PROGRAM	:	**B.ING** *MECHANICAL ENGINEERING SCIENCE*
SUBJECT	:	**THERMAL SYSTEMS 4B**
CODE	:	**TML 4B**
DATE	:	12 November 2019
DURATION	:	(12:30) 3 HOURS
WEIGHT	:	50 : 50
TOTAL MARKS	:	100

EXAMINER	:	DR. S KRUGER
MODERATOR	:	PROF L PRETORIUS
NUMBER OF PAGES	:	4 PAGES AND 14 ANNEXURES

- 1700m psychrometric chart
- Steam Tables
- R134a saturation tables
- R134a P-h Diagram
- Temperature-pressure concentration diagram of LiBr- water solution
- Enthalpy of LiBr water solutions

INSTRUCTIONS TO CANDIDATES:

PLEASE ANSWER ALL THE QUESTIONS.
SUBMIT YOUR PSHYCHROMETRIC CHART WITH THE ANSWER BOOK

QUESTION 1 [44]

A terminal-reheat air conditioning plant serving an office building is located at 1700m above sea level. In the system $5m^3/s$ of outside air is mixed with $17m^3/s$ of return air. The dry bulb temperature of the outside air is 36ºC with a relative humidity of 50%. The design condition for the controlled zones is a dry bulb temperature of 22ºC and a relative humidity of 55%. The total sensible heat load in the controlled zones is 150kW and the latent heat load is 75kW.
The apparatus dew point temperature of the cooling coil is 6ºC. The temperature of the air after passing through the cooling coil is 13ºC. The re-heaters are also fitted with humidifiers.

1.1 Draw the process on a psychrometric chart.

1.2 Determine all the mixture properties

1.3 Calculate the cooling load of the cooling coil

1.4 Calculate the load of the heaters

1.5 Calculate the humidifier load

1.6 Calculate the rate at which water must be removed from the cooling coil

1.7 Determine the rate at which water is added to the system by the humidifiers

QUESTION 2 [11]

The temperature in a cold room is maintained at 1ºC, and the expected maximum temperature outside the room is 30ºC. The external dimensions of the room are 5m x 6m and the height is 2.5m. Three of the walls are fabricated with layers of polymer, polystyrene and steel, while one of the 5m walls is comprised of a triple layer of glass with 13mm air spaces. Thermal properties of the materials used are given in the table.

2.1 Calculate the overall heat transfer coefficient

2.2 If it can be assumed that the heat transferred out of the cold room through the roof and floor can be neglected, calculate:

a. The heat load due to heat transfer through the glass wall
b. The heat load due to heat transfer through the other three walls. The construction of the door is similar to that of the walls.
c. The total heat load

Material	Thickness (mm)	Thermal Conductivity K (W/mK)	1/R (W/m^2K)	U (W/m^2K)
Internal Air Film			4	
Polymer	20	0.5		
Polystyrene	50	0.04		
Steel	3	12		
External Air Film			8	
Triple Glass panes (including air spaces and films)				1.8

QUESTION 3 [25]

Calculate the power requirement by the two compressors in a R-134a system which serves a 200 kW evaporator at -15°C shown in Figure 1. The system uses two stage compression with intercooling and flash gas. The condensing temperature is 45°C and the compression is isentropic.

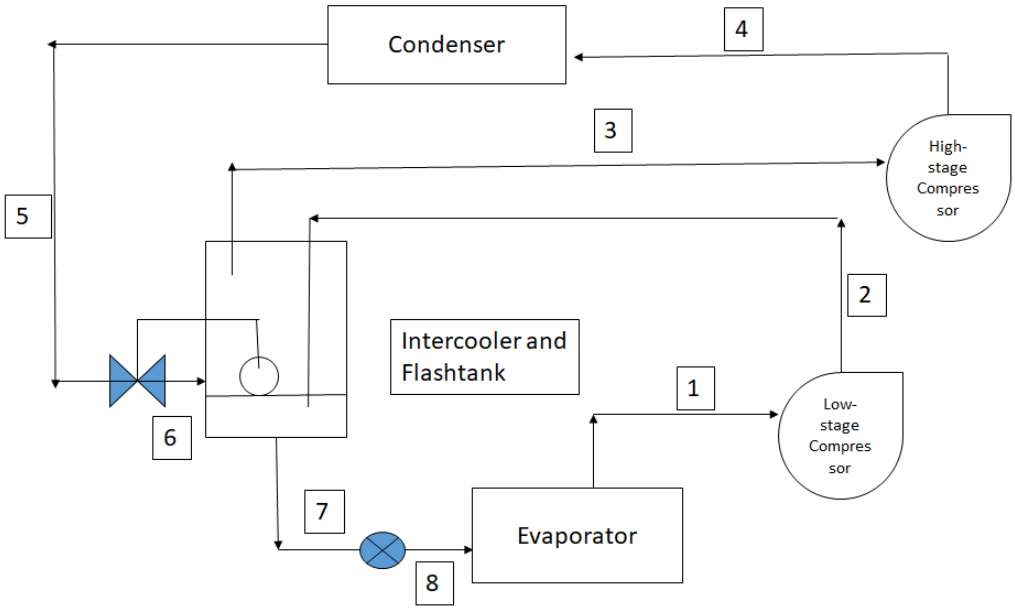


Figure 1

3.1 Draw the pressure-enthalpy diagram of the system

3.2 Calculate the intermediate pressure of the intercooler for optimum economy, which can be calculated from equation :

$$P_i = \sqrt{p_s p_d}$$

p_i = intercooler pressure

p_s = suction pressure of low stage compressor

p_d = discharge pressure of high stage compressor

3.3 Determine all enthalpy values h_1 to h_7

3.4 Determine the mass flow rate through the low stage compressor

3.5 Calculate the flow rate through the high stage compressor by means of the heat and mass balance around the intercooler

3.6 Determine the power requirement of the low and high stage Compressor and the total power for the system

3.7 Compare the power requirement to a single compressor system without inter-cooler

QUESTION 4 [20]

The following system temperatures apply to a LiBr water solution absorption refrigeration system:

Temperature in generator	105 ºC
Temperature in condenser	45 ºC
Temperature in evaporator	3 ºC
Temperature in absorber	30 ºC
The refrigeration capacity	300 kW

4.1 Calculate the flow rates of the system

4.2 Calculate all the heat transfers and COP of the system

4.3 If a heat exchanger is installed, calculate the outlet temperature from the heat exchanger of the flow of the flow to the generator from the heat exchanger if the COP is to be increased by 10%

FORMULA SHEET

$$\dot{m}\left(h_1+\frac{V_1^2}{2}+gz_1\right)+\dot{Q}-\dot{m}\left(h_2+\frac{V_2^2}{2}+gz_2\right)-\dot{W}=\frac{dE}{dt}$$

$h_v \cong h_g(T)$ $\quad h=h_a+Wh_v$, $h_a=C_{pa}t$ $\quad \boxed{SHR=\frac{\dot{Q}_S}{\dot{Q}_{Coil}}=\frac{\dot{Q}_S}{\dot{Q}_S+\dot{Q}_L}}$ $\quad P_s=0.6105e^{\frac{17..27t}{237.3+t}}$

Contact Factor: $(\beta)=\frac{\omega_a-\omega_b}{\omega_a-\omega_c}=\frac{h_a-h_b}{h_a-h_c}=\frac{t_a-t_b}{t_a-t_c}$

Bypass Factor: $BPF=(1-\beta)=\frac{t_b-t_c}{P_a-P_c}$

$\frac{\dot{m}_{a1}}{\dot{m}_{a2}}=\frac{h_2-h_3}{h_3-h_1}=\frac{\omega_2-\omega_3}{\omega_3-\omega_1}$ $\quad \omega=\frac{m_v}{m_a}$ $\quad P=P_a+P_v$ $\quad \phi=\frac{P_v/P}{P_s/P}=\frac{P_v}{P_s}$

$\boxed{v=\frac{R_aT}{P_a}=\frac{R_aT}{P_t-P_v}}$ $\quad \boxed{\omega=0.622\frac{p_v}{(p_t-p_v)}}$ $\quad \frac{\dot{m}_{a2}}{\dot{m}_{a3}}=\frac{h_3-h_1}{h_2-h_1}$ $\quad \boxed{P_s=0.6105e^{\frac{17.27\times t}{237.3+t}}}$

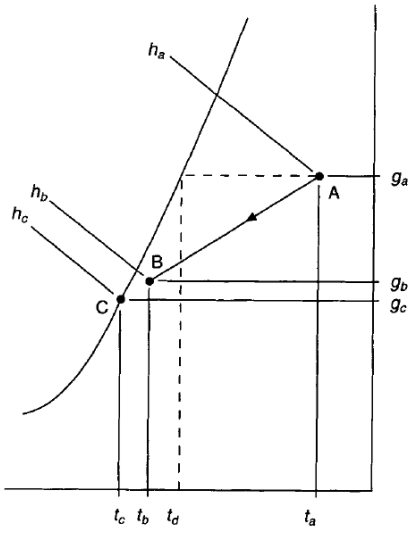
$P_s = 0.6105\ e^{\frac{17.27xt}{237.3+t}}$ kPa : t in °C

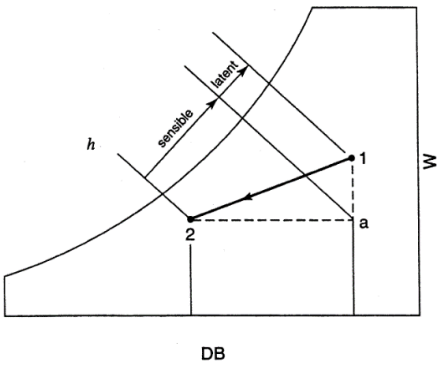
h = 1.005 x t + ω h_g : h_g = enthalpy of sat.steam at t°C, t in °C

$v=\frac{287T}{p_t-p_v}$: T in K

$p_v = p_{sw} - \frac{1.8(p_t-p_{sw})(t_{db}-t_{wb})}{2800-1.3t_{wb}}$ or

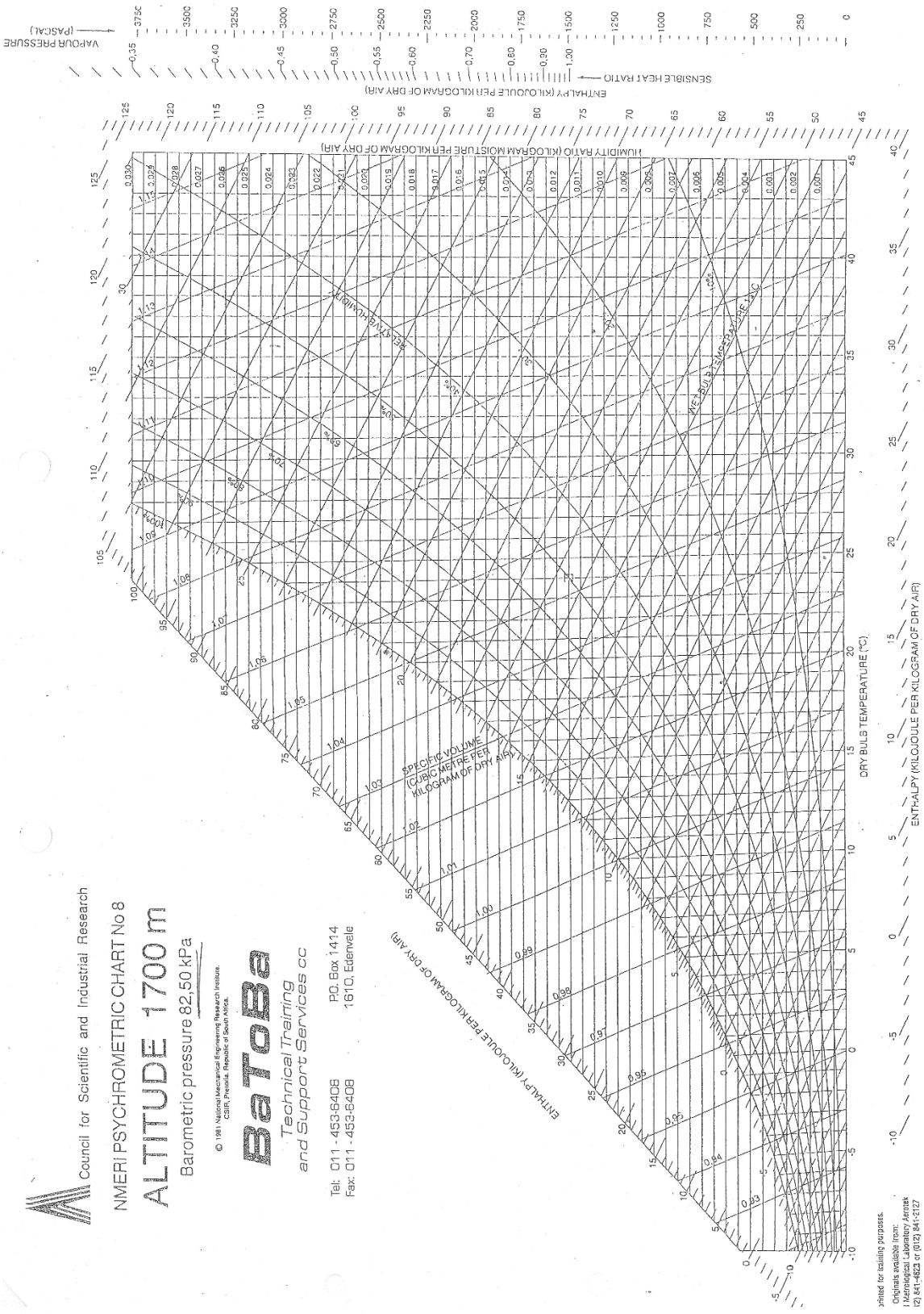
$t_{wb}=\frac{t_{db}+\frac{2800}{1.8}(\frac{p_v-p_{sw}}{p_t-p_{sw}})}{1+\frac{1.3}{1.8}(\frac{p_v-p_{sw}}{p_t-p_{sw}})}$





$$\dot{Q}_L = \dot{m}_a \left(h_1 - h_a \right)$$

$$\dot{Q}_S = \dot{m}_a \left(h_x - h_2 \right)$$


Council for Scientific and Industrial Research
NMERI PSYCHROMETRIC CHART No 8
ALTITUDE 1700 m
Barometric pressure 82,50 kPa
© 1981 National Mechanical Engineering Research Institute, CSIR, Pretoria, Republic of South Africa.
batba
Technical Training and Support Services cc
Tel: 011 - 453-6406
Fax: 011 - 453-6408
P.O. Box 1414
1610, Edenvale
VAPOUR PRESSURE (PASCAL)
ENTHALPY (KILOJOULE PER KILOGRAM OF DRY AIR)
SENSIBLE HEAT RATIO
HUMIDITY RATIO (KILOGRAM MOISTURE PER KILOGRAM OF DRY AIR)
WET BULB TEMPERATURE °C
SPECIFIC VOLUME (CUBIC METRE PER KILOGRAM OF DRY AIR)
ENTHALPY (KILOJOULE PER KILOGRAM OF DRY AIR)
DRY BULB TEMPERATURE (°C)
ENTHALPY (KILOJOULE PER KILOGRAM OF DRY AIR)

Psychrometrics **1.5**

Table 3 Thermodynamic Properties of Water at Saturation

Temp., °C	Absolute Pressure	Specific Volume, m^3/kg_w			Specific Enthalpy, kJ/kg_w			Specific Entropy, $kJ/(kg_w \cdot K)$			Temp., °C
		Sat. Solid	Evap.	Sat. Vapor	Sat. Solid	Evap.	Sat. Vapor	Sat. Solid	Evap.	Sat. Vapor	
t	p_{ws}, kPa	v_i/v_f	v_{ig}/v_{fg}	v_g	h_i/h_f	h_{ig}/h_{fg}	h_g	s_i/s_f	s_{ig}/s_{fg}	s_g	t
–60	0.00108	0.001081	90971.58	90971.58	–446.12	2836.27	2390.14	–1.6842	13.3064	11.6222	–60
59	0.00124	0.001082	79885.31	79885.31	444.46	2836.45	2391.99	1.6764	13.2452	11.5687	59
–58	0.00141	0.001082	70235.77	70235.78	–442.79	2836.63	2393.85	–1.6687	13.1845	11.5158	–58
–57	0.00161	0.001082	61826.23	61826.24	–441.11	2836.81	2395.70	–1.6609	13.1243	11.4634	–57
56	0.00184	0.001082	54488.28	54488.28	439.42	2836.97	2397.55	1.6531	13.0646	11.4115	56
55	0.00209	0.001082	48077.54	48077.54	437.73	2837.13	2399.40	1.6453	13.0054	11.3601	55
54	0.00238	0.001082	42470.11	42470.11	436.03	2837.28	2401.25	1.6375	12.9468	11.3092	54
–53	0.00271	0.001082	37559.49	37559.50	–434.32	2837.42	2403.10	–1.6298	12.8886	11.2589	–53
–52	0.00307	0.001083	33254.07	33254.07	–432.61	2837.56	2404.95	–1.6220	12.8310	11.2090	–52
–51	0.00348	0.001083	29474.87	29474.87	–430.88	2837.69	2406.81	–1.6142	12.7738	11.1596	–51
50	0.00394	0.001083	26153.80	26153.80	429.16	2837.81	2408.66	1.6065	12.7171	11.1106	50
49	0.00445	0.001083	23232.03	23232.04	427.42	2837.93	2410.51	1.5987	12.6609	11.0622	49
–48	0.00503	0.001083	20658.70	20658.70	–425.68	2838.04	2412.36	–1.5909	12.6051	11.0142	–48
47	0.00568	0.001083	18389.75	18389.75	423.93	2838.14	2414.21	1.5832	12.5498	10.9666	47
–46	0.00640	0.001083	16387.03	16387.03	–422.17	2838.23	2416.06	–1.5754	12.4950	10.9196	–46
–45	0.00720	0.001084	14617.39	14617.39	–420.40	2838.32	2417.91	–1.5677	12.4406	10.8729	–45
44	0.00810	0.001084	13052.07	13052.07	418.63	2838.39	2419.76	1.5599	12.3867	10.8267	44
43	0.00910	0.001084	11666.02	11666.02	416.85	2838.47	2421.62	1.5522	12.3331	10.7810	43
–42	0.01022	0.001084	10437.46	10437.46	–415.06	2838.53	2423.47	–1.5444	12.2801	10.7356	–42
–41	0.01146	0.001084	9347.38	9347.38	–413.27	2838.59	2425.32	–1.5367	12.2274	10.6907	–41
–40	0.01284	0.001084	8379.20	8379.20	–411.47	2838.64	2427.17	–1.5289	12.1752	10.6462	–40
39	0.01437	0.001085	7518.44	7518.44	409.66	2838.68	2429.02	1.5212	12.1234	10.6022	39
38	0.01607	0.001085	6752.43	6752.43	407.85	2838.72	2430.87	1.5135	12.0720	10.5585	38
–37	0.01795	0.001085	6070.08	6070.08	–406.02	2838.74	2432.72	–1.5057	12.0210	10.5152	–37
–36	0.02004	0.001085	5461.68	5461.68	–404.19	2838.76	2434.57	–1.4980	11.9704	10.4724	–36
–35	0.02234	0.001085	4918.69	4918.69	–402.36	2838.78	2436.42	–1.4903	11.9202	10.4299	–35
–34	0.02489	0.001085	4433.64	4433.64	–400.51	2838.78	2438.27	–1.4825	11.8703	10.3878	–34
–33	0.02771	0.001085	3999.95	3999.95	–398.66	2838.78	2440.12	–1.4748	11.8209	10.3461	–33
32	0.03081	0.001086	3611.82	3611.82	396.80	2838.77	2441.97	1.4671	11.7718	10.3047	32
31	0.03423	0.001086	3264.15	3264.16	394.94	2838.75	2443.82	1.4594	11.7231	10.2638	31
–30	0.03801	0.001086	2952.46	2952.46	–393.06	2838.73	2445.67	–1.4516	11.6748	10.2232	–30
–29	0.04215	0.001086	2672.77	2672.77	–391.18	2838.70	2447.51	–1.4439	11.6269	10.1830	–29
–28	0.04672	0.001086	2421.58	2421.58	–389.29	2838.66	2449.36	–1.4362	11.5793	10.1431	–28
27	0.05173	0.001086	2195.80	2195.80	387.40	2838.61	2451.21	1.4285	11.5321	10.1036	27
26	0.05724	0.001087	1992.68	1992.68	385.50	2838.56	2453.06	1.4208	11.4852	10.0644	26
–25	0.06327	0.001087	1809.79	1809.79	–383.59	2838.49	2454.91	–1.4131	11.4386	10.0256	–25
24	0.06989	0.001087	1644.99	1644.99	381.67	2838.42	2456.75	1.4054	11.3925	9.9871	24
–23	0.07714	0.001087	1496.36	1496.36	–379.75	2838.35	2458.60	–1.3977	11.3466	9.9489	–23
–22	0.08508	0.001087	1362.21	1362.21	–377.81	2838.26	2460.45	–1.3899	11.3011	9.9111	–22
21	0.09376	0.001087	1241.03	1241.03	375.88	2838.17	2462.29	1.3822	11.2559	9.8736	21
20	0.10324	0.001087	1131.49	1131.49	373.93	2838.07	2464.14	1.3745	11.2110	9.8365	20
19	0.11360	0.001088	1032.38	1032.38	371.98	2837.96	2465.98	1.3668	11.1665	9.7996	19
–18	0.12490	0.001088	942.64	942.65	–370.01	2837.84	2467.83	–1.3591	11.1223	9.7631	–18
–17	0.13722	0.001088	861.34	861.34	–368.05	2837.72	2469.67	–1.3514	11.0784	9.7269	–17
16	0.15065	0.001088	787.61	787.61	366.07	2837.59	2471.51	1.3437	11.0348	9.6910	16
15	0.16527	0.001088	720.70	720.70	364.09	2837.45	2473.36	1.3360	10.9915	9.6554	15
–14	0.18119	0.001088	659.94	659.94	–362.10	2837.30	2475.20	–1.3284	10.9485	9.6201	–14
–13	0.19849	0.001089	604.72	604.73	–360.10	2837.14	2477.04	–1.3207	10.9058	9.5851	–13
12	0.21729	0.001089	554.51	554.51	358.10	2836.98	2478.88	1.3130	10.8634	9.5504	12
–11	0.23771	0.001089	508.81	508.81	–356.08	2836.80	2480.72	–1.3053	10.8213	9.5160	–11
10	0.25987	0.001089	467.19	467.19	354.06	2836.62	2482.56	1.2976	10.7795	9.4819	10
–9	0.28391	0.001089	429.25	429.26	–352.04	2836.44	2484.40	–1.2899	10.7380	9.4481	–9
8	0.30995	0.001089	394.66	394.66	350.00	2836.24	2486.23	1.2822	10.6967	9.4145	8
7	0.33817	0.001090	363.09	363.09	347.96	2836.03	2488.07	1.2745	10.6558	9.3812	7
–6	0.36871	0.001090	334.26	334.26	–345.91	2835.82	2489.91	–1.2668	10.6151	9.3482	–6
–5	0.40174	0.001090	307.92	307.92	–343.86	2835.60	2491.74	–1.2592	10.5747	9.3155	–5
4	0.43745	0.001090	283.82	283.83	341.79	2835.37	2493.57	1.2515	10.5345	9.2830	4
3	0.47604	0.001090	261.78	261.78	339.72	2835.13	2495.41	1.2438	10.4946	9.2508	3
–2	0.51770	0.001091	241.60	241.60	–337.64	2834.88	2497.24	–1.2361	10.4550	9.2189	–2
–1	0.56266	0.001091	223.10	223.11	–335.56	2834.63	2499.07	–1.2284	10.4157	9.1872	–1
0	0.61115	0.001091	206.15	206.15	–333.47	2834.36	2500.90	–1.2208	10.3766	9.1558	0
Transition from saturated solid to saturated liquid											
0	0.6112	0.001000	206.139	206.140	0.04	2500.93	2500.89	0.0002	9.1559	9.1558	0
1	0.6571	0.001000	192.444	192.445	4.18	2498.55	2502.73	0.0153	9.1138	9.1291	1
2	0.7060	0.001000	179.763	179.764	8.39	2496.17	2504.57	0.0306	9.0721	9.1027	2

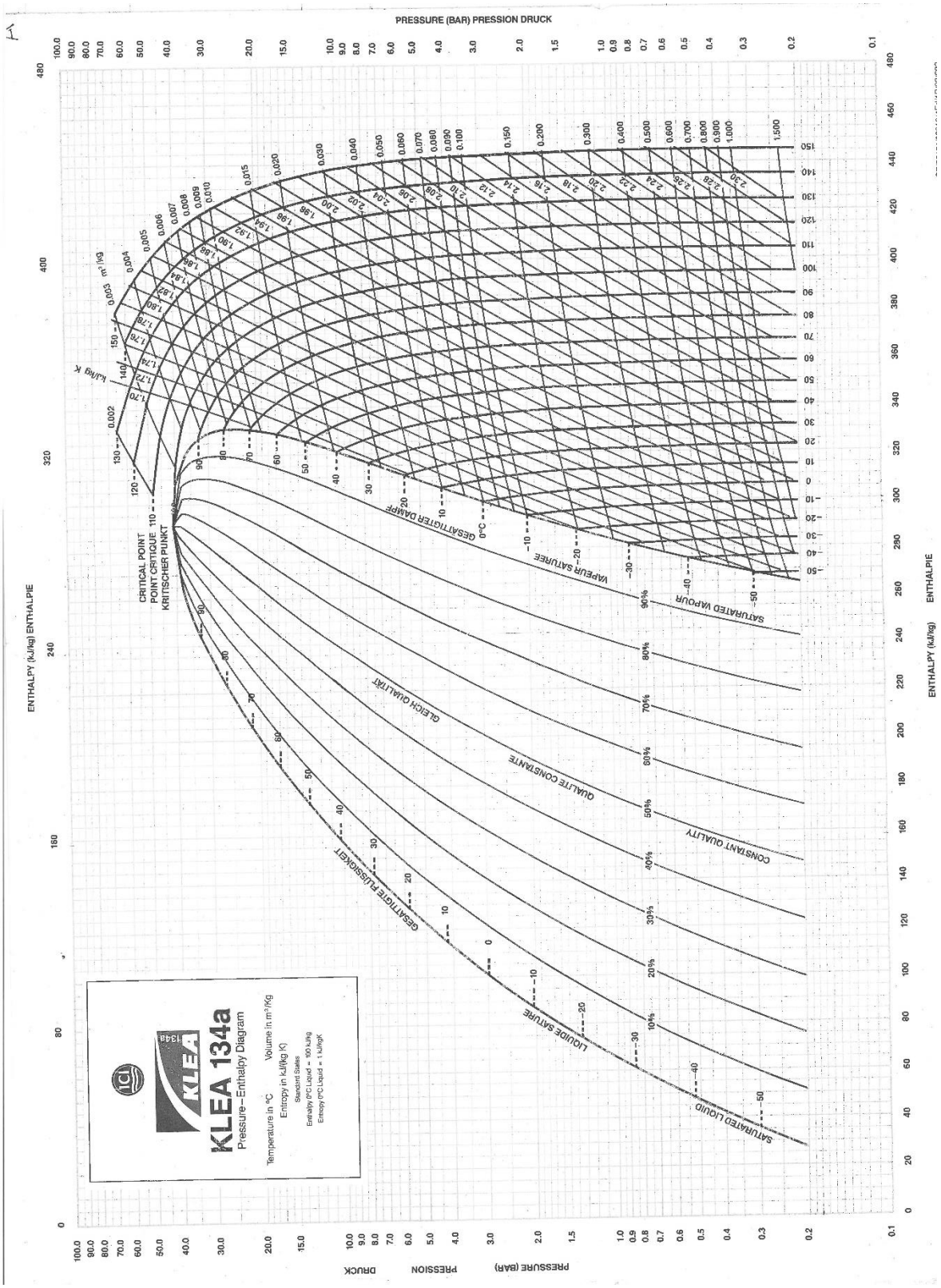
Table 3 Thermodynamic Properties of Water at Saturation (*Continued*)

Temp., °C t	Absolute Pressure p_{ws}, kPa	Specific Volume, m^3/kg_w			Specific Enthalpy, kJ/kg_w			Specific Entropy, $kJ/(kg_w \cdot K)$			Temp., °C t
		Sat. Liquid v_f	Evap. v_{fg}	Sat. Vapor v_g	Sat. Liquid h_f	Evap. h_{fg}	Sat. Vapor h_g	Sat. Liquid s_f	Evap. s_{fg}	Sat. Vapor s_g	
3	0.7581	0.001000	168.013	168.014	12.60	2493.80	2506.40	0.0459	9.0306	9.0765	3
4	0.8135	0.001000	157.120	157.121	16.81	2491.42	2508.24	0.0611	8.9895	9.0506	4
5	0.8726	0.001000	147.016	147.017	21.02	2489.05	2510.07	0.0763	8.9486	9.0249	5
6	0.9354	0.001000	137.637	137.638	25.22	2486.68	2511.91	0.0913	8.9081	8.9994	6
7	1.0021	0.001000	128.927	128.928	29.43	2484.31	2513.74	0.1064	8.8678	8.9742	7
8	1.0730	0.001000	120.833	120.834	33.63	2481.94	2515.57	0.1213	8.8278	8.9492	8
9	1.1483	0.001000	113.308	113.309	37.82	2479.58	2517.40	0.1362	8.7882	8.9244	9
10	1.2282	0.001000	106.308	106.309	42.02	2477.21	2519.23	0.1511	8.7488	8.8998	10
11	1.3129	0.001000	99.792	99.793	46.22	2474.84	2521.06	0.1659	8.7096	8.8755	11
12	1.4028	0.001001	93.723	93.724	50.41	2472.48	2522.89	0.1806	8.6708	8.8514	12
13	1.4981	0.001001	88.069	88.070	54.60	2470.11	2524.71	0.1953	8.6322	8.8275	13
14	1.5989	0.001001	82.797	82.798	58.79	2467.75	2526.54	0.2099	8.5939	8.8038	14
15	1.7057	0.001001	77.880	77.881	62.98	2465.38	2528.36	0.2245	8.5559	8.7804	15
16	1.8188	0.001001	73.290	73.291	67.17	2463.01	2530.19	0.2390	8.5181	8.7571	16
17	1.9383	0.001001	69.005	69.006	71.36	2460.65	2532.01	0.2534	8.4806	8.7341	17
18	2.0647	0.001001	65.002	65.003	75.55	2458.28	2533.83	0.2678	8.4434	8.7112	18
19	2.1982	0.001002	61.260	61.261	79.73	2455.92	2535.65	0.2822	8.4064	8.6886	19
20	2.3392	0.001002	57.760	57.761	83.92	2453.55	2537.47	0.2965	8.3696	8.6661	20
21	2.4881	0.001002	54.486	54.487	88.10	2451.18	2539.29	0.3108	8.3331	8.6439	21
22	2.6452	0.001002	51.421	51.422	92.29	2448.81	2541.10	0.3250	8.2969	8.6218	22
23	2.8109	0.001003	48.551	48.552	96.47	2446.45	2542.92	0.3391	8.2609	8.6000	23
24	2.9856	0.001003	45.862	45.863	100.66	2444.08	2544.73	0.3532	8.2251	8.5783	24
25	3.1697	0.001003	43.340	43.341	104.84	2441.71	2546.54	0.3673	8.1895	8.5568	25
26	3.3637	0.001003	40.976	40.977	109.02	2439.33	2548.35	0.3813	8.1542	8.5355	26
27	3.5679	0.001004	38.757	38.758	113.20	2436.96	2550.16	0.3952	8.1192	8.5144	27
28	3.7828	0.001004	36.674	36.675	117.38	2434.59	2551.97	0.4091	8.0843	8.4934	28
29	4.0089	0.001004	34.718	34.719	121.56	2432.21	2553.78	0.4230	8.0497	8.4727	29
30	4.2467	0.001004	32.881	32.882	125.75	2429.84	2555.58	0.4368	8.0153	8.4521	30
31	4.4966	0.001005	31.153	31.154	129.93	2427.46	2557.39	0.4506	7.9812	8.4317	31
32	4.7592	0.001005	29.528	29.529	134.11	2425.08	2559.19	0.4643	7.9472	8.4115	32
33	5.0351	0.001005	28.000	28.001	138.29	2422.70	2560.99	0.4780	7.9135	8.3914	33
34	5.3247	0.001006	26.561	26.562	142.47	2420.32	2562.79	0.4916	7.8800	8.3715	34
35	5.6286	0.001006	25.207	25.208	146.64	2417.94	2564.58	0.5052	7.8467	8.3518	35
36	5.9475	0.001006	23.931	23.932	150.82	2415.56	2566.38	0.5187	7.8136	8.3323	36
37	6.2818	0.001007	22.728	22.729	155.00	2413.17	2568.17	0.5322	7.7807	8.3129	37
38	6.6324	0.001007	21.594	21.595	159.18	2410.78	2569.96	0.5457	7.7480	8.2936	38
39	6.9997	0.001007	20.525	20.526	163.36	2408.39	2571.75	0.5591	7.7155	8.2746	39
40	7.3844	0.001008	19.516	19.517	167.54	2406.00	2573.54	0.5724	7.6832	8.2557	40
41	7.7873	0.001008	18.564	18.565	171.72	2403.61	2575.33	0.5858	7.6512	8.2369	41
42	8.2090	0.001009	17.664	17.665	175.90	2401.21	2577.11	0.5990	7.6193	8.2183	42
43	8.6503	0.001009	16.815	16.816	180.08	2398.82	2578.89	0.6123	7.5876	8.1999	43
44	9.1118	0.001009	16.012	16.013	184.26	2396.42	2580.67	0.6255	7.5561	8.1816	44
45	9.5944	0.001010	15.252	15.253	188.44	2394.02	2582.45	0.6386	7.5248	8.1634	45
46	10.0988	0.001010	14.534	14.535	192.62	2391.61	2584.23	0.6517	7.4937	8.1454	46
47	10.6259	0.001011	13.855	13.856	196.80	2389.21	2586.00	0.6648	7.4628	8.1276	47
48	11.1764	0.001011	13.212	13.213	200.98	2386.80	2587.77	0.6778	7.4320	8.1099	48
49	11.7512	0.001012	12.603	12.604	205.16	2384.39	2589.54	0.6908	7.4015	8.0923	49
50	12.3513	0.001012	12.027	12.028	209.34	2381.97	2591.31	0.7038	7.3711	8.0749	50
51	12.9774	0.001013	11.481	11.482	213.52	2379.56	2593.08	0.7167	7.3409	8.0576	51
52	13.6305	0.001013	10.963	10.964	217.70	2377.14	2594.84	0.7296	7.3109	8.0405	52
53	14.3116	0.001014	10.472	10.473	221.88	2374.72	2596.60	0.7424	7.2811	8.0235	53
54	15.0215	0.001014	10.006	10.007	226.06	2372.30	2598.35	0.7552	7.2514	8.0066	54
55	15.7614	0.001015	9.5639	9.5649	230.24	2369.87	2600.11	0.7680	7.2219	7.9899	55
56	16.5322	0.001015	9.1444	9.1454	234.42	2367.44	2601.86	0.7807	7.1926	7.9733	56
57	17.3350	0.001016	8.7461	8.7471	238.61	2365.01	2603.61	0.7934	7.1634	7.9568	57
58	18.1708	0.001016	8.3678	8.3688	242.79	2362.57	2605.36	0.8060	7.1344	7.9405	58
59	19.0407	0.001017	8.0083	8.0093	246.97	2360.13	2607.10	0.8186	7.1056	7.9243	59
60	19.9458	0.001017	7.6666	7.6677	251.15	2357.69	2608.85	0.8312	7.0770	7.9082	60
61	20.8873	0.001018	7.3418	7.3428	255.34	2355.25	2610.58	0.8438	7.0485	7.8922	61
62	21.8664	0.001018	7.0328	7.0338	259.52	2352.80	2612.32	0.8563	7.0201	7.8764	62
63	22.8842	0.001019	6.7389	6.7399	263.71	2350.35	2614.05	0.8687	6.9919	7.8607	63
64	23.9421	0.001019	6.4591	6.4601	267.89	2347.89	2615.78	0.8811	6.9639	7.8451	64
65	25.0411	0.001020	6.1928	6.1938	272.08	2345.43	2617.51	0.8935	6.9361	7.8296	65
66	26.1827	0.001020	5.9392	5.9402	276.27	2342.97	2619.23	0.9059	6.9083	7.8142	66
67	27.3680	0.001021	5.6976	5.6986	280.45	2340.50	2620.96	0.9182	6.8808	7.7990	67
68	28.5986	0.001022	5.4674	5.4684	284.64	2338.03	2622.67	0.9305	6.8534	7.7839	68
69	29.8756	0.001022	5.2479	5.2490	288.83	2335.56	2624.39	0.9428	6.8261	7.7689	69

Psychrometrics **1.7**

Table 3 Thermodynamic Properties of Water at Saturation (*Continued*)

Temp., °C t	Absolute Pressure p_{ws}, kPa	Specific Volume, m^3/kg_w			Specific Enthalpy, kJ/kg_w			Specific Entropy, $kJ/(kg_w \cdot K)$			Temp., °C t
		Sat. Liquid v_f	Evap. v_{fg}	Sat. Vapor v_g	Sat. Liquid h_f	Evap. h_{fg}	Sat. Vapor h_g	Sat. Liquid s_f	Evap. s_{fg}	Sat. Vapor s_g	
70	31.2006	0.001023	5.0387	5.0397	293.02	2333.08	2626.10	0.9550	6.7990	7.7540	70
71	32.5750	0.001023	4.8392	4.8402	297.21	2330.60	2627.81	0.9672	6.7720	7.7392	71
72	34.0001	0.001024	4.6488	4.6498	301.40	2328.11	2629.51	0.9793	6.7452	7.7245	72
73	35.4775	0.001025	4.4671	4.4681	305.59	2325.62	2631.21	0.9915	6.7185	7.7100	73
74	37.0088	0.001025	4.2937	4.2947	309.78	2323.13	2632.91	1.0035	6.6920	7.6955	74
75	38.5954	0.001026	4.1281	4.1291	313.97	2320.63	2634.60	1.0156	6.6656	7.6812	75
76	40.2389	0.001026	3.9699	3.9709	318.17	2318.13	2636.29	1.0276	6.6393	7.6669	76
77	41.9409	0.001027	3.8188	3.8198	322.36	2315.62	2637.98	1.0396	6.6132	7.6528	77
78	43.7031	0.001028	3.6743	3.6754	326.56	2313.11	2639.66	1.0516	6.5872	7.6388	78
79	45.5271	0.001028	3.5363	3.5373	330.75	2310.59	2641.34	1.0635	6.5613	7.6248	79
80	47.4147	0.001029	3.4042	3.4053	334.95	2308.07	2643.01	1.0754	6.5356	7.6110	80
81	49.3676	0.001030	3.2780	3.2790	339.15	2305.54	2644.68	1.0873	6.5100	7.5973	81
82	51.3875	0.001030	3.1572	3.1582	343.34	2303.01	2646.35	1.0991	6.4846	7.5837	82
83	53.4762	0.001031	3.0415	3.0426	347.54	2300.47	2648.01	1.1109	6.4592	7.5701	83
84	55.6355	0.001032	2.9309	2.9319	351.74	2297.93	2649.67	1.1227	6.4340	7.5567	84
85	57.8675	0.001032	2.8249	2.8259	355.95	2295.38	2651.33	1.1344	6.4090	7.5434	85
86	60.1738	0.001033	2.7234	2.7244	360.15	2292.83	2652.98	1.1461	6.3840	7.5301	86
87	62.5565	0.001034	2.6262	2.6272	364.35	2290.27	2654.62	1.1578	6.3592	7.5170	87
88	65.0174	0.001035	2.5330	2.5341	368.56	2287.70	2656.26	1.1694	6.3345	7.5039	88
89	67.5587	0.001035	2.4437	2.4448	372.76	2285.14	2657.90	1.1811	6.3099	7.4909	89
90	70.1824	0.001036	2.3581	2.3591	376.97	2282.56	2659.53	1.1927	6.2854	7.4781	90
91	72.8904	0.001037	2.2760	2.2771	381.18	2279.98	2661.16	1.2042	6.2611	7.4653	91
92	75.6849	0.001037	2.1973	2.1983	385.38	2277.39	2662.78	1.2158	6.2368	7.4526	92
93	78.5681	0.001038	2.1217	2.1228	389.59	2274.80	2664.39	1.2273	6.2127	7.4400	93
94	81.5420	0.001039	2.0492	2.0502	393.81	2272.20	2666.01	1.2387	6.1887	7.4275	94
95	84.6089	0.001040	1.9796	1.9806	398.02	2269.60	2667.61	1.2502	6.1648	7.4150	95
96	87.7711	0.001040	1.9128	1.9138	402.23	2266.98	2669.22	1.2616	6.1411	7.4027	96
97	91.0308	0.001041	1.8486	1.8497	406.45	2264.37	2670.81	1.2730	6.1174	7.3904	97
98	94.3902	0.001042	1.7870	1.7880	410.66	2261.74	2672.40	1.2844	6.0938	7.3782	98
99	97.8518	0.001043	1.7277	1.7288	414.88	2259.11	2673.99	1.2957	6.0704	7.3661	99
100	101.4180	0.001043	1.6708	1.6719	419.10	2256.47	2675.57	1.3070	6.0471	7.3541	100
101	105.0910	0.001044	1.6161	1.6171	423.32	2253.83	2677.15	1.3183	6.0238	7.3421	101
102	108.8735	0.001045	1.5635	1.5645	427.54	2251.18	2678.72	1.3296	6.0007	7.3303	102
103	112.7678	0.001046	1.5129	1.5140	431.76	2248.52	2680.28	1.3408	5.9777	7.3185	103
104	116.7765	0.001047	1.4642	1.4653	435.99	2245.85	2681.84	1.3520	5.9548	7.3068	104
105	120.9021	0.001047	1.4174	1.4185	440.21	2243.18	2683.39	1.3632	5.9320	7.2951	105
106	125.1472	0.001048	1.3724	1.3734	444.44	2240.50	2684.94	1.3743	5.9092	7.2836	106
107	129.5145	0.001049	1.3290	1.3301	448.67	2237.81	2686.48	1.3854	5.8866	7.2721	107
108	134.0065	0.001050	1.2873	1.2883	452.90	2235.12	2688.02	1.3965	5.8641	7.2607	108
109	138.6261	0.001051	1.2471	1.2481	457.13	2232.41	2689.55	1.4076	5.8417	7.2493	109
110	143.3760	0.001052	1.2083	1.2094	461.36	2229.70	2691.07	1.4187	5.8194	7.2380	110
111	148.2588	0.001052	1.1710	1.1721	465.60	2226.99	2692.58	1.4297	5.7972	7.2268	111
112	153.2775	0.001053	1.1351	1.1362	469.83	2224.26	2694.09	1.4407	5.7750	7.2157	112
113	158.4348	0.001054	1.1005	1.1015	474.07	2221.53	2695.60	1.4517	5.7530	7.2047	113
114	163.7337	0.001055	1.0671	1.0681	478.31	2218.78	2697.09	1.4626	5.7310	7.1937	114
115	169.1770	0.001056	1.0349	1.0359	482.55	2216.03	2698.58	1.4735	5.7092	7.1827	115
116	174.7678	0.001057	1.0038	1.0049	486.80	2213.27	2700.07	1.4844	5.6874	7.1719	116
117	180.5090	0.001058	0.9739	0.9750	491.04	2210.51	2701.55	1.4953	5.6658	7.1611	117
118	186.4036	0.001059	0.9450	0.9461	495.29	2207.73	2703.02	1.5062	5.6442	7.1504	118
119	192.4547	0.001059	0.9171	0.9182	499.53	2204.94	2704.48	1.5170	5.6227	7.1397	119
120	198.6654	0.001060	0.8902	0.8913	503.78	2202.15	2705.93	1.5278	5.6013	7.1291	120
122	211.5782	0.001062	0.8392	0.8403	512.29	2196.53	2708.82	1.5494	5.5587	7.1081	122
124	225.1676	0.001064	0.7916	0.7927	520.80	2190.88	2711.69	1.5708	5.5165	7.0873	124
126	239.4597	0.001066	0.7472	0.7483	529.32	2185.19	2714.52	1.5922	5.4746	7.0668	126
128	254.4813	0.001068	0.7058	0.7068	537.85	2179.47	2717.32	1.6134	5.4330	7.0465	128
130	270.2596	0.001070	0.6670	0.6681	546.39	2173.70	2720.09	1.6346	5.3918	7.0264	130
132	286.8226	0.001072	0.6308	0.6318	554.93	2167.89	2722.83	1.6557	5.3508	7.0066	132
134	304.1989	0.001074	0.5969	0.5979	563.49	2162.04	2725.53	1.6767	5.3102	6.9869	134
136	322.4175	0.001076	0.5651	0.5662	572.05	2156.15	2728.20	1.6977	5.2698	6.9675	136
138	341.5081	0.001078	0.5353	0.5364	580.62	2150.22	2730.84	1.7185	5.2298	6.9483	138
140	361.5010	0.001080	0.5074	0.5085	589.20	2144.24	2733.44	1.7393	5.1900	6.9293	140
142	382.4271	0.001082	0.4813	0.4823	597.79	2138.22	2736.01	1.7600	5.1505	6.9105	142
144	404.3178	0.001084	0.4567	0.4577	606.39	2132.15	2738.54	1.7806	5.1112	6.8918	144
146	427.2053	0.001086	0.4336	0.4346	615.00	2126.04	2741.04	1.8011	5.0723	6.8734	146
148	451.1220	0.001088	0.4118	0.4129	623.62	2119.88	2743.50	1.8216	5.0335	6.8551	148
150	476.1014	0.001091	0.3914	0.3925	632.25	2113.67	2745.92	1.8420	4.9951	6.8370	150
152	502.1771	0.001093	0.3722	0.3733	640.89	2107.41	2748.30	1.8623	4.9569	6.8191	152
154	529.3834	0.001095	0.3541	0.3552	649.55	2101.10	2750.64	1.8825	4.9189	6.8014	154
156	557.7555	0.001097	0.3370	0.3381	658.21	2094.74	2752.95	1.9027	4.8811	6.7838	156
158	587.3287	0.001100	0.3209	0.3220	666.89	2088.32	2755.21	1.9228	4.8436	6.7664	158
160	618.1392	0.001102	0.3057	0.3068	675.57	2081.86	2757.43	1.9428	4.8063	6.7491	160


PRESSURE (BAR) PRESSION DRUCK
ENTHALPY (kJ/kg) ENTHALPIE
KLEA 134a
Pressure–Enthalpy Diagram
Temperature in °C
Volume in m³/kg
Entropy in kJ/(kg K)
Standard States
Enthalpy 0°C Liquid = 100 kJ/kg
Entropy 0°C Liquid = 1 kJ/kgK
CRITICAL POINT
POINT CRITIQUE
KRITISCHER PUNKT
SATURATED LIQUID
LIQUIDE SATURE
CONSTANT QUALITY
QUALITE CONSTANTE
GLEICH QUALITÄT
SATURATED VAPOUR
VAPEUR SATUREE
GESÄTTIGTER DAMPF
GESÄTTIGTE FLÜSSIGKEIT
PRESSURE (BAR)
PRESSION
DRUCK

C 134a SATURATION PROPERTIES (SI Units)

Temp	Absolute	Volume		Density		Enthalpy			Entropy		Temp
K	Pressure	L/kg	m^3/kg	kg/L	kg/m^3	kJ/kg			kJ/(kg K)		C
	bar	Liquid	Vapour	Liquid	Vapour	Liquid	Latent	Vapour	Liquid	Vapour	
193.15	0.03651	0.65613	4.291820	1.5241	0.2330	-1.546	250.328	248.782	0.56228	1.85832	-80
194.15	0.03964	0.65724	3.972532	1.5215	0.2517	-0.331	249.725	249.393	0.56856	1.85480	-79
195.15	0.04299	0.65835	3.680589	1.5189	0.2717	0.884	249.122	250.006	0.57480	1.85137	-78
196.15	0.04658	0.65947	3.413372	1.5164	0.2930	2.100	248.519	250.619	0.58102	1.84800	-77
197.15	0.05042	0.66060	3.168539	1.5138	0.3156	3.318	247.916	251.234	0.58721	1.84470	-76
198.15	0.05453	0.66173	2.943988	1.5112	0.3397	4.536	247.313	251.849	0.59337	1.84148	-75
199.15	0.05891	0.66287	2.737836	1.5086	0.3653	5.754	246.711	252.465	0.59950	1.83832	-74
200.15	0.06358	0.66402	2.548393	1.5060	0.3924	6.974	246.108	253.083	0.60561	1.83523	-73
201.15	0.06857	0.66517	2.374138	1.5034	0.4212	8.195	245.506	253.701	0.61169	1.83220	-72
202.15	0.07387	0.66633	2.213703	1.5008	0.4517	9.416	244.903	254.320	0.61775	1.82924	-71
203.15	0.07952	0.66749	2.065857	1.4981	0.4841	10.639	244.300	254.939	0.62378	1.82634	-70
204.15	0.08553	0.66866	1.929486	1.4955	0.5183	11.862	243.697	255.560	0.62978	1.82350	-69
205.15	0.09191	0.66984	1.803590	1.4929	0.5544	13.087	243.094	256.181	0.63576	1.82072	-68
206.15	0.09868	0.67103	1.687261	1.4903	0.5927	14.312	242.490	256.803	0.64172	1.81800	-67
207.15	0.10586	0.67222	1.579679	1.4876	0.6330	15.539	241.886	257.425	0.64765	1.81534	-66
208.15	0.11347	0.67342	1.480102	1.4850	0.6756	16.767	241.281	258.048	0.65356	1.81274	-65
209.15	0.12154	0.67462	1.387858	1.4823	0.7205	17.995	240.676	258.672	0.65945	1.81019	-64
210.15	0.13007	0.67584	1.302336	1.4796	0.7679	19.225	240.071	259.296	0.66531	1.80769	-63
211.15	0.13910	0.67706	1.222982	1.4770	0.8177	20.456	239.464	259.921	0.67116	1.80525	-62
212.15	0.14864	0.67829	1.149293	1.4743	0.8701	21.689	238.857	260.546	0.67697	1.80286	-61
213.15	0.15871	0.67952	1.080811	1.4716	0.9252	22.922	238.249	261.171	0.68277	1.80052	-60
214.15	0.16934	0.68077	1.017118	1.4689	0.9832	24.157	237.640	261.797	0.68855	1.79824	-59
215.15	0.18055	0.68202	0.957836	1.4662	1.0440	25.393	237.031	262.423	0.69430	1.79600	-58
216.15	0.19237	0.68328	0.902616	1.4635	1.1079	26.630	236.420	263.050	0.70003	1.79381	-57
217.15	0.20481	0.68454	0.851143	1.4608	1.1749	27.868	235.808	263.677	0.70575	1.79167	-56
218.15	0.21791	0.68582	0.803129	1.4581	1.2451	29.108	235.195	264.304	0.71144	1.78958	-55
219.15	0.23169	0.68710	0.758308	1.4554	1.3187	30.349	234.582	264.931	0.71711	1.78753	-54
220.15	0.24618	0.68839	0.716439	1.4527	1.3958	31.592	233.966	265.558	0.72276	1.78552	-53
221.15	0.26140	0.68969	0.677300	1.4499	1.4765	32.836	233.350	266.186	0.72840	1.78356	-52
222.15	0.27738	0.69100	0.640689	1.4472	1.5608	34.081	232.732	266.813	0.73401	1.78165	-51
223.15	0.29415	0.69232	0.606419	1.4444	1.6490	35.328	232.113	267.441	0.73960	1.77977	-50
224.15	0.31173	0.69364	0.574319	1.4417	1.7412	36.576	231.493	268.069	0.74518	1.77794	-49
225.15	0.33017	0.69498	0.544233	1.4389	1.8374	37.826	230.871	268.696	0.75074	1.77615	-48
226.15	0.34947	0.69632	0.516017	1.4361	1.9379	39.077	230.247	269.324	0.75628	1.77439	-47
227.15	0.36969	0.69767	0.489536	1.4333	2.0428	40.330	229.622	269.952	0.76180	1.77268	-46

[TURN OVER]

FC 134a SATURATION PROPERTIES (SI Units)

Temp	Absolute	Volume		Density		Enthalpy			Entropy		Temp
K	Pressure	L/kg	m^3/kg	kg/L	kg/m^3	kJ/kg			kJ/(kg K)		C
	bar	Liquid	Vapour	Liquid	Vapour	Liquid	Latent	Vapour	Liquid	Vapour	
228.15	0.39084	0.69903	0.464669	1.4306	2.1521	41.584	228.995	270.579	0.76730	1.77100	-45
229.15	0.41297	0.70040	0.441304	1.4278	2.2660	42.840	228.367	271.206	0.77279	1.76937	-44
230.15	0.43609	0.70178	0.419336	1.4249	2.3847	44.097	227.736	271.834	0.77825	1.76777	-43
231.15	0.46025	0.70317	0.398670	1.4221	2.5083	45.356	227.104	272.460	0.78371	1.76620	-42
232.15	0.48548	0.70457	0.379217	1.4193	2.6370	46.617	226.470	273.087	0.78914	1.76467	-41
233.15	0.51181	0.70597	0.360895	1.4165	2.7709	47.879	225.834	273.713	0.79456	1.76318	-40
234.15	0.53927	0.70739	0.343628	1.4136	2.9101	49.143	225.196	274.340	0.79996	1.76172	-39
235.15	0.56791	0.70882	0.327348	1.4108	3.0549	50.409	224.556	274.965	0.80535	1.76029	-38
236.15	0.59776	0.71026	0.311989	1.4079	3.2052	51.677	223.914	275.591	0.81072	1.75890	-37
237.15	0.62885	0.71171	0.297490	1.4051	3.3615	52.946	223.270	276.215	0.81607	1.75754	-36
238.15	0.66122	0.71316	0.283798	1.4022	3.5236	54.217	222.623	276.840	0.82141	1.75621	-35
239.15	0.69490	0.71463	0.270859	1.3993	3.6920	55.490	221.974	277.464	0.82673	1.75491	-34
240.15	0.72995	0.71611	0.258625	1.3964	3.8666	56.764	221.323	278.087	0.83204	1.75364	-33
241.15	0.76638	0.71761	0.247054	1.3935	4.0477	58.041	220.669	278.710	0.83733	1.75240	-32
242.15	0.80425	0.71911	0.236103	1.3906	4.2354	59.319	220.013	279.332	0.84261	1.75119	-31
243.15	0.84360	0.72062	0.225733	1.3877	4.4300	60.600	219.354	279.954	0.84788	1.75001	-30
244.15	0.88445	0.72215	0.215909	1.3848	4.6316	61.882	218.693	280.575	0.85313	1.74886	-29
245.15	0.92686	0.72368	0.206599	1.3818	4.8403	63.166	218.029	281.195	0.85836	1.74774	-28
246.15	0.97087	0.72523	0.197770	1.3789	5.0564	64.452	217.363	281.815	0.86359	1.74664	-27
247.15	1.01651	0.72679	0.189393	1.3759	5.2800	65.740	216.694	282.434	0.86879	1.74556	-26
248.15	1.06382	0.72836	0.181443	1.3729	5.5114	67.030	216.022	283.052	0.87399	1.74452	-25
249.15	1.11286	0.72995	0.173894	1.3700	5.7506	68.322	215.347	283.669	0.87917	1.74350	-24
250.15	1.16367	0.73155	0.166722	1.3670	5.9980	69.616	214.669	284.285	0.88434	1.74250	-23
251.15	1.21628	0.73316	0.159905	1.3640	6.2537	70.913	213.988	284.901	0.88950	1.74153	-22
252.15	1.27074	0.73478	0.153424	1.3610	6.5179	72.211	213.304	285.515	0.89464	1.74058	-21
253.15	1.32710	0.73641	0.147258	1.3579	6.7908	73.511	212.617	286.128	0.89977	1.73966	-20
254.15	1.38540	0.73806	0.141390	1.3549	7.0726	74.814	211.927	286.741	0.90489	1.73876	-19
255.15	1.44568	0.73973	0.135804	1.3518	7.3636	76.119	211.234	287.352	0.91000	1.73788	-18
256.15	1.50800	0.74140	0.130483	1.3488	7.6639	77.425	210.537	287.962	0.91509	1.73702	-17
257.15	1.57240	0.74310	0.125412	1.3457	7.9737	78.735	209.837	288.572	0.92017	1.73618	-15
258.15	1.63893	0.74480	0.120579	1.3426	8.2933	80.046	209.134	289.180	0.92524	1.73537	-15
259.15	1.70762	0.74652	0.115970	1.3395	8.6229	81.360	208.427	289.786	0.93030	1.73457	-14
260.15	1.77854	0.74826	0.111572	1.3364	8.9628	82.675	207.716	290.392	0.93535	1.73380	-13
261.15	1.85173	0.75001	0.107375	1.3333	9.3131	83.994	207.002	290.996	0.94039	1.73304	-12
262.15	1.92724	0.75177	0.103368	1.3302	9.6741	85.314	206.285	291.599	0.94541	1.73231	-11

HFC 134a SATURATION PROPERTIES (SI Units)

Temp	Absolute Pressure	Volume		Density		Enthalpy			Entropy		Temp
K	bar	L/kg	m^3/kg	kg/L	kg/m^3	kJ/kg			kJ/(kg K)		C
		Liquid	Vapour	Liquid	Vapour	Liquid	Latent	Vapour	Liquid	Vapour	
263.15	2.00512	0.75355	0.099541	1.3271	10.046	86.637	205.563	292.200	0.95042	1.73159	-10
264.15	2.08541	0.75535	0.095884	1.3239	10.429	87.962	204.838	292.800	0.95543	1.73089	-9
265.15	2.16817	0.75716	0.092389	1.3207	10.824	89.290	204.109	293.399	0.96042	1.73021	-8
266.15	2.25344	0.75899	0.089047	1.3175	11.230	90.620	203.376	293.996	0.96540	1.72954	-7
267.15	2.34129	0.76084	0.085850	1.3143	11.648	91.952	202.639	294.591	0.97038	1.72890	-6
268.15	2.43175	0.76270	0.082790	1.3111	12.079	93.287	201.898	295.185	0.97534	1.72827	-5
269.15	2.52488	0.76458	0.079862	1.3079	12.522	94.625	201.152	295.777	0.98029	1.72765	-4
270.15	2.62074	0.76648	0.077058	1.3047	12.977	95.965	200.403	296.368	0.98523	1.72705	-3
271.15	2.71937	0.76839	0.074372	1.3014	13.446	97.307	199.649	296.956	0.99016	1.72647	-2
272.15	2.82083	0.77033	0.071798	1.2981	13.928	98.652	198.891	297.543	0.99509	1.72590	-1
273.15	2.92517	0.77228	0.069331	1.2949	14.423	100.000	198.128	298.128	1.00000	1.72535	0
274.15	3.03244	0.77425	0.066966	1.2916	14.933	101.350	197.361	298.711	1.00490	1.72481	1
275.15	3.14271	0.77624	0.064697	1.2883	15.457	102.703	196.589	299.293	1.00980	1.72428	2
276.15	3.25602	0.77826	0.062520	1.2849	15.995	104.059	195.813	299.872	1.01468	1.72377	3
277.15	3.37242	0.78029	0.060430	1.2816	16.548	105.417	195.032	300.449	1.01956	1.72327	4
278.15	3.49198	0.78234	0.058424	1.2782	17.116	106.778	194.246	301.024	1.02443	1.72278	5
279.15	3.61474	0.78442	0.056498	1.2748	17.700	108.142	193.455	301.596	1.02929	1.72230	6
280.15	3.74077	0.78651	0.054647	1.2714	18.299	109.508	192.659	302.167	1.03414	1.72184	7
281.15	3.87013	0.78863	0.052868	1.2680	18.915	110.877	191.858	302.735	1.03898	1.72138	8
282.15	4.00286	0.79077	0.051158	1.2646	19.547	112.249	191.051	303.301	1.04382	1.72094	9
283.15	4.13902	0.79293	0.049514	1.2611	20.196	113.624	190.239	303.864	1.04864	1.72051	10
284.15	4.27868	0.79512	0.047933	1.2577	20.863	115.002	189.422	304.424	1.05346	1.72009	11
285.15	4.42188	0.79733	0.046411	1.2542	21.547	116.383	188.600	304.983	1.05827	1.71968	12
286.15	4.56870	0.79956	0.044947	1.2507	22.248	117.766	187.772	305.538	1.06307	1.71927	13
287.15	4.71918	0.80182	0.043537	1.2472	22.969	119.153	186.938	306.091	1.06787	1.71888	14
288.15	4.87339	0.80411	0.042180	1.2436	23.708	120.543	186.098	306.641	1.07266	1.71849	15
289.15	5.03138	0.80642	0.040872	1.2400	24.467	121.935	185.252	307.188	1.07744	1.71812	16
290.15	5.19322	0.80876	0.039612	1.2365	25.245	123.331	184.401	307.732	1.08221	1.71775	17
291.15	5.35897	0.81113	0.038398	1.2329	26.043	124.730	183.543	308.272	1.08698	1.71738	18
292.15	5.52868	0.81352	0.037227	1.2292	26.862	126.132	182.679	308.810	1.09174	1.71703	19
293.15	5.70243	0.81595	0.036099	1.2256	27.702	127.537	181.808	309.345	1.09649	1.71668	20
294.15	5.88026	0.81840	0.035010	1.2219	28.563	128.945	180.931	309.876	1.10124	1.71633	21
295.15	6.06224	0.82088	0.033959	1.2182	29.447	130.356	180.048	310.404	1.10598	1.71600	22
296.15	6.24844	0.82340	0.032946	1.2145	30.353	131.771	179.157	310.928	1.11071	1.71566	23
297.15	6.43892	0.82594	0.031967	1.2107	31.282	133.189	178.260	311.449	1.11544	1.71534	24

[TURN OVER]

134a SATURATION PROPERTIES (SI Units)

Temp	Absolute Pressure	Volume		Density		Enthalpy			Entropy		Temp
K	bar	L/kg	m^3/kg	kg/L	kg/m^3	kJ/kg			kJ/(kg K)		C
		Liquid	Vapour	Liquid	Vapour	Liquid	Latent	Vapour	Liquid	Vapour	
298.15	6.63374	0.82852	0.031022	1.2070	32.235	134.611	177.356	311.966	1.12016	1.71501	25
299.15	6.83297	0.83113	0.030110	1.2032	33.212	136.035	176.444	312.479	1.12487	1.71469	26
300.15	7.03666	0.83378	0.029228	1.1994	34.214	137.464	175.525	312.989	1.12958	1.71437	27
301.15	7.24489	0.83646	0.028376	1.1955	35.241	138.896	174.598	313.494	1.13429	1.71406	28
302.15	7.45773	0.83918	0.027553	1.1916	36.294	140.331	173.664	313.995	1.13899	1.71375	29
303.15	7.67523	0.84194	0.026757	1.1877	37.373	141.770	172.722	314.492	1.14368	1.71344	30
304.15	7.89746	0.84473	0.025987	1.1838	38.480	143.212	171.772	314.985	1.14837	1.71313	31
305.15	8.12449	0.84756	0.025243	1.1799	39.615	144.659	170.814	315.473	1.15305	1.71283	32
306.15	8.35640	0.85043	0.024523	1.1759	40.779	146.109	169.847	315.956	1.15773	1.71252	33
307.15	8.59324	0.85335	0.023826	1.1719	41.972	147.563	168.872	316.435	1.16241	1.71221	34
308.15	8.83509	0.85631	0.023151	1.1678	43.195	149.020	167.888	316.908	1.16708	1.71191	35
309.15	9.08202	0.85931	0.022498	1.1637	44.449	150.482	166.895	317.377	1.17175	1.71160	36
310.15	9.33409	0.86236	0.021865	1.1596	45.735	151.948	165.893	317.841	1.17641	1.71129	37
311.15	9.59139	0.86545	0.021252	1.1555	47.054	153.418	164.881	318.299	1.18107	1.71098	38
312.15	9.85397	0.86859	0.020659	1.1513	48.406	154.892	163.860	318.751	1.18573	1.71067	39
313.15	10.1219	0.87178	0.020083	1.1471	49.792	156.370	162.829	319.198	1.19038	1.71035	40
314.15	10.3953	0.87503	0.019526	1.1428	51.214	157.852	161.787	319.639	1.19503	1.71003	41
315.15	10.6742	0.87832	0.018985	1.1385	52.673	159.339	160.735	320.074	1.19968	1.70971	42
316.15	10.9587	0.88168	0.018461	1.1342	54.168	160.831	159.672	320.503	1.20433	1.70938	43
317.15	11.2488	0.88508	0.017952	1.1298	55.703	162.327	158.598	320.926	1.20897	1.70904	44
318.15	11.5447	0.88855	0.017459	1.1254	57.277	163.828	157.513	321.341	1.21361	1.70870	45
319.15	11.8464	0.89208	0.016980	1.1210	58.892	165.334	156.416	321.750	1.21825	1.70836	46
320.15	12.1540	0.89567	0.016516	1.1165	60.549	166.845	155.307	322.152	1.22290	1.70800	47
321.15	12.4676	0.89932	0.016064	1.1119	62.249	168.361	154.186	322.547	1.22754	1.70764	48
322.15	12.7872	0.90305	0.015626	1.1074	63.995	169.882	153.052	322.934	1.23217	1.70727	49
323.15	13.1130	0.90684	0.015201	1.1027	65.786	171.409	151.904	323.313	1.23681	1.70689	50
324.15	13.4450	0.91070	0.014787	1.0981	67.626	172.941	150.744	323.684	1.24146	1.70650	51
325.15	13.7832	0.91464	0.014385	1.0933	69.514	174.478	149.569	324.047	1.24610	1.70610	52
326.15	14.1279	0.91866	0.013995	1.0885	71.454	176.022	148.379	324.401	1.25074	1.70568	53
327.15	14.4791	0.92277	0.013615	1.0837	73.447	177.572	147.175	324.747	1.25539	1.70525	54
328.15	14.8368	0.92695	0.013246	1.0788	75.494	179.128	145.955	325.083	1.26003	1.70481	55
329.15	15.2012	0.93123	0.012887	1.0739	77.598	180.690	144.719	325.409	1.26468	1.70436	56
330.15	15.5724	0.93560	0.012538	1.0688	79.761	182.259	143.466	325.725	1.26934	1.70389	57
331.15	15.9504	0.94006	0.012198	1.0638	81.984	183.835	142.196	326.032	1.27400	1.70340	58
332.15	16.3353	0.94463	0.011867	1.0586	84.271	185.419	140.908	326.327	1.27866	1.70289	59

[TURN OVER]

RFR371-S
October/November 2005

HFC 134a .TURATION PROPERTIES (SI Units)

Temp	Absolute Pressure	Volume		Density		Enthalpy			Entropy		Temp
K	bar	L/kg	m^3/kg	kg/L	kg/m^3	kJ/kg			kJ/(kg K)		C
		Liquid	Vapour	Liquid	Vapour	Liquid	Latent	Vapour	Liquid	Vapour	
333.15	16.7272	0.94930	0.011544	1.0534	86.623	187.009	139.602	326.611	1.28333	1.70237	60
334.15	17.1263	0.95408	0.011230	1.0481	89.044	188.608	138.276	326.884	1.28801	1.70182	61
335.15	17.5326	0.95898	0.010925	1.0428	91.536	190.214	136.930	327.144	1.29270	1.70126	62
336.15	17.9463	0.96400	0.010627	1.0373	94.102	191.829	135.563	327.392	1.29739	1.70067	63
337.15	18.3674	0.96915	0.010336	1.0318	96.746	193.453	134.174	327.627	1.30209	1.70005	64
338.15	18.7960	0.97443	0.010053	1.0262	99.471	195.086	132.762	327.848	1.30680	1.69941	65
339.15	19.2323	0.97985	0.009777	1.0206	102.280	196.728	131.326	328.054	1.31153	1.69875	66
340.15	19.6764	0.98543	0.009508	1.0148	105.177	198.380	129.866	328.246	1.31626	1.69805	67
341.15	20.1283	0.99116	0.009245	1.0089	108.168	200.043	128.379	328.422	1.32101	1.69732	68
342.15	20.5883	0.99706	0.008988	1.0029	111.255	201.717	126.864	328.581	1.32578	1.69656	69
343.15	21.0564	1.00314	0.008738	0.9969	114.445	203.403	125.321	328.723	1.33056	1.69577	70
344.15	21.5327	1.00941	0.008493	0.9907	117.743	205.100	123.747	328.847	1.33536	1.69493	71
345.15	22.0174	1.01587	0.008254	0.9844	121.155	206.811	122.141	328.952	1.34018	1.69406	72
346.15	22.5105	1.02256	0.008020	0.9779	124.687	208.536	120.501	329.036	1.34503	1.69314	73
347.15	23.0124	1.02947	0.007791	0.9714	128.345	210.274	118.825	329.099	1.34989	1.69218	74
348.15	23.5230	1.03662	0.007568	0.9647	132.139	212.029	117.111	329.140	1.35479	1.69117	75
349.15	24.0425	1.04404	0.007349	0.9578	136.076	213.799	115.357	329.156	1.35971	1.69011	76
350.15	24.5711	1.05175	0.007134	0.9508	140.166	215.588	113.560	329.147	1.36467	1.68899	77
351.15	25.1089	1.05975	0.006924	0.9436	144.419	217.395	111.716	329.111	1.36966	1.68780	78
352.15	25.6561	1.06809	0.006718	0.9362	148.847	219.222	109.824	329.046	1.37469	1.68656	79
353.15	26.2129	1.07680	0.006516	0.9287	153.462	221.070	107.879	328.949	1.37976	1.68524	80
354.15	26.7794	1.08589	0.006318	0.9209	158.280	222.942	105.877	328.819	1.38488	1.68384	81
355.15	27.3558	1.09541	0.006123	0.9129	163.317	224.840	103.814	328.653	1.39006	1.68236	82
356.15	27.9422	1.10541	0.005931	0.9046	168.592	226.764	101.684	328.448	1.39529	1.68079	83
357.15	28.5390	1.11594	0.005743	0.8961	174.126	228.719	99.482	328.201	1.40058	1.67912	84
358.15	29.1463	1.12704	0.005557	0.8873	179.945	230.707	97.200	327.907	1.40595	1.67734	85
359.15	29.7643	1.13880	0.005374	0.8781	186.078	232.731	94.831	327.562	1.41140	1.67544	86
360.15	30.3933	1.15130	0.005193	0.8686	192.559	234.796	92.366	327.162	1.41694	1.67340	87
361.15	31.0334	1.16463	0.005014	0.8586	199.428	236.905	89.793	326.698	1.42258	1.67121	88
62.15	31.6850	1.17892	0.004837	0.8482	206.736	239.066	87.099	326.165	1.42834	1.66885	89
63.15	32.3484	1.19432	0.004661	0.8373	214.543	241.284	84.268	325.552	1.43424	1.66629	90
64.15	33.0238	1.21102	0.004486	0.8258	222.922	243.569	81.280	324.849	1.44030	1.66351	91
65.15	33.7117	1.22927	0.004311	0.8135	231.970	245.931	78.109	324.040	1.44655	1.66046	92
66.15	34.4123	1.24941	0.004135	0.8004	241.809	248.386	74.723	323.108	1.45303	1.65710	93
67.15	35.1260	1.27188	0.003959	0.7862	252.608	250.952	71.076	322.028	1.45978	1.65337	94

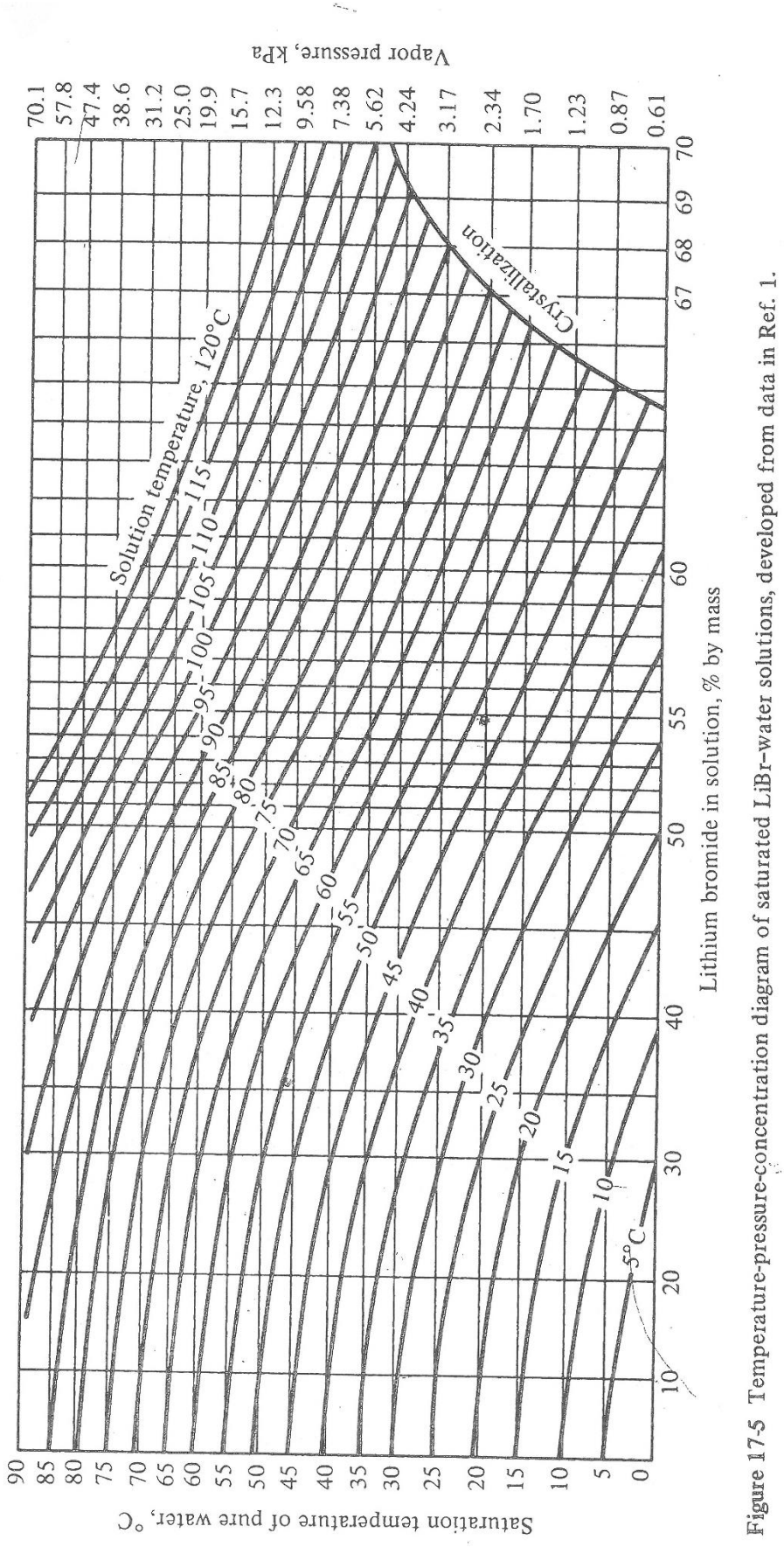


Figure 17-5 Temperature-pressure-concentration diagram of saturated LiBr–water solutions, developed from data in Ref. 1.

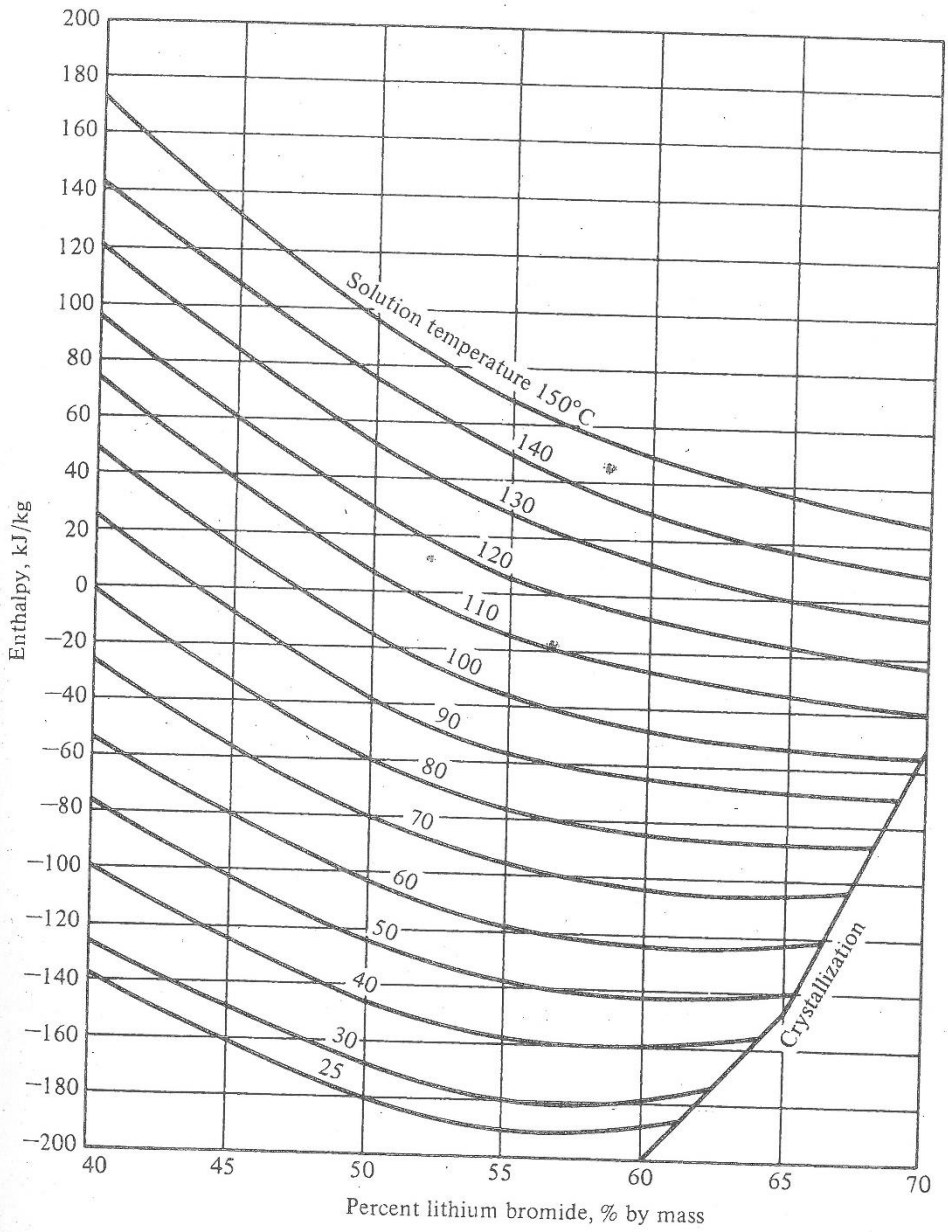


Figure 17-8 Enthalpy of LiBr–water solutions; data from Ref. 1.