

國立臺北科技大學九十五學年度碩士班招生考試

系所組別：1411 能源與冷凍空調工程系碩士班甲組

第二節 冷凍空調原理（選考）試題

填准考證號碼

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注意事項：

1. 本試題共五題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

1. A building has a total cooling load of 410kW. The latent portion of the load is 100 kW. The space is to be maintained at 25°C db and 50% relative humidity. Outdoor air is at 38°C and 50% relative humidity, and 10% by mass of the air supplied to the space is outdoor air. Air is to be supplied to the space at 18°C. Assume sea level pressure and find:

- (a) The minimum amount of air supplied to the space in m^3/s (10%)
- (b) The capacity, apparatus dew point, by pass factor, and SHF of the cooling coil. (20%)

2. How many people could occupy a room where the concentration level of carbon dioxide is to be kept below 1000 ppm if air with a concentration of 300 ppm CO_2 is being supplied to the room at the rate of $2.5 \text{ m}^3/\text{s}$? Assume that each person is producing carbon dioxide at the average rate of 5.0 mL/s and that the incoming air is completely mixed with the room air. (20%)

3. Please explain the methods commonly used to reduce the reciprocating compressor capacity. (10%)

4. (1) Explain the effect of evaporating temperature on the compressor power requirement as shown in Figure 1. (5%)
- (2) Explain how to avoid a potential motor overload during a pull-down of temperature. (5%)

5. A two-stage ammonia system using flash-gas removal and intercooling operates on the cycle shown in Fig. 2. The condensing temperature is 40°C. The saturation temperature of the intermediate-temperature evaporator is 0°C, and its capacity is 200 kW. The saturation temperature of the low-temperature evaporator is -40°C, and its capacity is 300 kW. Calculate the power required by the compressors and COP of the system? Assume that refrigerant enters the low-stage and high-stage compressors as saturated vapor and leaves condenser without subcooling. (30%)

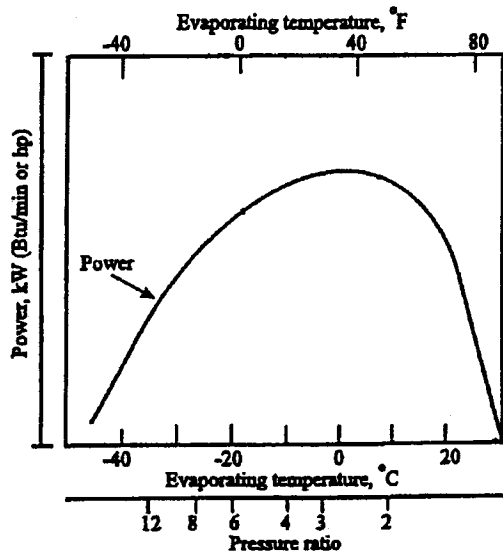


Figure 1 Effect of evaporating temperature on the compressor power requirement

Table 1 Properties of water saturated liquid and vapor

Temp [C]	Pressure [MPa]	Density (L) [kg/m ³]	Density (V) [kg/m ³]	Enthalpy (L) [kJ/kg]	Enthalpy (V) [kJ/kg]	Entropy (L) [kJ/K-kg]	Entropy (V) [kJ/K-kg]
10	0.00123	999.7	0.00941	-639.9	1837	-1.870	6.879
15	0.00171	999.1	0.01284	-619.0	1846	-1.796	6.759
20	0.00234	998.2	0.01731	-598.1	1855	-1.724	6.645
25	0.00317	997.0	0.02307	-577.1	1865	-1.654	6.536
30	0.00425	995.6	0.03042	-556.2	1874	-1.584	6.431
35	0.00563	994.0	0.03967	-535.3	1883	-1.516	6.331
40	0.00738	992.2	0.05124	-514.4	1892	-1.448	6.235

Table 2 Properties of ammonia saturated liquid and vapor

Temp [C]	Pressure [MPa]	Volume (f) [m ³ /kg]	Volume (g) [m ³ /kg]	Enthalpy (f) [kJ/kg]	Enthalpy (g) [kJ/kg]	Entropy (f) [kJ/K-kg]	Entropy (g) [kJ/K-kg]
-40	0.0717	0.00145	1.55300	0.00	1389	0.0000	5.96
-30	0.1194	0.00148	0.96400	44.43	1404	0.1863	5.78
-20	0.1901	0.00150	0.62370	89.38	1419	0.3670	5.62
-10	0.2907	0.00153	0.41830	134.80	1432	0.5425	5.47
0	0.4294	0.00157	0.28930	180.80	1443	0.7133	5.33

10	0.6150	0.00160	0.20540	227.40	1453	0.8796	5.21
20	0.8575	0.00164	0.14920	274.60	1461	1.0420	5.09
30	1.1670	0.00168	0.11050	322.60	1467	1.2010	4.98
40	1.5550	0.00173	0.08310	371.50	1471	1.3580	4.87

Table 3 Properties of superheated ammonia
 Saturation = 0°C, p= 0.4294MPa

Temp [C]	Volume [m ³ /kg]	Enthalpy [kJ/kg]	Entropy [kJ/K-kg]
75	0.3860	1624	5.922
76	0.3872	1627	5.929
77	0.3884	1629	5.935
78	0.3896	1631	5.942
79	0.3908	1633	5.948
80	0.3921	1636	5.955
81	0.3933	1638	5.961
82	0.3945	1640	5.968
83	0.3957	1643	5.974
84	0.3969	1645	5.981
85	0.3981	1647	5.987

Table 4 Properties of superheated ammonia
 Saturation = 40°C, p=1.5554MPa

Temp [C]	Volume [m ³ /kg]	Enthalpy [kJ/kg]	Entropy [kJ/K-kg]
90	0.1048	1620	5.311
91	0.1052	1622	5.318
92	0.1056	1625	5.325
93	0.1060	1628	5.333
94	0.1064	1630	5.340
95	0.1068	1633	5.347
96	0.1072	1636	5.354
97	0.1075	1638	5.362
98	0.1079	1641	5.369
99	0.1083	1644	5.376
100	0.1087	1646	5.383

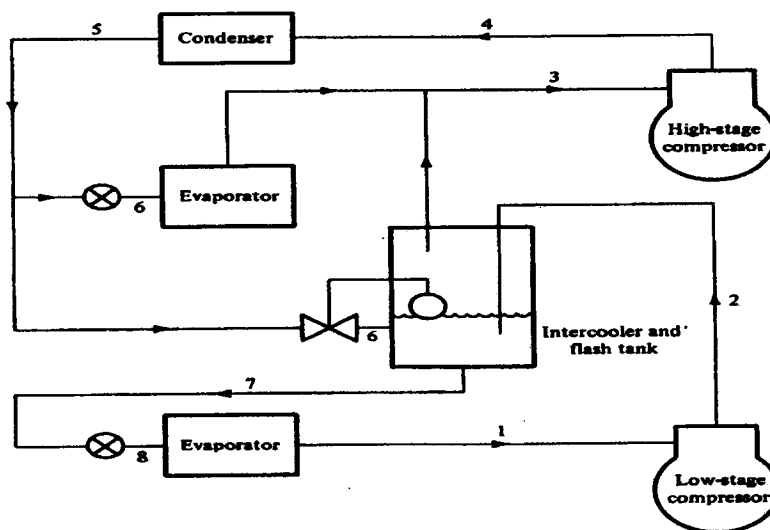


Figure 2 Two compressors and two evaporators operating with intercooling and flash-gas removal

