UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 2003/2004

Februari / Mac 2004

JNK 504/3– PENYEJUKAN DAN PENYAMANAN UDARA

Masa : 3 jam

ARAHAN KEPADA CALON :

Sila pastikan bahawa kertas soalan ini mengandungi **SEMBILAN (9)** mukasurat dan **TUJUH (7)** soalan yang bercetak serta **SEPULUH (10)** halaman lampiran sebelum anda memulakan peperiksaan.

Sila jawab **LIMA (5)** soalan sahaja.

Calon perlu menjawab semua soalan dalam Bahasa Inggeris.

LAMPIRAN :

1. Table A-1 Water : properties of liquid and saturated vapor [2 mukasurat]
2. Table A-2 Ammonia : properties of liquid and saturated vapor[3] [2 mukasurat]
3. Pressure-enthlpy Diagram of Superheated Ammonia Vapor [1 mukasurat]
4. Psychrometric chart [1 mukasurat]
5. Friction Chart For Round Duct ($\rho = 1.2$ kg/m^3 and $\varepsilon = 0.09$ mm) [1 mukasurat]
6. ASHRAF Psychrometric Chart No. 1 [1 mukasurat]
7. Temperature-pressure-concentration diagram of saturated LiBr-water solutions [2 mukasurat]

Setiap soalan mestilah dimulakan pada mukasurat yang baru.

Serahkan **KESELURUHAN** soalan dan jawapan kertas peperiksaan ini kepada Ketua Pengawas di akhir sidang peperiksaan. Pelajar yang gagal berbuat demikian akan diambil tindakan disiplin.

KETUA PENGAWAS : Sila pungut :

(a) **KESELURUHAN** kertas soalan ini (tanpa diceraikan mana-mana muka surat) dan mana-mana kertas soalan peperiksaan ini yang berlebihan untuk dikembalikan kepada Bahagian Peperiksaan, Jabatan Pendaftar, USM.

Peringatan :

a pastikan bahawa anda telah menulis angka giliran dengan betul.

S1. [a] **Lakarkan satu kitar penyejukan dengan keadaan panas lampau dai subdingin pada gambarajah p-h dan T-s. Apakah kesan-kesan dai subdingai?**

Sketch a refrigeration cycle with superheat and subcooling on p-h and T-diagrams. What are the effects of subcooling?

(30 markah

[b] **Terangkan kesan-kesan dari suhu penyejatan ke atas kadar aliral isipadu per kilowatt penyejukan dan pekali prestasi di dalam sebual pemampat unggul yang beroperasi pada suhu pemeluapan malar.**

Explain the effects of evaporating temperature on volume flow rate pe kilowatt of refrigeration and coefficient of performance in an idec compressor operating at constant condensing temperature.

(30 markah

[c] **Takrifkan Nisbah Penolakan haba dan nyatakan julat nilai yang and jangkakan di dalam satu system penyejukan biasa.**

Define Heat Rejection Ratio and indicate the range of value you would expec in a typical refrigeration system.

(20 markah

[d] **Huraikan tiga sebab bagi kehilangan air dari operasi menar pendinginan.**

Describe the three causes of water loss from cooling tower operation.

(20 markah

S2. [a] **Dengan merujuk kepada lakaran berlabel, huraikan operasi dan tujual bagi pengatur tekanan penyejat.**

Making reference to a labelled sketch, describe the operation and purpose c an evaporator pressure regulator.

(40 markah

[b] **Terangkan fungsi dan kedudukan penumpuk di dalam sistel penyejukan. Mengapa ia merupakan satu komponen penting di dalal sistem penyejukan di mana tiub rerambut digunakan?**

Explain the function and location of an accumulator in a refrigeration systen Why is it an essential component in a system where capillary tube is used?

(30 markah

[c] **Senaraikan lima ciri/kualiti yang dikehendaki dalam bahan pendingin dan terangkan secara ringkas bagaimana ciri-ciri tersebut mempengaruhi prestasi sistem.**

List five properties/qualities which are desirable in a refrigerant and briefly explain how they affect system performance.

(30 markah)

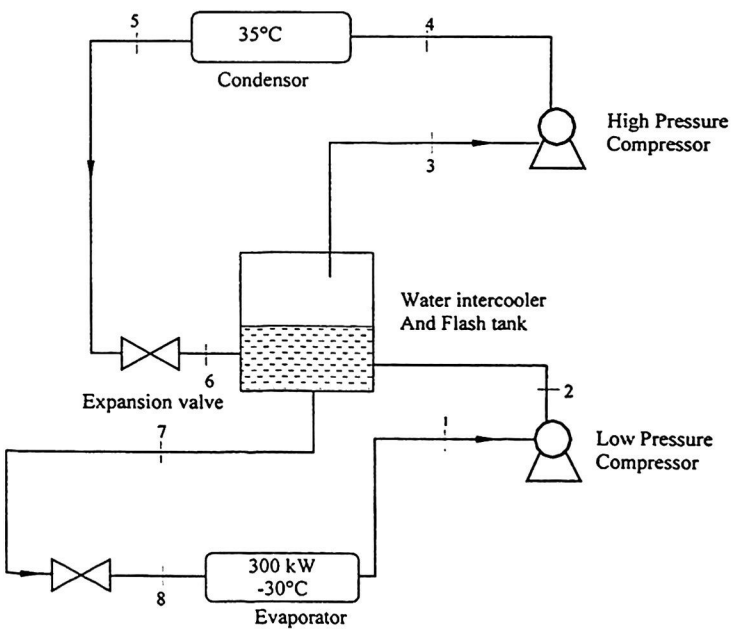
S3. [a] **Mengapa pendinginan antara digunakan di dalam sistem penyejukan pelbagai tekanan? Apakah dua kaedah biasa bagi pendinginan-antara?**

Why is intercooling used in a multipressure refrigeration system? What are the two common methods of intercooling?

(20 markah)

[b] **Di dalam system penyejukan NH_3 yang digunakan didalam setor sejuk, seperti yang ditunjuk dalam Rajah S3[b] sebuah penyejat akan membekalkan 300 kW bagi penyejukan pada suhu -30°C. Sistem tersebut menggunakan mampatan dua peringkat, seperti yang ditunjuk dalam Rajah yang sama, berserta dengan pendinginan-antara dan penyingkiran gas kilat. Suhu pemeluwapan ialah 35°C.**

In an NH_3 refrigeration system employed in a cold store, as shown in Figure Q3[b] one evaporator is to provide 300 kW of refrigeration at –30°C. The system uses two-stage compression, as shown in the same Figure, with intercooling and removal of flash gas. The condensing temperature is 35°C.



Gambarajah Skematik Sistem Pelbagai Tekanan
Schematic diagram of the multipressure system

Rajah S3[b]
Figure Q3[b]

Lukis kitar di atas gambarajah p-h.

Draw the cycle on a p-h diagram.

(20 markah)

(i) Kira nilai kuasa yang diperlukan oleh pemampat.

Calculate the power required by the compressors.

(40 markah)

(ii) Kira pekali prestasi.

Calculate the coefficient of performance.

(20 markah)

S4. [a] Namakan sebarang dua kombinasi bahan pendingin-bahan penyerap dan aplikasinya. Kombinasi yang manakah digunakan di dalam aplikasi penyamanan udara?

Name any two combinations of refrigerant-absorbent and their applications. Which combination is used in air conditioning application?

(20 markah)

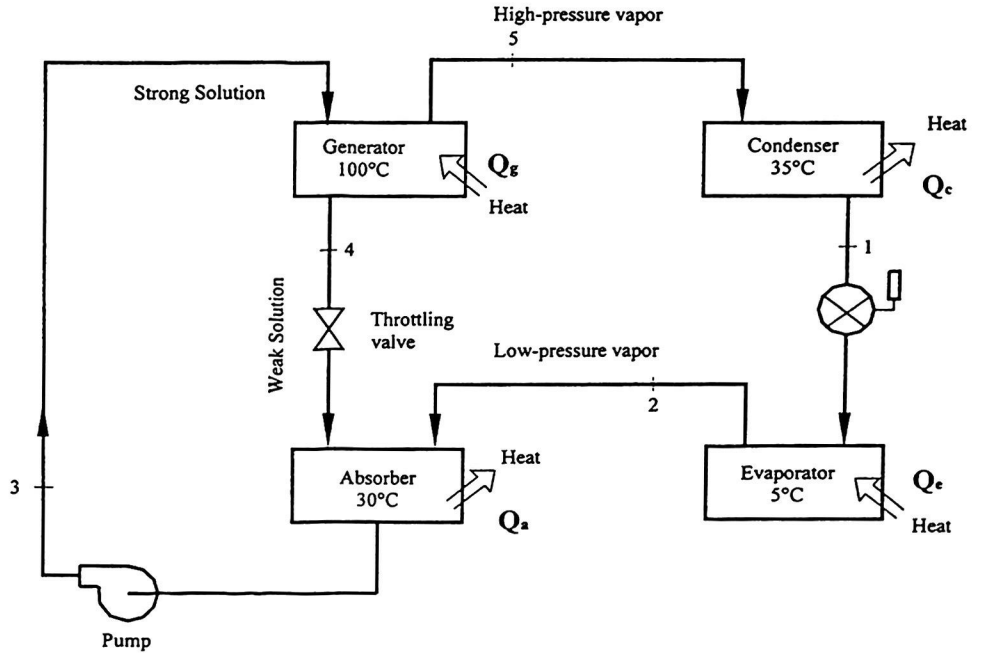
[b] Suhu operasi bagi sistem penyerapan air litium-bromid, seperti yang ditunjuk dalam Rajah S4[b], adalah seperti berikut:

The operating temperatures of a lithium-bromide water absorption system, as shown in Figure Q4[b], are as follows:

Penjana/*Generator*	*100°C*
Pemeluwap/*Condenser*	*35°C*
Penyejat/*Evaporator*	*5°C*
Penyerap/*Absorber*	*30°C*

Kadar aliran jisim yang dihantar oleh pam akua ialah 0.4 kg/s. Kira

The mass flow rate delivered by the aqua pump is 0.4 kg/s. Calculate



Rajah skematik kitaran serapan wap
Schematic diagram of the vapour absorption cycle

Rajah S4[b]
Figure Q4[b]

(i) Haba yang dibekalkan ke penjana

The heat supplied to the generator

(15 markah)

(ii) Haba yang dikeluarkan di pemeluwap dan di penyerap,

The heat rejected at the condenser and absorber,

(30 markah)

(iii) Penyejukan yang dihasilkan oleh penyejat, dan

The cooling produced by the evaporator, and

(15 markah)

(iv) Pekali prestasi bagi kitar

The coefficient of performance of the cycle.

(20 markah)

S5. [a] **Apakah modifikasi-modifikasi yang perlu untuk menukar penyaman udara domestik yang digunakan untuk penyejukan ketika musim panas kepada penggunaan dalam musim sejuk juga? Gambarkan jawapan anda dengan lakaran ringkas.**

ATAU

What modifications are necessary to convert a domestic air conditioner meant for summer cooling to be used in winter as well? Illustrate your answer with a simple sketch

OR

Mengapa pengawal tekanan statik diperlukan di dalam sistem VAV?

Why is a static pressure controller needed in VAV systems?

(40 markah)

[b] **Dengan bantuan lakaran ringkas, namakan komponen-komponen utama bagi Unit Pengelolaan Udara yang biasa?**

With the aid of a simple sketch name the main components of a typical Air Handling unit?

(30 markah)

[c] **Terangkan secara ringkas punca-punca bagi pencemaran udara dalam rumah/bangunan.**

Briefly describe the causes of indoor air pollution.

(30 markah)

S6. **Sebuah penyaman udara menarik 0.95 m^3/s keseluruhan udara di sepanjang lingkaran penyejukan. Keadaan udara luaran adalah pada 35°C T_{db} and 25°C T_{wb} dan ruang yang selesa adalah kekal pada 26°C T_{db} dan 45% kelembapan nisbi. Nisbah Haba Deria yang dikira ialah 0.72. Udara yang meninggalkan lingkaran adalah 90 peratus tepu. Dapatkan nilai-nilai berikut:**

An air conditioner is drawing 0.95 m^3/s of all outside air over a cooling coil. The outdoor air condition is at 35°C T_{db} and 25°C T_{wb} and the conditioned space is being maintained at 26°C T_{db} and 45% relative humidity. Sensible Heat Ratio is calculated as 0.72. The air leaving the coil is 90 per cent saturated. Find the following:

(i) **Titik embun radas,**

The apparatus dew point,

(25 markah)

(ii) **Suhu bagi udara yang meninggalkan lingkaran,**

The temperature of air leaving coil,

(25 markah)

(iii) **Berapa banyak penyejukan dalam kW yang dilakukan oleh unit tersebut?**

How much cooling in kW is the unit doing?

(25 markah)

(iv) **Berapa banyak lembapan dalam kg per kg udara kering yang termeluwap dari udara masuk per jam?**

How much moisture in kg per kg of dry air is condensed out of incoming air per hour?

(25 markah)

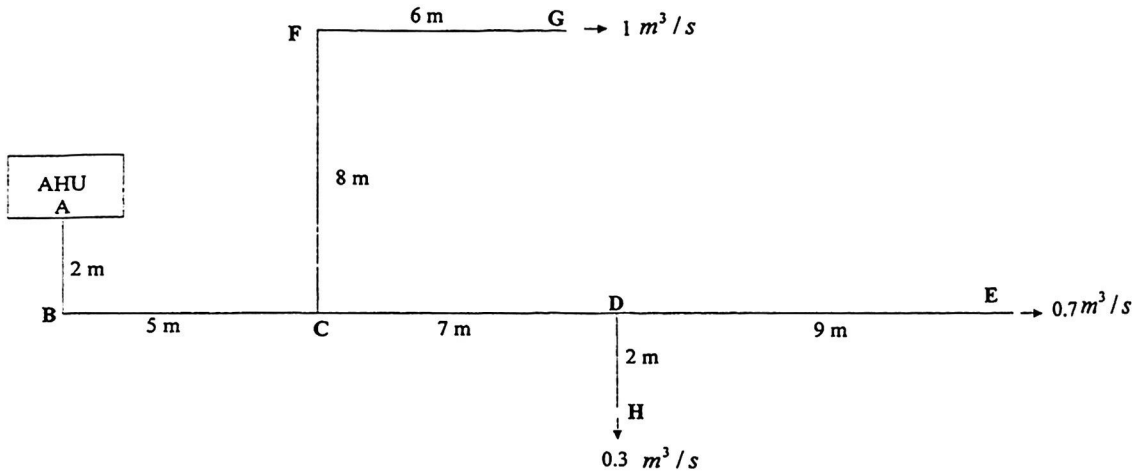
S7. [a] **Takrifkan nisbah aspek salur. Apakah nisbah yang disarankan di dalam rekabentuk sesuatu sistem salur?**

Define duct aspect ratio. What is the recommended aspect ratio in the design of a duct system?

(20 markah)

[b] **Sebuah penyaman udara membekalkan udara ke tiga bilik di dalam premis pejabat yang kecil. Bentangan skema bagi sistem salur dan kadar aliran isipadu kesetiap bilik ialah seperti yang ditunjuk di dalam Gambarajah S7[b]. Setiap segmen salur dan panjangnya dijadualkan di dalam Jadual 1.**

An air conditioner supplies air to three rooms in a small office premises. The schematic layout of the duct system and the volume flow rate to each room is shown in Figure Q7[b]. Each duct segment and its lengths are tabulated in Table 1.



Rajah S7[b]
Figure Q7[b]

Segment	*AB*	*BC*	*CD*	*DE*	*DH*	*CF*	*FG*
Length, m	*2*	*5*	*7*	*9*	*2*	*8*	*6*

Jadual 1
Table 1

(i) **Saiz sistem salur yang ditunjuk di dalam Gambarajah S7[b] menggunakan kaedah geseran sama yang disarankan untuk kerja-kerja salur tekanan rendah. Salur tersebut seharusnya mempunyai piawai keratin bulat dengan diameter secara meningkat sebanyak 25 mm. Halaju udara di dalam keratin pertama adalah tidak melebihi 8 m/s.**

Size the duct system shown in Figure Q7[b] using equal friction method recommended for low-pressure ductwork. The duct shall be of standard round section with diameters in increments of 25 mm. The air velocity in the first section is not to exceed 8 m/s.

(50 markah)

(ii) **Anggarkan tekanan statik di dalam larian indeks bagi rangkaian salur dan nyatakan jumlah yang diserapkan ke cawangan-cawangan lain untuk mengimbangi aliran tersebut. Ambil kira tekanan turun sebanyak 25 Pa di setiap gril keluar di D, E dan F. Di dalam pengiraan, ambil kira rintangan disebabkan siku dan Tee masing-masing sebanyak 10 Pa dan 15 Pa.**

Estimate the static pressure in the index run of the duct network and indicate the amount of dampering to the other branches to balance the flow. Consider a pressure drop of 25 Pa at each of the outlet grilles at D, E and F. In the calculation, consider the resistance due to the elbow and Tee as 10 Pa and 15 Pa respectively.

(30 markah)

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

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	Saturation pressure,	Specific volume, m^3/kg		Enthalpy, kJ/kg		Entropy, kJ/kg · K	
t, °C	kPa	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	159.00	2570.8	0.5452	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

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

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

Table A-2 Ammonia : properties of liquid and saturated vapor[3]

Table A-2 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	1.4087	1.6269	163.748
18	805.25	284.255	1478.25	1.29626	5.3971	1.6308	158.683
	831.69	289.005	1479.01	1.31238	5.3855	1.6347	153.804
	858.79	293.762	1479.75	1.32847	5.3740	1.6386	149.106

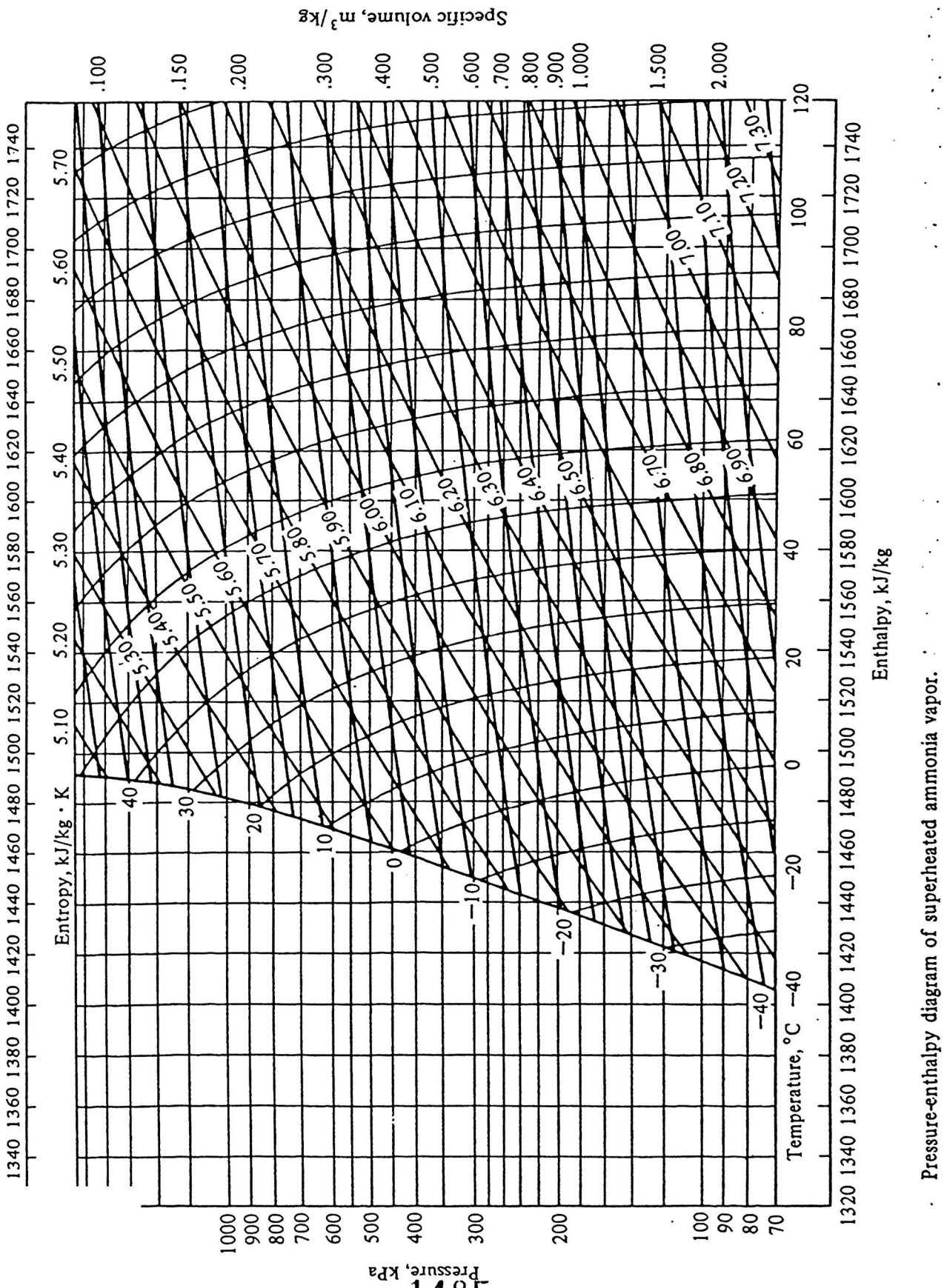
Table A-2 Ammonia : properties of liquid and saturated vapor[3] (Continued)

Table A-2 Ammonia : properties of liquid and saturated vapor[3] (Continued)

		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
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

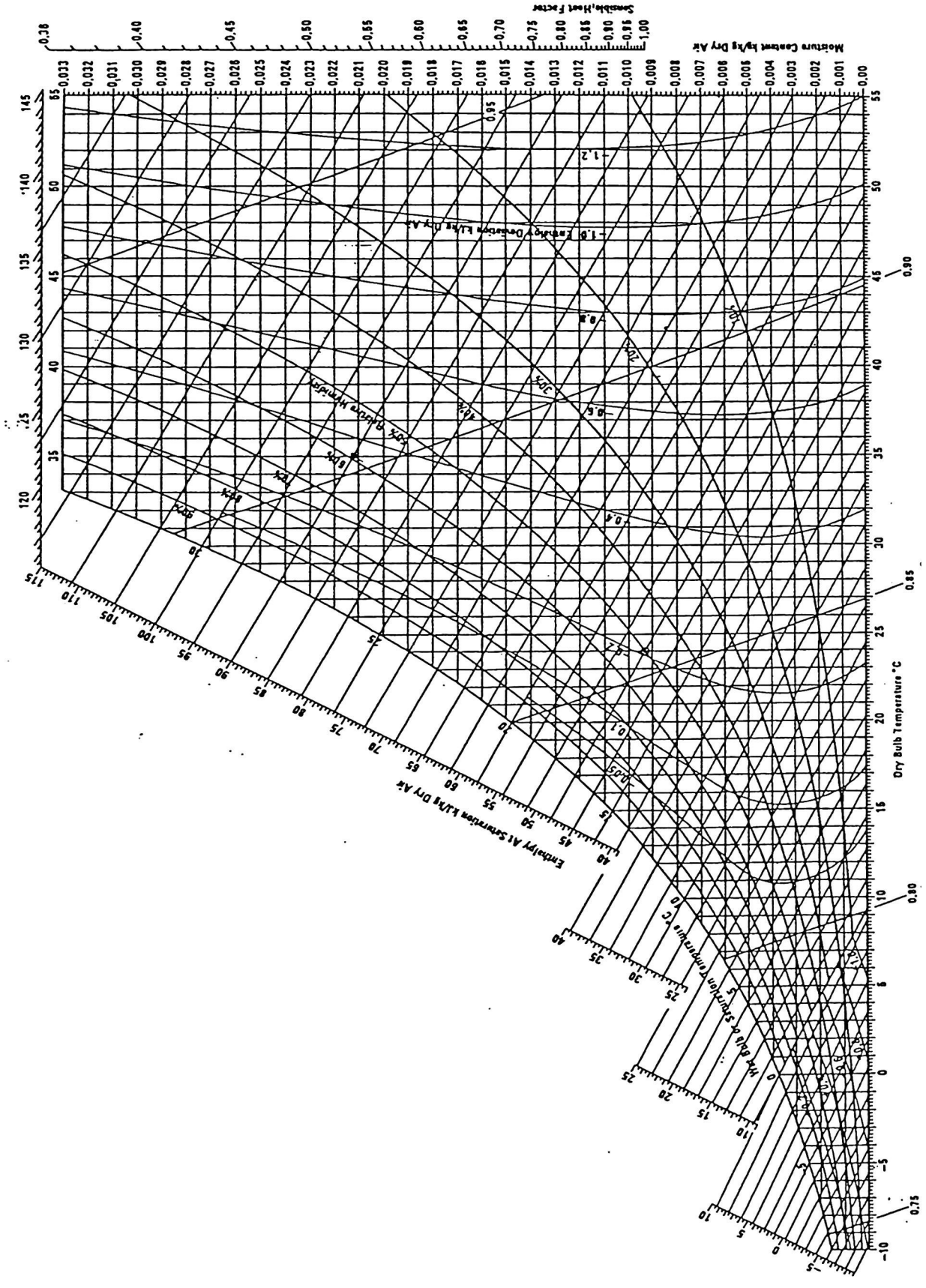
LAMPIRAN 3

Pressure-enthlpy diagram of superheated ammonia vapor.



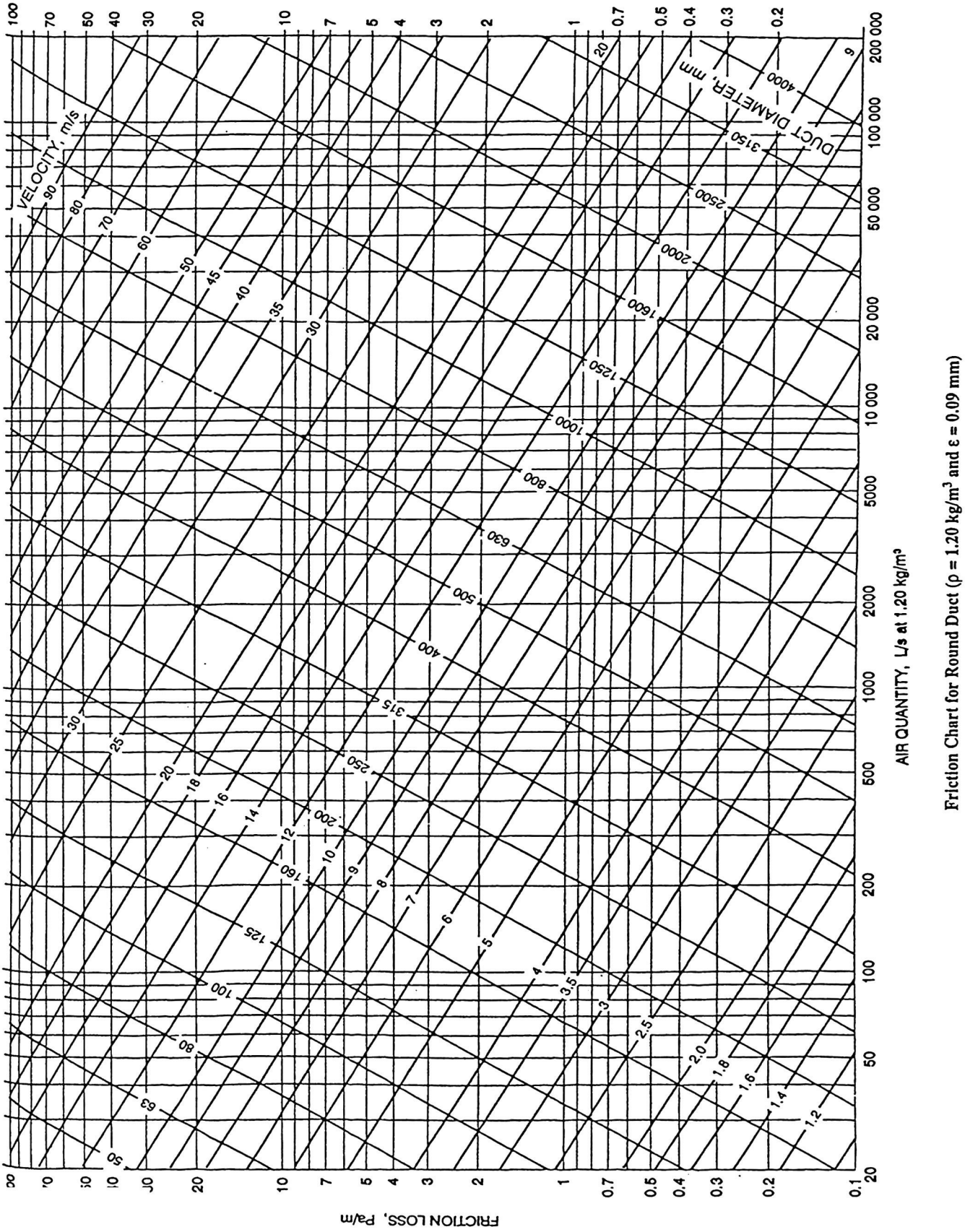
Pressure-enthalpy diagram of superheated ammonia vapor.

Psychrometric chart

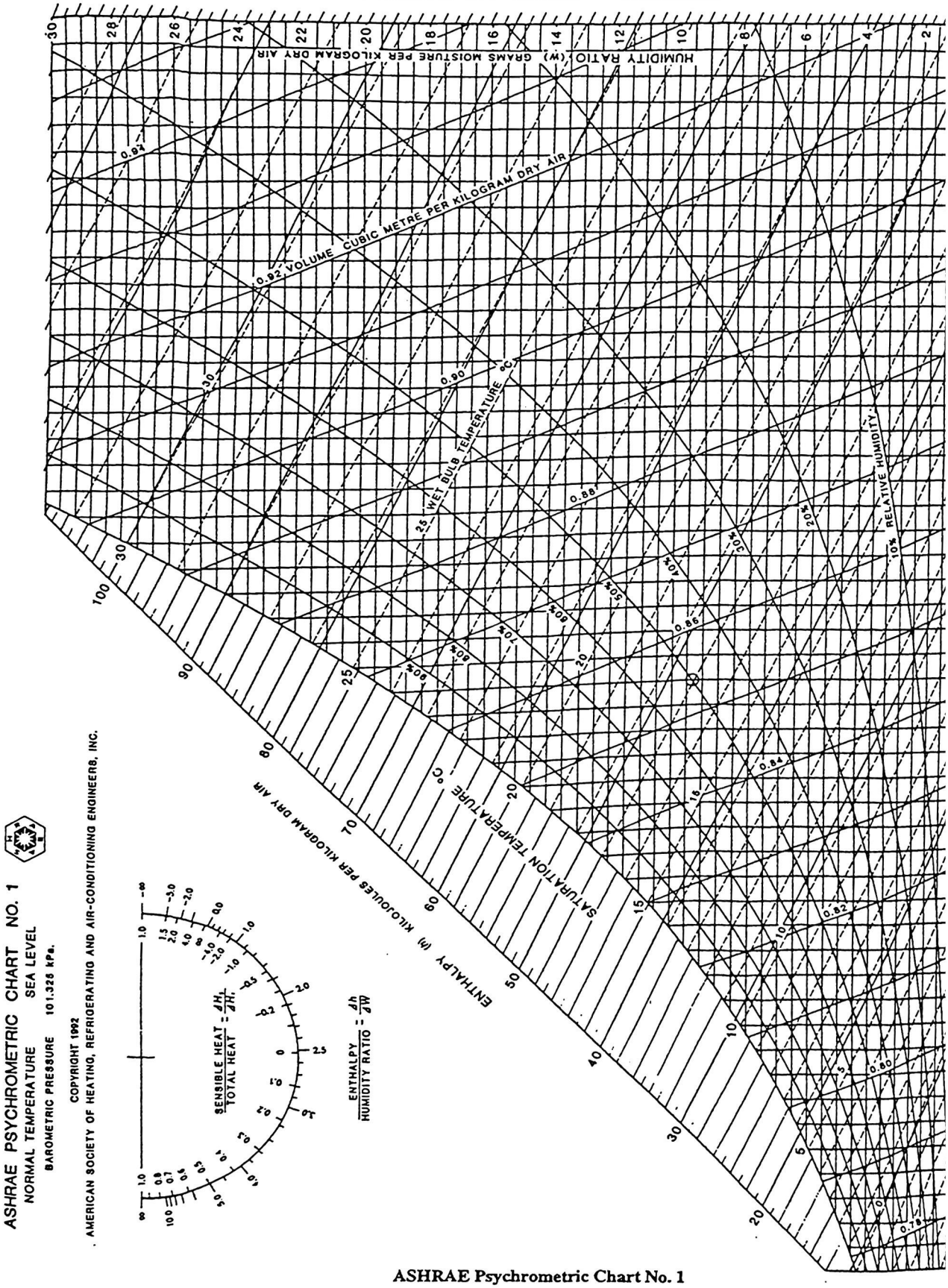


LAMPIRAN 5

Friction Chart for Round Duct (ρ = 1.20 kg/m^3 and ε = 0.09 mm)



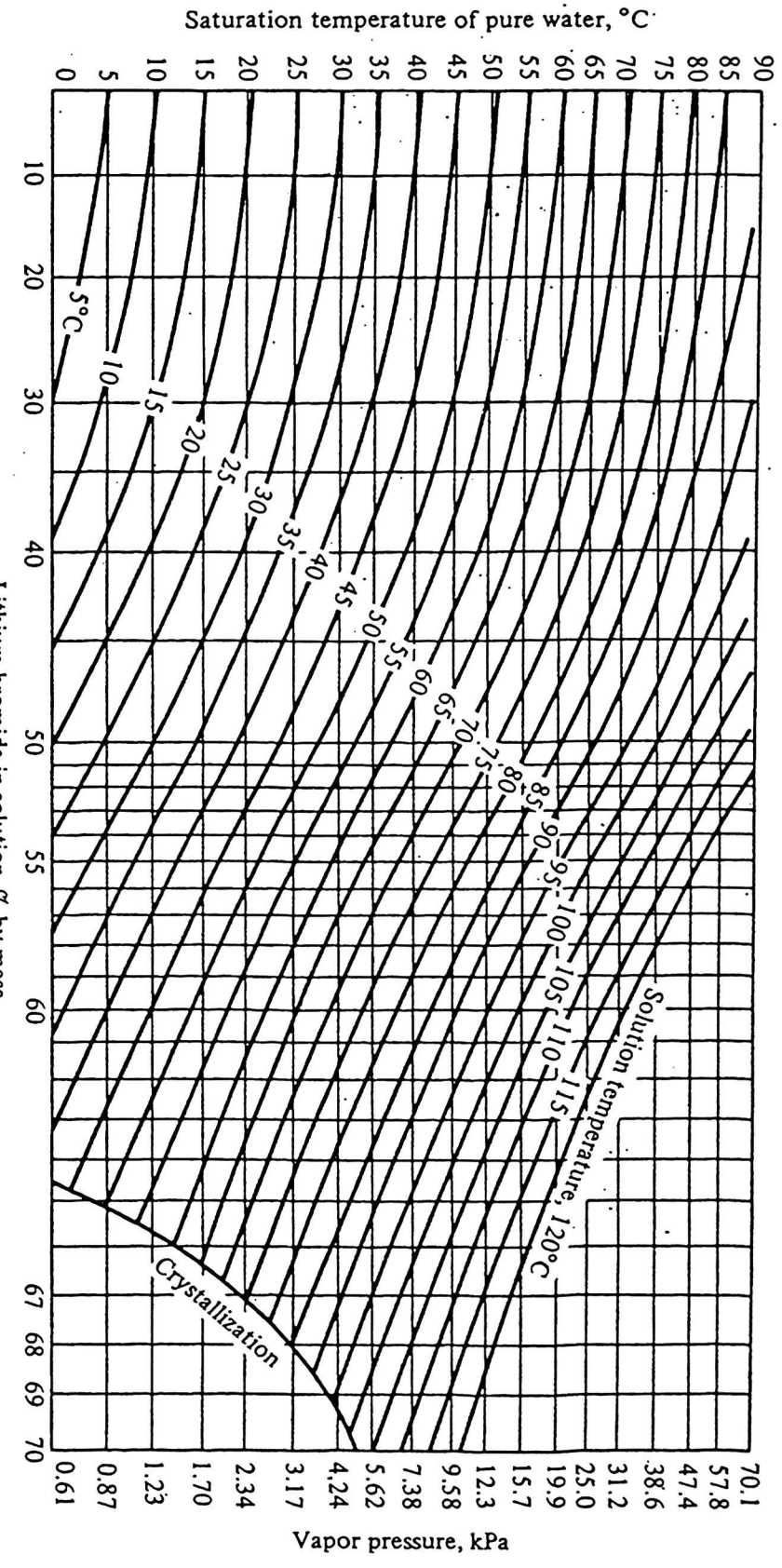
ASHRAF Psychrometric Chart No. 1



ASHRAE Psychrometric Chart No. 1

LAMPIRAN 7

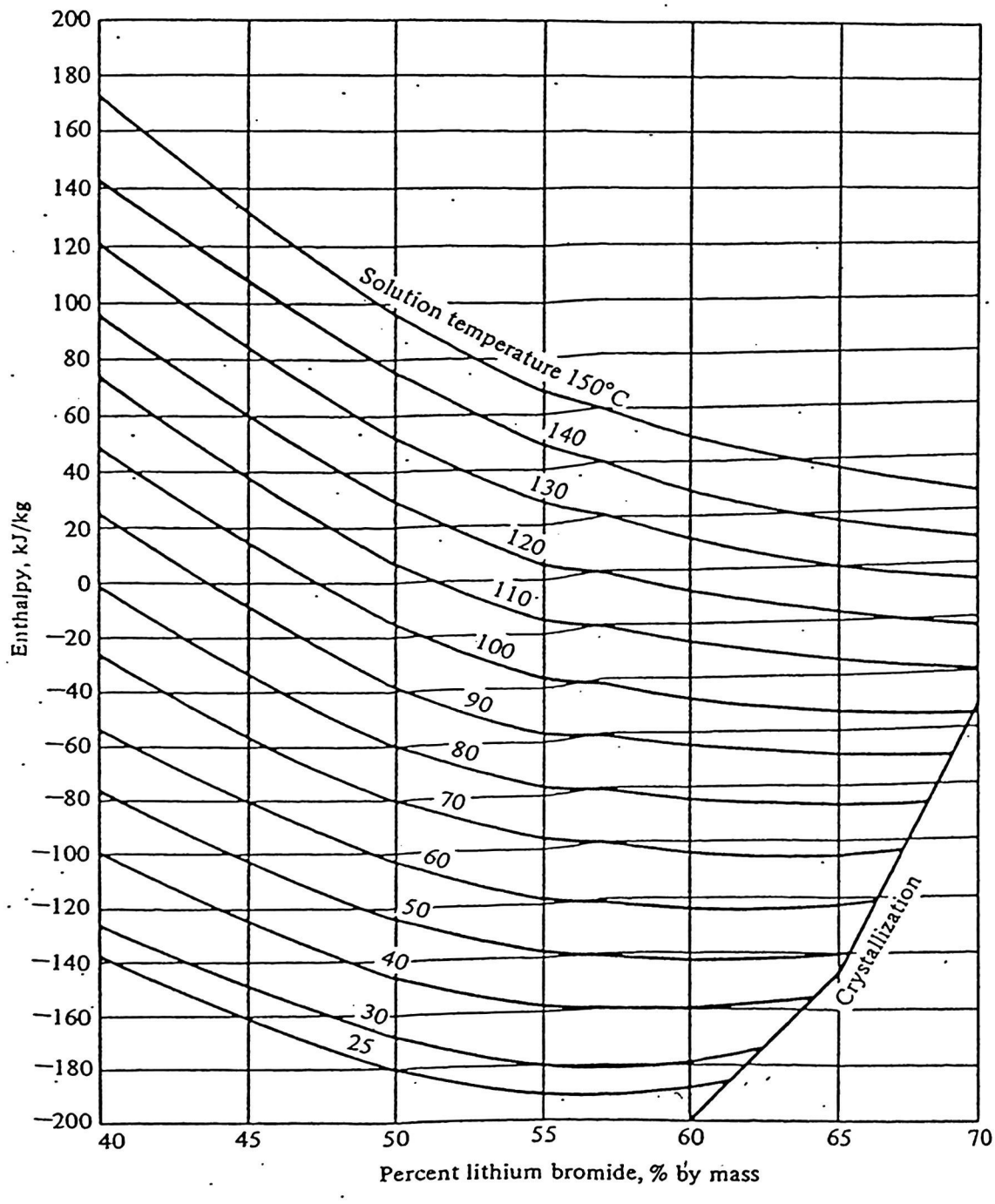
Temperature-pressure-concentration diagram of saturated LiBr-water solutions



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

1489

Temperature-pressure-concentration diagram of saturated LiBr-water solutions (Continued)



Enthalpy of LiBr–water solutions;