Marks Scored:

KATHMANDU UNIVERSITY
End Semester Examination
February/March, 2018

Level: B. E.
Year : IV

Course : MEPP 403
Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date MAR 15 2018

SECTION "A"
[10 Q. × 1 =10 marks]

Mark [√] for the most appropriate answer.

1) The sub-cooling is a process of cooling the refrigerant in a vapor compression refrigeration system
[ ] before compression
[ ] after compression
[ ] before throttling
[ ] after throttling

2) Which of the following statements is correct.
[ ] Dew point temperature can be measured with the help of thermometer.
[ ] Dew point temperature is the saturation temperature corresponding to the partial pressure of the water vapor in moist air.
[ ] Dew point temperature is the same as the wet bulb temperature.
[ ] For saturated air, dew point temperature is less than the wet bulb temperature.

3) At the same dry bulb temperature
[ ] wet bulb temperature increases with decrease in relative humidity.
[ ] wet bulb temperature decreases with decrease in relative humidity.
[ ] wet bulb temperature remains constant with decrease in relative humidity.
[ ] wet bulb temperature has no dependence on relative humidity.

4) In multi-stage vapor compression system with flash chamber the suction vapor to the second stage compression are
[ ] normally superheated
[ ] normally wet
[ ] normally dry saturated
[ ] may be wet or dry saturated

5) The designation of refrigerants with chemical formula $CHClF_2$is
[ ] R 12
[ ] R 22
[ ] R 113
[ ] R 133

6) The outdoor air enters into the air-conditioning space through window cracks and through doors when opened is termed as
[ ] leaks
[ ] infiltration
[ ] glazing
[ ] penetration

7) Bell-coleman cycle is a working cycle for
[ ] Steam turbine
[ ] Air refrigeration
[ ] Gas turbine
[ ] Absorption refrigeration

8) Dry compression cycle for a vapor compression refrigeration means
[ ] the entire compression of the vapor should be in superheated region
[ ] the entire compression of the vapor should be in wet region
[ ] the entire compression should be in sub-cooled region
[ ] the vapor enters the compressor in dry state but leaves the condenser in wet state

9) The actual vapor compression cycle may have

[ ] superheating of the vapor in the evaporator
[ ] pressure increase in the suction line
[ ] pressure increase in the condenser
[ ] sub cooled in the suction line

10) In lithium bromide - water absorption refrigeration system

[ ] ammonia is used as a refrigerant and water as an absorbent
[ ] water is used as a refrigerant and lithium bromide as an absorbent
[ ] ammonia is used as an absorbent and lithium bromide as refrigerant
[ ] lithium bromide is used as a refrigerant and water as an absorbent

SECTION "B"

[10 Q. × 1 = 10 marks]

11) In a refrigerating machine, heat rejected is ....heat absorbed.

12) The difference between the dry bulb and wet bulb temperature is called ....

13) The function of a ....is to direct the air from air handling unit to the room.

14) Wet - bulb temperature of air whose relative humidity is 100% is ....to dry bulb temperature.

15) The relative humidity ....during heating and dehumidification process.

16) In a .... constant volume air conditioning system cooling in some zones and heating in other zones can be achieved simultaneously.

17) Comparing vapor compression refrigeration system with absorption refrigeration system, the compressor of the former is replaced by ....

18) Multi evaporator systems are widely used when refrigeration is required at ....temperatures.

19) The .... cycle is described as a heat operated cycle.

20) In a vapor compression refrigeration system, COP of dry compression is ....that of wet compression of the cycle.

KATHMANDU UNIVERSITY
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Year : IV
Time : 2 hrs. 30 mins.

Course : MEPP 403
Semester : I
F. M. : 55

SECTION "C"
[5Q × 11 = 55 marks]

Attempt *ALL* questions. Assume suitable data if any is missing.

1. a. Explain with the help of suitable schematic and T-S diagram the difference between multistage vapor compression system with flash chamber and flash chamber with intercooling. [6]
   b. What is thermal distribution system in air conditioning system? Discuss with the help of suitable schematic diagram about the single duct variable air flow (VAF) air conditioning system. [5]

2. a. A LiBr-water absorption refrigerant system having 100 °C generator temperature, 40 °C condenser temperature, 30 °C absorber temperature and 10 °C evaporator temperature is in operation. The mass flow rate of LiBr-water solution from absorber to generator is 0.6 kg/s. Compute the rate flow of refrigerant through the condenser and evaporator as well as the rate of heat transfer from generator, condenser, absorber and evaporator. [8]
   b. Explain briefly the influencing factors that affect thermal comfort. [3]

3. a. A two stage vapor compression refrigeration system with a flash gas removal and intercooling operates with ammonia as the refrigerant. The evaporator and condenser temperature are -25 °C and 35 °C respectively. If the refrigerating capacity of the plant is 123 kW, estimate the work of low stage and high stage compressors and the COP of the cycle. Had the compression been done in a single stage, what would have been the percentage increase in the total work of compressor and COP of the cycle? [8]
   b. What are the refrigerants? Describe the desirable properties of refrigerants. [3]

4. a. In an aircraft, cabin cooling is required even though the outside temperature is very low at high altitudes. Explain why cooling is required at this high altitude and also describe which kind of refrigeration system is used for it and why. [6]
   b. Explain briefly the important variables and the basic steps to be considered while making heat load estimation. [5]

5. a. An office is to be air conditioned for 60 staff when the outdoor conditions are 12 °C DBT and 10 °C WBT and required conditions of the room are 20 °C and 60% RH. If the quantity of air supplied is 0.3 m3/min/person, find the following: [8]
   i. Heating capacity of the coil in kW,
   ii. The surface temperature required if the bypass factor of the heating coil is 0.4, and
   iii. The capacity of the humidifier, and
   The required condition is achieved first by heating and then by adiabatic humidification. (Use Psychometric chart to solve the problem and leave the chart along with your answer copy)
   b. With the help of T-S diagram, show how reversed Carnot cycle has larger refrigerating effect and smaller compression work than the ideal vapor compression refrigeration cycle. [3]

APPENDIX

Entropy, kJ/kg · K	
Liquid	Vapor
-0.0002	9.1577
0.0306	9.1047
0.0611	9.0526
0.0913	9.0015
0.1213	8.9513
0.1510	8.9020
0.1805	8.8536
0.2098	8.8060
0.2388	8.7593
0.2677	8.7135
0.2963	8.6684
0.3247	8.6241
0.3530	8.5806
0.3810	8.5379
0.4088	8.4959
0.4365	8.4546
0.4640	8.4140
0.4913	8.3740
0.5184	8.3348
0.5453	8.2962
0.5721	8.2583
0.5987	8.2209
0.6252	8.1842
0.6514	8.1481

Table – MEPP 403

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Table A-1 (continued)

t, °C	Saturation pressure, kPa	Specific volume, m^3/kg		Enthalpy, kJ/kg		Entropy, kJ/kg · K	
		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor
48	11.162	0.0010112	13.23	200.89	2588.6	0.6776	8.1125
50	12.335	0.0010121	12.05	209.26	2592.2	0.7035	8.0776
52	13.613	0.0010131	10.98	217.62	2595.7	0.7293	8.0432
54	15.002	0.0010140	10.02	225.98	2599.2	0.7550	8.0093
56	16.511	0.0010150	9.159	234.35	2602.7	0.7804	7.9759
58	18.147	0.0010161	8.381	242.72	2606.2	0.8058	7.9431
60	19.920	0.0010171	7.679	251.09	2609.7	0.8310	7.9108
62	21.84	0.0010182	7.044	259.46	2613.2	0.8560	7.8790
64	23.91	0.0010193	6.469	267.84	2616.6	0.8809	7.8477
66	26.15	0.0010205	5.948	276.21	2620.1	0.9057	7.8168
68	28.56	0.0010217	5.476	284.59	2623.5	0.9303	7.7864
70	31.16	0.0010228	5.046	292.97	2626.9	0.9548	7.7565
72	33.96	0.0010241	4.646	301.35	2630.3	0.9792	7.7270
74	36.96	0.0010253	4.300	309.74	2633.7	1.0034	7.6979
76	40.19	0.0010266	3.976	318.13	2637.1	1.0275	7.6693
78	43.65	0.0010279	3.680	326.52	2640.4	1.0514	7.6410
80	47.36	0.0010292	3.409	334.92	2643.8	1.0753	7.6132
82	51.33	0.0010305	3.162	343.31	2647.1	1.0990	7.5850
84	55.57	0.0010319	2.935	351.71	2650.4	1.1225	7.5588
86	60.11	0.0010333	2.727	360.12	2653.6	1.1460	7.5321
88	64.95	0.0010347	2.536	368.53	2656.9	1.1693	7.5058
90	70.11	0.0010361	2.361	376.94	2660.1	1.1925	7.4799
92	75.61	0.0010376	2.200	385.36	2663.4	1.2156	7.4543
94	81.46	0.0010391	2.052	393.78	2666.6	1.2386	7.4291
96	87.69	0.0010406	1.915	402.20	2669.7	1.2615	7.4042
98	94.30	0.0010421	1.789	410.63	2672.9	1.2842	7.3796
100	101.33	0.0010437	1.673	419.06	2676.0	1.3069	7.3554
102	108.78	0.0010453	1.566	427.50	2679.1	1.3294	7.3315
104	116.68	0.0010469	1.466	435.95	2682.2	1.3518	7.3078
106	125.04	0.0010485	1.374	444.40	2685.3	1.3742	7.2845
108	133.90	0.0010502	1.289	452.85	2688.3	1.3964	7.2615
110	143.26	0.0010519	1.210	461.32	2691.3	1.4185	7.2388
112	153.16	0.0010536	1.137	469.78	2694.3	1.4405	7.2164
114	163.62	0.0010553	1.069	478.26	2697.2	1.4624	7.1942
116	174.65	0.0010571	1.005	486.74	2700.2	1.4842	7.1723
118	186.28	0.0010588	0.9463	495.23	2703.1	1.5060	7.1507
120	198.54	0.0010606	0.8915	503.72	2706.0	1.5276	7.1293

Source: Abstracted by permission from Ref. 1.

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Table A-3 Ammonia: properties of liquid and saturated vapor[3]

		Enthalpy, kJ/kg		Entropy, kJ/kg · K		Specific volume, L/kg	
t, °C	P, kPa	h_f	h_g	s_f	s_g	v_f	v_g
−60	21.99	−69.5330	1373.19	−0.10909	6.6592	1.4010	4685.08
−55	30.29	−47.5062	1382.01	−0.00717	6.5454	1.4126	3474.22
−50	41.03	−25.4342	1390.64	0.09264	6.4382	1.4245	2616.51
−45	54.74	−3.3020	1399.07	0.19049	6.3369	1.4367	1998.91
−40	72.01	18.9024	1407.26	0.28651	6.2410	1.4493	1547.36
−35	93.49	41.1883	1415.20	0.38082	6.1501	1.4623	1212.49
−30	119.90	63.5629	1422.86	0.47351	6.0636	1.4757	960.867
−28	132.02	72.5387	1425.84	0.51015	6.0302	1.4811	878.100
−26	145.11	81.5300	1428.76	0.54655	5.9974	1.4867	803.761
−24	159.22	90.5370	1431.64	0.58272	5.9652	1.4923	736.868
−22	174.41	99.5600	1434.46	0.61865	5.9336	1.4980	676.570
−20	190.74	108.599	1437.23	0.65436	5.9025	1.5037	622.122
−18	208.26	117.656	1439.94	0.68984	5.8720	1.5096	572.875
−16	227.04	126.729	1442.60	0.72511	5.8420	1.5155	528.257
−14	247.14	135.820	1445.20	0.76016	5.8125	1.5215	487.769
−12	268.63	144.929	1447.74	0.79501	5.7835	1.5276	450.971
−10	291.57	154.056	1450.22	0.82965	5.7550	1.5338	417.477
−9	303.60	158.628	1451.44	0.84690	5.7409	1.5369	401.860
−8	316.02	163.204	1452.64	0.86410	5.7269	1.5400	386.944
−7	328.84	167.785	1453.83	0.88125	5.7131	1.5432	372.692
−6	342.07	172.371	1455.00	0.89835	5.6993	1.5464	359.071
−5	355.71	176.962	1456.15	0.91541	5.6856	1.5496	346.046
−4	369.77	181.559	1457.29	0.93242	5.6721	1.5528	333.589
−3	384.26	186.161	1458.42	0.94938	5.6586	1.5561	321.670
−2	399.20	190.768	1459.53	0.96630	5.6453	1.5594	310.263
−1	414.58	195.381	1460.62	0.98317	5.6320	1.5627	299.340
0	430.43	200.000	1461.70	1.00000	5.6189	1.5660	288.880
1	446.74	204.625	1462.76	1.01679	5.6058	1.5694	278.858
2	463.53	209.256	1463.80	1.03354	5.5929	1.5727	269.253
3	480.81	213.892	1464.83	1.05024	5.5800	1.5762	260.046
4	498.59	218.535	1465.84	1.06691	5.5672	1.5796	251.216
5	516.87	223.185	1466.84	1.08353	5.5545	1.5831	242.745
6	535.67	227.841	1467.82	1.10012	5.5419	1.5866	234.618
7	555.00	232.503	1468.78	1.11667	5.5294	1.5901	226.817
8	574.87	237.172	1469.72	1.13317	5.5170	1.5936	219.326
9	595.28	241.848	1470.64	1.14964	5.5046	1.5972	212.132
10	616.25	246.531	1471.57	1.16607	5.4924	1.6008	205.221
11	637.78	251.221	1472.46	1.18246	5.4802	1.6045	198.580
12	659.89	255.918	1473.34	1.19882	5.4681	1.6081	192.196
13	682.59	260.622	1474.20	1.21515	5.4561	1.6118	186.058
14	705.88	265.334	1475.05	1.23144	5.4441	1.6156	180.154
15	729.79	270.053	1475.88	1.24769	5.4322	1.6193	174.475
16	754.31	274.779	1476.69	1.26391	5.4204	1.6231	169.009
17	779.46	279.513	1477.48	1.28010	5.4087	1.6269	163.748
18	805.25	284.255	1478.25	1.29626	5.3971	1.6308	158.683
19	831.69	289.005	1479.01	1.31238	5.3855	1.6347	153.804
20	858.79	293.762	1479.75	1.32847	5.3740	1.6386	149.106

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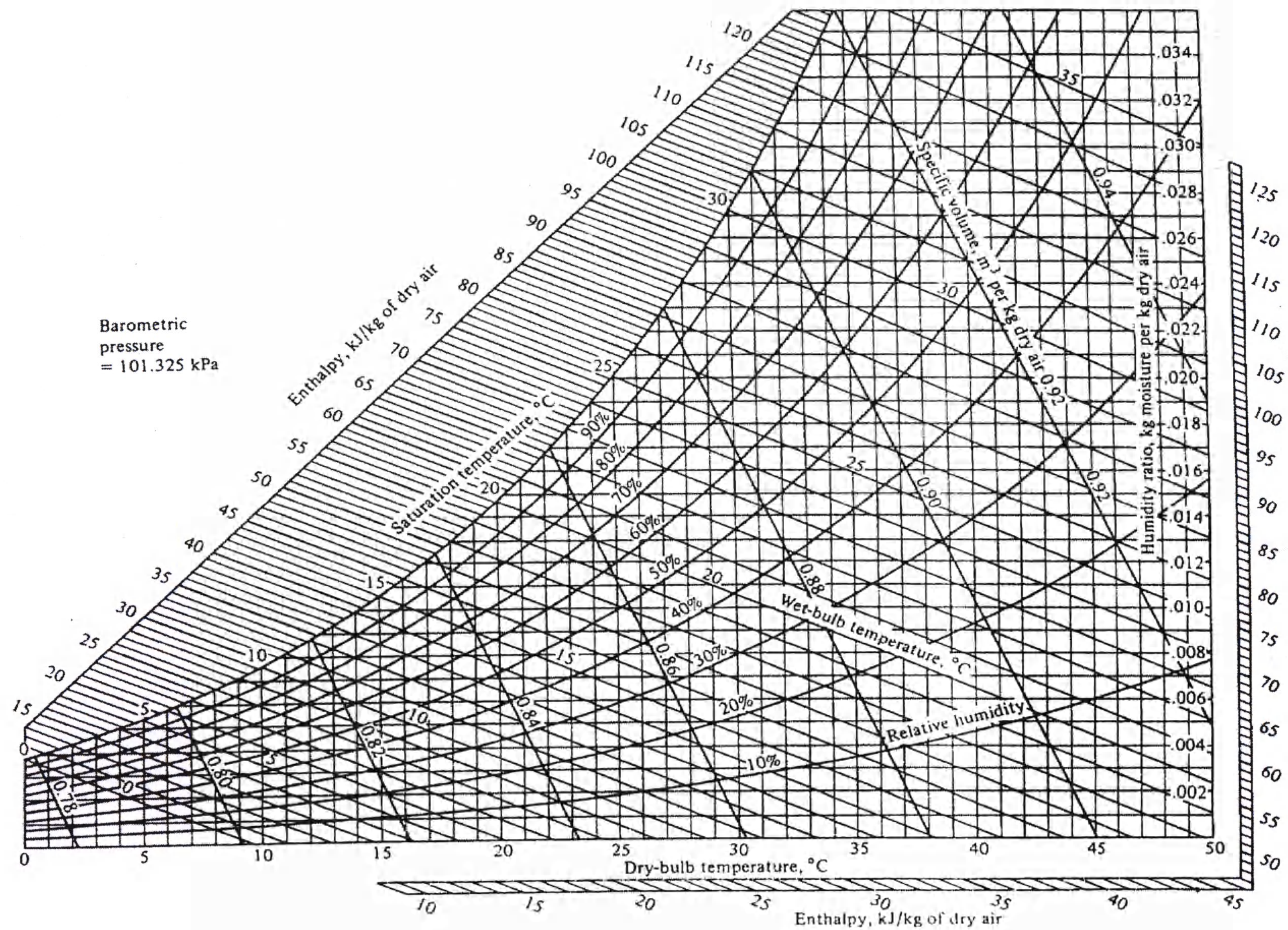
Table A-3 (continued)

t, °C	P, kPa	Enthalpy, kJ/kg		Entropy, kJ/kg · K		Specific volume, L/kg	
		h_f	h_g	s_f	s_g	v_f	v_g
21	886.57	298.527	1480.48	1.34452	5.3626	1.6426	144.578
22	915.03	303.300	1481.18	1.36055	5.3512	1.6466	140.214
23	944.18	308.081	1481.87	1.37654	5.3399	1.6507	136.006
24	974.03	312.870	1482.53	1.39250	5.3286	1.6547	131.950
25	1004.6	317.667	1483.18	1.40843	5.3175	1.6588	128.037
26	1035.9	322.471	1483.81	1.42433	5.3063	1.6630	124.261
27	1068.0	327.284	1484.42	1.44020	5.2953	1.6672	120.619
28	1100.7	332.104	1485.01	1.45604	5.2843	1.6714	117.103
29	1134.3	336.933	1485.59	1.47185	5.2733	1.6757	113.708
30	1168.6	341.769	1486.14	1.48762	5.2624	1.6800	110.430
31	1203.7	346.614	1486.67	1.50337	5.2516	1.6844	107.263
32	1239.6	351.466	1487.18	1.51908	5.2408	1.6888	104.205
33	1276.3	356.326	1487.66	1.53477	5.2300	1.6932	101.248
34	1313.9	361.195	1488.13	1.55042	5.2193	1.6977	98.3913
35	1352.2	366.072	1488.57	1.56605	5.2086	1.7023	95.6290
36	1391.5	370.957	1488.99	1.58165	5.1980	1.7069	92.9579
37	1431.5	375.851	1489.39	1.59722	5.1874	1.7115	90.3743
38	1472.4	380.754	1489.76	1.61276	5.1768	1.7162	87.8748
39	1514.3	385.666	1490.10	1.62828	5.1663	1.7209	85.4561
40	1557.0	390.587	1490.42	1.64377	5.1558	1.7257	83.1150
41	1600.6	395.519	1490.71	1.65924	5.1453	1.7305	80.8484
42	1645.1	400.462	1490.98	1.67470	5.1349	1.7354	78.6536
43	1690.6	405.416	1491.21	1.69013	5.1244	1.7404	76.5276
44	1737.0	410.382	1491.41	1.70554	5.1140	1.7454	74.4678
45	1784.3	415.362	1491.58	1.72095	5.1036	1.7504	72.4716
46	1832.6	420.358	1491.72	1.73635	5.0932	1.7555	70.5365
47	1881.9	425.369	1491.83	1.75174	5.0827	1.7607	68.6602
48	1932.2	430.399	1491.88	1.76714	5.0723	1.7659	66.8403
49	1983.5	435.450	1491.91	1.78255	5.0618	1.7712	65.0746
50	2035.9	440.523	1491.89	1.79798	5.0514	1.7766	63.3608
51	2089.2	445.623	1491.83	1.81343	5.0409	1.7820	61.6971
52	2143.6	450.751	1491.73	1.82891	5.0303	1.7875	60.0813
53	2199.1	455.913	1491.58	1.84445	5.0198	1.7931	58.5114
54	2255.6	461.112	1491.38	1.86004	5.0092	1.7987	56.9855
55	2313.2	466.353	1491.12	1.87571	4.9985	1.8044	55.5019

Psychrometric Chart



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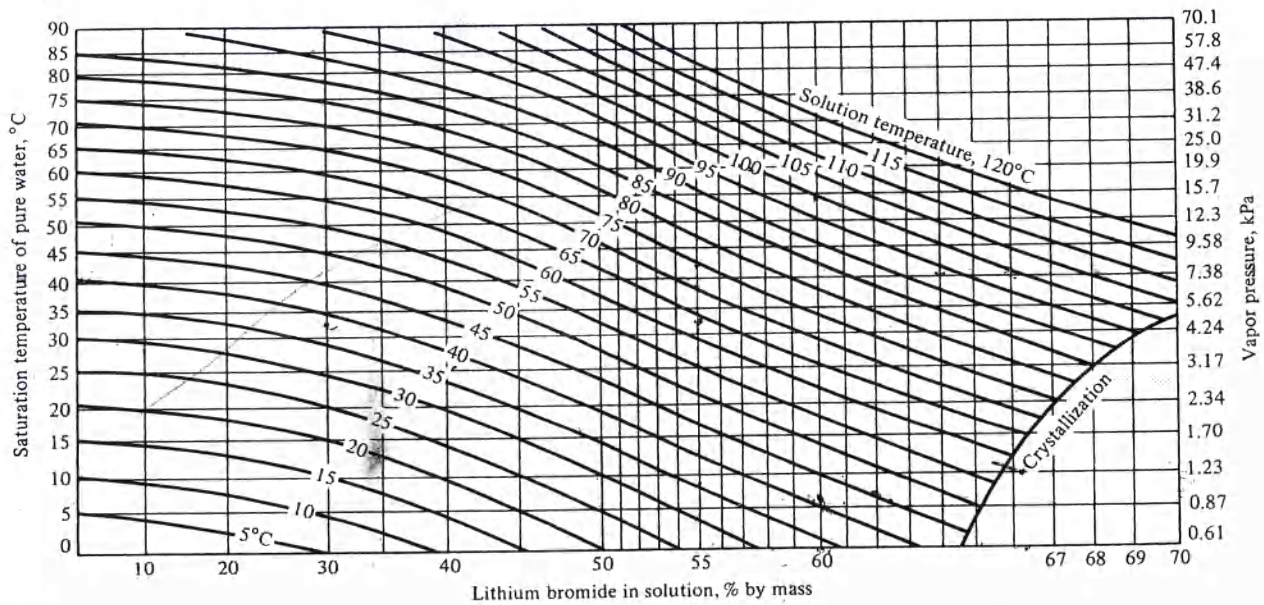

Figure 17-5 Temperature-pressure-concentration diagram of saturated LiBr–water solutions, developed from data in Ref. 1.

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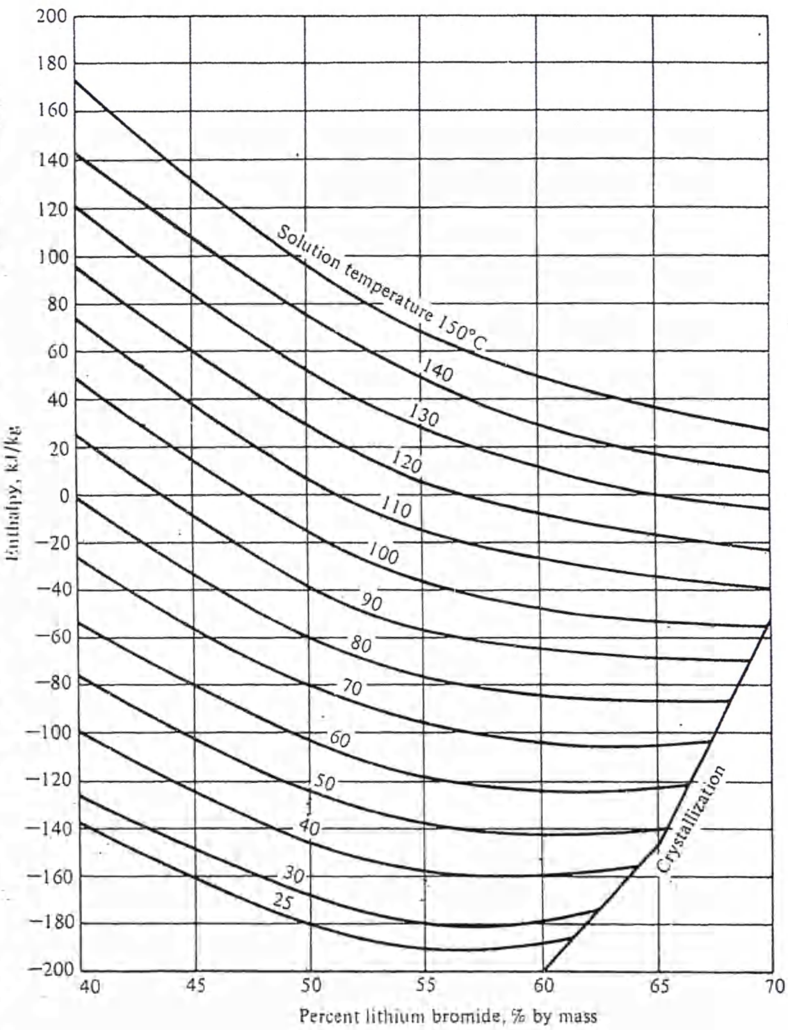

Figure 17-8 Enthalpy of LiBr–water solutions; data from Ref. 1.

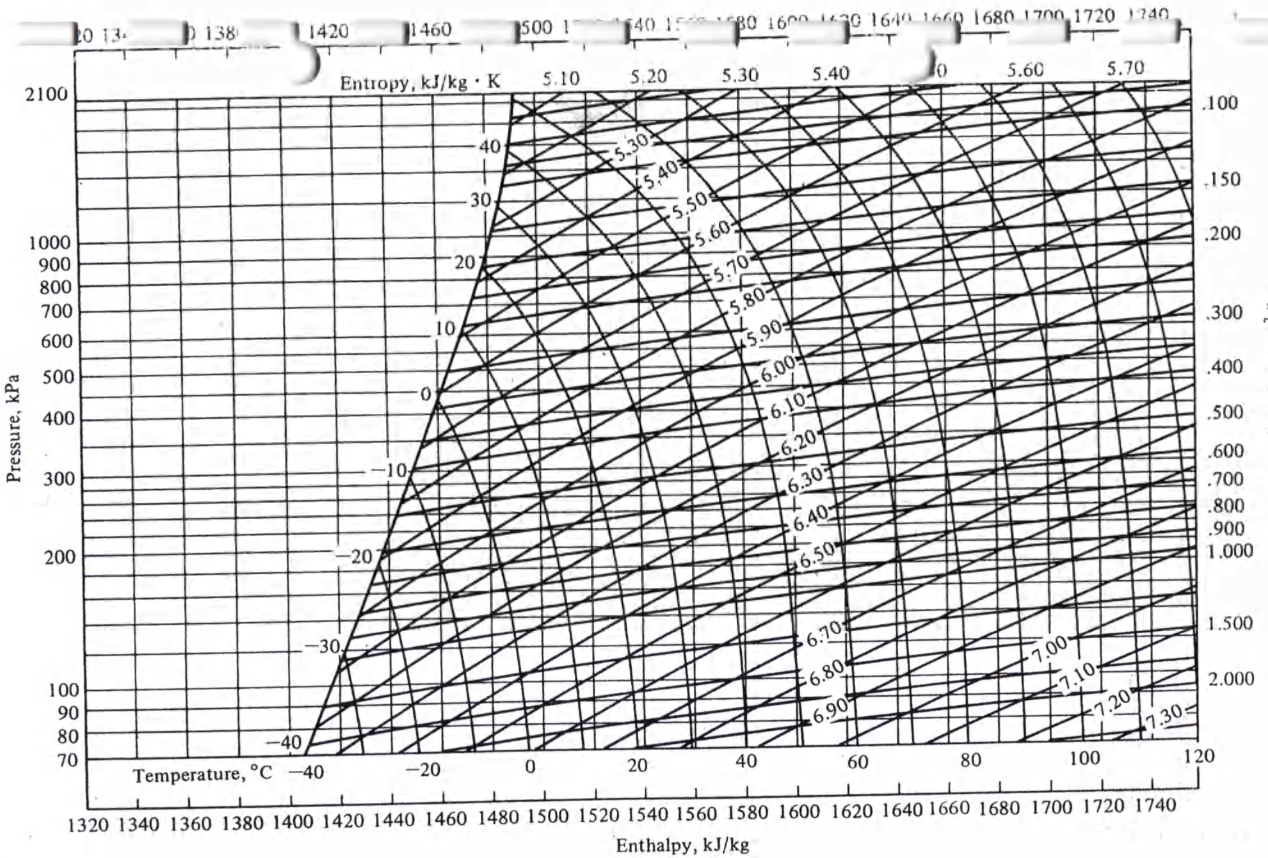

Figure A-1 Pressure-enthalpy diagram of superheated ammonia vapor. *(Prepared for this book by the Technical University of Denmark from Data in Ref. 8.)*

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APPENDIX

Table A-1 Water: properties of liquid and saturated vapor

t, °C	Saturation pressure, kPa	Specific volume, m^3/kg		Enthalpy, kJ/kg		Entropy, kJ/kg · K	
		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor
0	0.6108	0.0010002	206.3	−0.04	2501.6	−0.0002	9.1577
2	0.7055	0.0010001	179.9	8.39	2505.2	0.0306	9.1047
4	0.8129	0.0010000	157.3	16.80	2508.9	0.0611	9.0526
6	0.9345	0.0010000	137.8	25.21	2512.6	0.0913	9.0015
8	1.0720	0.0010001	121.0	33.60	2516.2	0.1213	8.9513
10	1.2270	0.0010003	106.4	41.99	2519.9	0.1510	8.9020
12	1.4014	0.0010004	93.84	50.38	2523.6	0.1805	8.8536
14	1.5973	0.0010007	82.90	58.75	2527.2	0.2098	8.8060
16	1.8168	0.0010010	73.38	67.13	2530.9	0.2388	8.7593
18	2.062	0.0010013	65.09	75.50	2534.5	0.2677	8.7135
20	2.337	0.0010017	57.84	83.86	2538.2	0.2963	8.6684
22	2.642	0.0010022	51.49	92.23	2541.8	0.3247	8.6241
24	2.982	0.0010026	45.93	100.59	2545.5	0.3530	8.5806
26	3.360	0.0010032	41.03	108.95	2549.1	0.3810	8.5379
28	3.778	0.0010037	36.73	117.31	2552.7	0.4088	8.4959
30	4.241	0.0010043	32.93	125.66	2556.4	0.4365	8.4546
32	4.753	0.0010049	29.57	134.02	2560.0	0.4640	8.4140
34	5.318	0.0010056	26.60	142.38	2563.6	0.4913	8.3740
36	5.940	0.0010063	23.97	150.74	2567.2	0.5184	8.3348
38	6.624	0.0010070	21.63	159.09	2570.8	0.5453	8.2962
40	7.375	0.0010078	19.55	167.45	2574.4	0.5721	8.2583
42	8.198	0.0010086	17.69	175.31	2577.9	0.5987	8.2209
44	9.100	0.0010094	16.04	184.17	2581.5	0.6252	8.1842
46	10.086	0.0010103	14.56	192.53	2585.1	0.6514	8.1481