(3) A two-stage centrifugal compressor operating at 60r/s is to compress refrigerant 123 from an evaporating temperature of 3℃ to a condensing temperature of 34℃. If doth wheels are to be of the same diameter, what is this diameter?

Table1 Thermodynamic properties of R123

Saturated Vapor					Superheated Vapor				
Temp [C]	Pressure [MPa]	Density [kg/m^3]	Enthalpy [kJ/kg]	Entropy [kJ/K-kg]	Temp [C]	Pressure [MPa]	Density [kg/m^3]	Enthalpy [kJ/kg]	Entropy [kJ/K-kg]
1	0.03416	2.339	382	1.664	34	0.090	5.587	402.8	1.684
3	0.03737	2.544	383.2	1.664	34	0.095	5.910	402.7	1.681
5	0.04082	2.762	384.4	1.663	34	0.100	6.234	402.6	1.678
7	0.04452	2.995	385.6	1.663	34	0.105	6.560	402.5	1.675
9	0.04848	3.244	386.9	1.663	34	0.110	6.887	402.3	1.672
10	0.05057	3.374	387.5	1.663	34	0.115	7.215	402.2	1.670
					34	0.120	7.546	402.1	1.667
					34	0.121	7.612	402.1	1.666
					34	0.122	7.678	402.0	1.666
					34	0.123	7.745	402.0	1.665
					34	0.124	7.811	402.0	1.665
					34	0.125	7.877	402.0	1.664
					34	0.126	7.944	401.9	1.664

(4) (a) A heat pump manufacturer claims that their product can produce hot water while supplying "free chilled water" for cooling. Discuss the advantages and disadvantages of this machine.

(b) A heat pump using the double-bundle condenser shown in Fig. 3 is to satisfy a heating load of 335kW when the outdoor temperature is -5℃, the return air temperature is 21℃, and the temperature of the cool supply air is 13℃. The minimum percentage of outdoor air specified for ventilation is 15 percent, and the flow rate of cool supply air is 40kg/s. If the COP of the heat pump at this condition is 3.2, how much power must be provided by the supplementary heaters?

(5) (a) What is the physical meaning of fin effectiveness?

(b) Consider bar fins of length L(m) and thickness 2y(m) with thermal conductivity k (W/mK) and air-side heat transfer coefficient h_f (W/m^{2}K), derive the fin effectiveness.

(6) In a refrigerant 22 refrigeration system the capacity is 180kW at a temperature of -30℃. The vapor from the evaporator is pumped by one compressor to the condensing pressure of 1500kPa. Later the system is revised to a two-stage compression operating on the cycle shown in Fig. 4 with intercooling but no removal of flash gas at 600kPa.

(a) Calculate the power required by the single compressor in the original system.

(b) Calculate the total power required by the two compressors in the revised system.

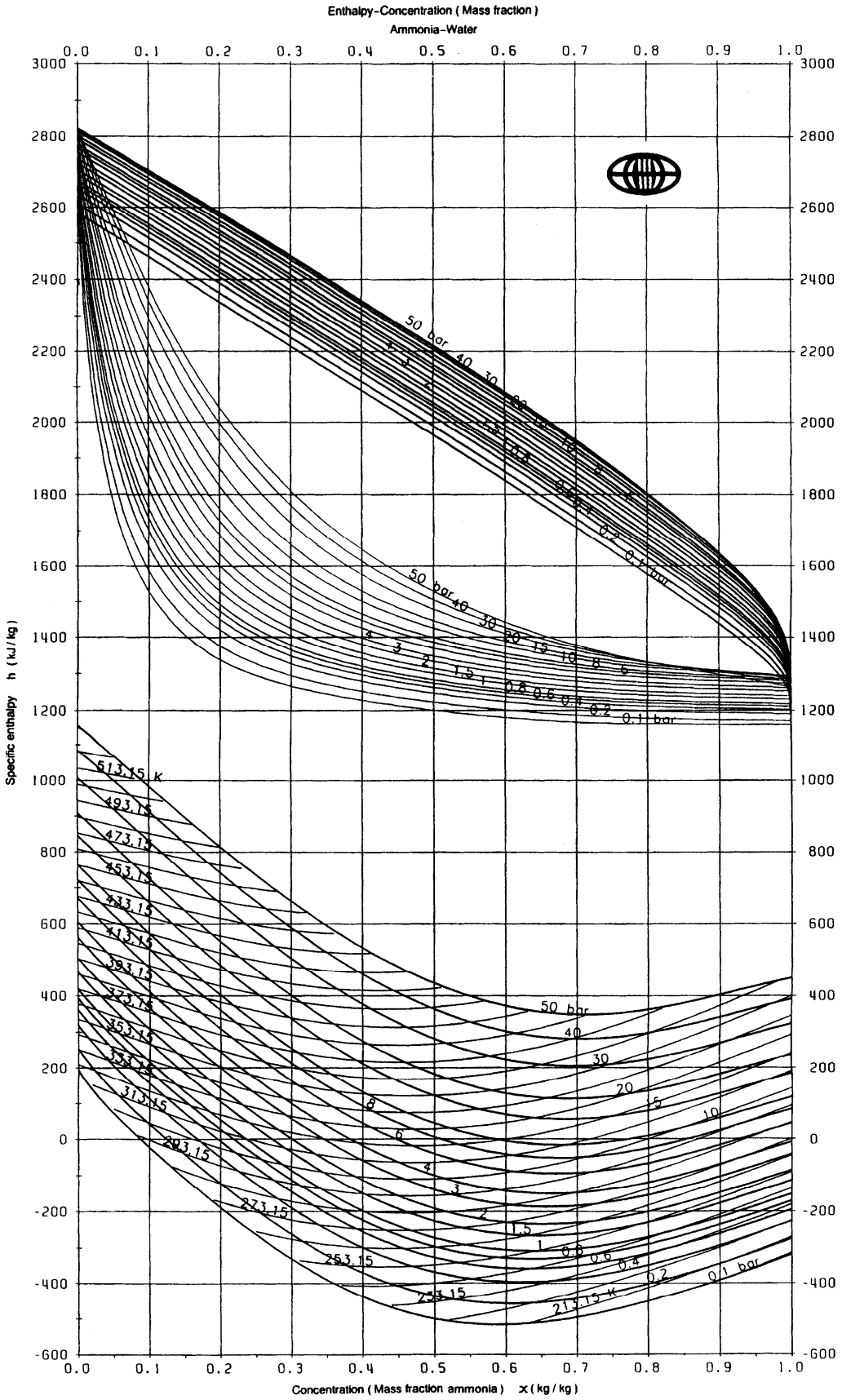

Fig.1 Enthalpy-concentration diagram for aqueous ammonia

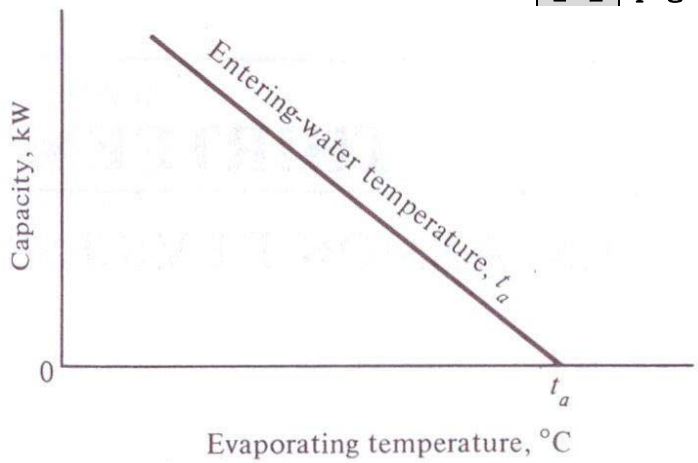

Fig.2 Evaporator performance curve

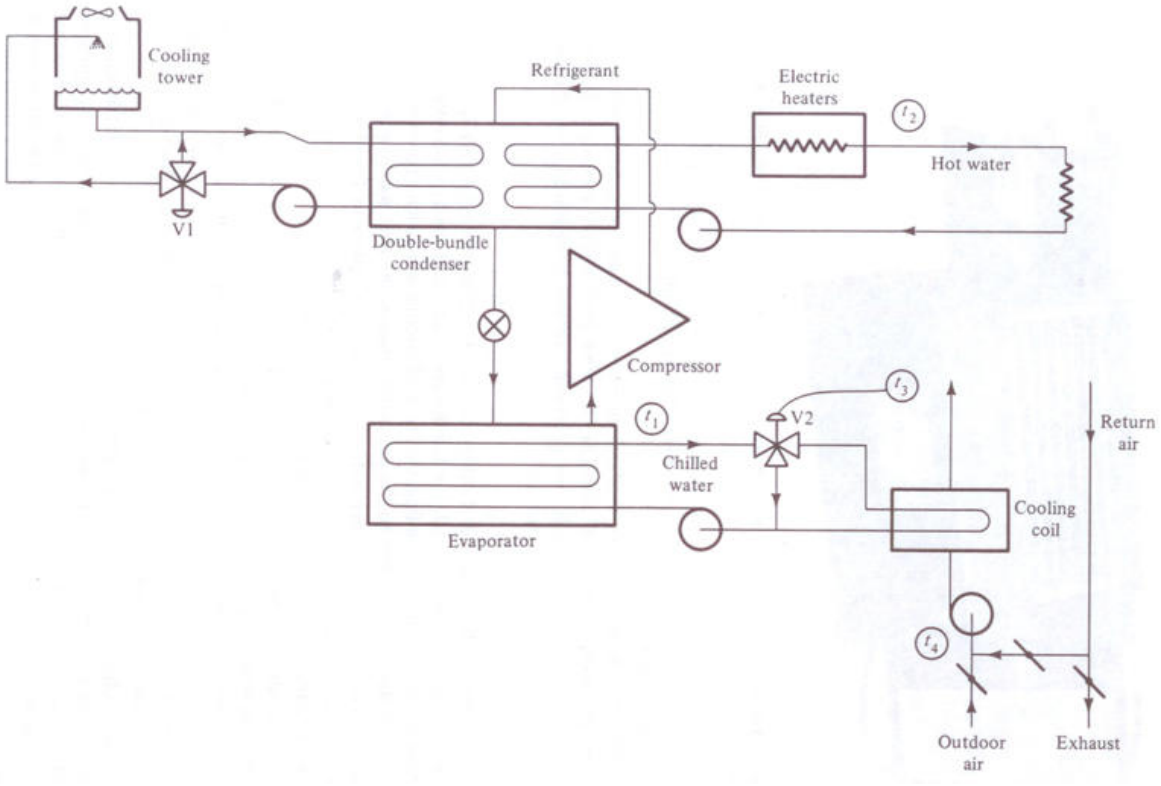

Fig.3 Heat pump with double-bundle condenser

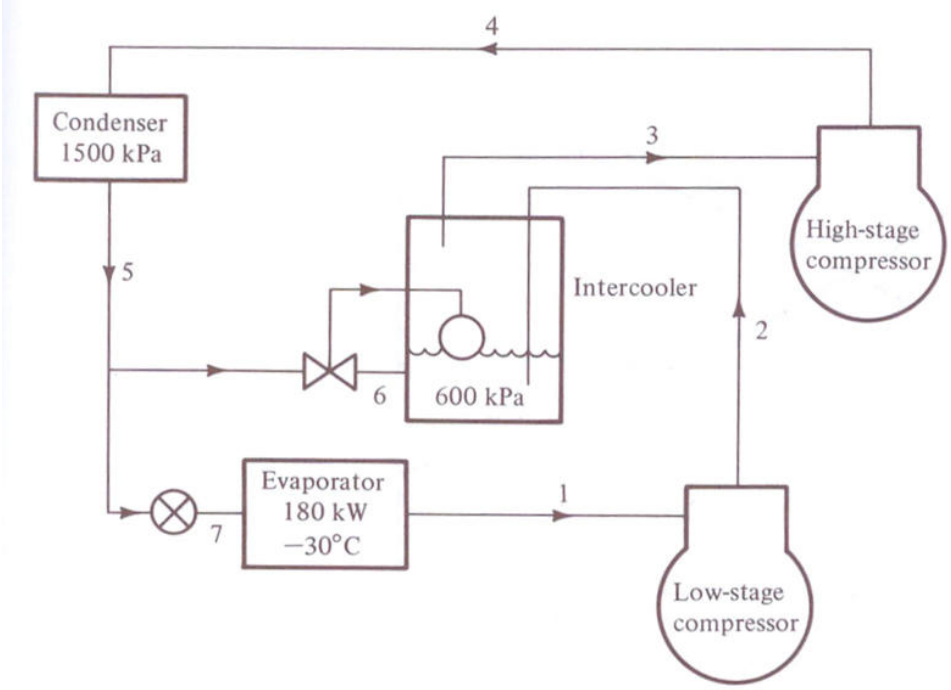

Fig. 4 Intercooling system in Prob.6

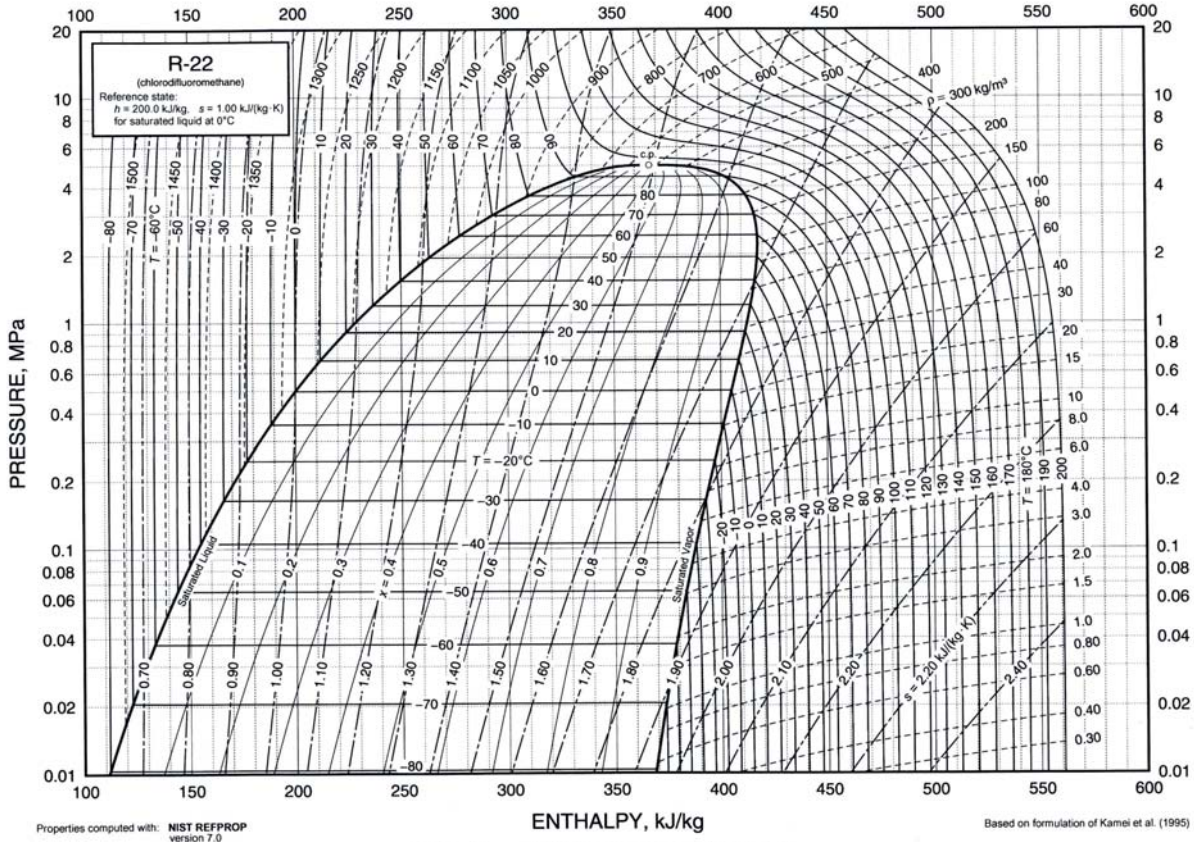

Fig. 5 Pressure-enthalpy diagram for R22