

ANEXO III. TABLAS Y GRÁFICAS

III.1. Propiedades del refrigerante R-134a

III.1.1. Propiedades del líquido y vapor saturados

T (°C)	P (kPa)	ρ_l (kg/m³)	v_g (m³/kg)	h_l (kJ/kg)	h_g (kJ/kg)	s_l (kJ/kgK)	s_g (kJ/kgK)
-30	84.4	1388.4	0.2258	160.8	380.3	0.849	1.751
-28	92.8	1382.4	0.2067	163.3	381.6	0.859	1.749
-26	101.7	1376.5	0.1895	165.9	382.8	0.869	1.747
-24	111.4	1370.4	0.1739	168.5	384.1	0.880	1.745
-22	121.7	1364.4	0.1600	171.1	385.3	0.890	1.743
-20	132.8	1358.3	0.1473	173.6	386.5	0.900	1.741
-18	144.7	1352.1	0.1358	176.2	387.8	0.910	1.740
-16	157.4	1345.9	0.1254	178.8	389.0	0.921	1.738
-14	170.9	1339.7	0.1160	181.4	390.2	0.931	1.736
-12	185.4	1333.4	0.1074	184.1	391.4	0.941	1.735
-10	200.7	1327.1	0.0995	186.7	392.7	0.951	1.733
-8	217.1	1320.8	0.0924	189.3	393.9	0.961	1.732
-6	234.4	1314.3	0.0858	192.0	395.1	0.971	1.731
-4	252.9	1307.9	0.0798	194.6	396.2	0.980	1.729
-2	272.4	1301.4	0.0743	197.3	397.4	0.990	1.728
0	293.0	1294.8	0.0693	200.0	398.6	1.000	1.727
2	314.8	1288.1	0.0646	202.7	399.8	1.010	1.726
4	337.9	1281.4	0.0603	205.4	400.9	1.019	1.725
6	362.2	1274.7	0.0564	208.1	402.1	1.029	1.724
8	387.9	1267.9	0.0528	210.8	403.2	1.039	1.723
10	414.9	1261.0	0.0494	213.6	404.3	1.048	1.722
12	443.3	1254.0	0.0463	216.3	405.4	1.058	1.721
14	473.2	1246.9	0.0434	219.1	406.5	1.068	1.720
16	504.6	1239.8	0.0407	221.9	407.6	1.077	1.720
18	537.5	1232.6	0.0383	224.7	408.7	1.087	1.719
20	572.1	1225.3	0.0360	227.5	409.7	1.096	1.718
22	608.3	1218.0	0.0338	230.3	410.8	1.106	1.717
24	646.2	1210.5	0.0318	233.1	411.8	1.115	1.716
26	685.8	1202.9	0.0300	236.0	412.8	1.125	1.716
28	727.3	1195.2	0.0282	238.8	413.8	1.134	1.715
30	770.6	1187.5	0.0266	241.7	414.8	1.143	1.714
32	815.9	1179.6	0.0251	244.6	415.8	1.153	1.714
34	863.1	1171.6	0.0237	247.5	416.7	1.162	1.713
36	912.4	1163.4	0.0224	250.5	417.6	1.172	1.712
38	963.7	1155.2	0.0211	253.4	418.5	1.181	1.712
40	1017.1	1146.7	0.0200	256.4	419.4	1.190	1.711
42	1072.8	1138.2	0.0189	259.4	420.3	1.200	1.710
44	1130.7	1129.5	0.0178	262.4	421.1	1.209	1.710
46	1190.9	1120.6	0.0169	265.5	421.9	1.219	1.709
48	1253.6	1111.5	0.0159	268.5	422.7	1.228	1.708
50	1318.6	1102.3	0.0151	271.6	423.4	1.237	1.707
52	1386.2	1092.9	0.0143	274.7	424.1	1.247	1.706
54	1456.3	1083.2	0.0135	277.9	424.8	1.256	1.705
56	1529.0	1073.4	0.0128	281.1	425.4	1.266	1.704
58	1604.5	1063.2	0.0121	284.3	426.0	1.275	1.703
60	1682.8	1052.9	0.0114	287.5	426.6	1.285	1.702
62	1763.8	1042.2	0.0108	290.8	427.1	1.294	1.701
64	1847.9	1031.3	0.0102	294.1	427.6	1.304	1.700
66	1934.9	1020.0	0.0097	297.4	428.0	1.314	1.699
68	2025.0	1008.3	0.0091	300.8	428.3	1.323	1.697
70	2118.2	996.3	0.0086	304.3	428.6	1.333	1.695

III.1.2. Entalpía específica del líquido subenfriado y vapor sobrecalentado

T_{sat} (°C)	P (kPa)	T (°C)											
		-30	-20	-10	0	10	20	30	40	50	60	70	80
70	2118.2	161.5	174.3	187.2	200.4	213.9	227.6	241.7	256.2	271.3	287.2		443.3
65	1891.0	161.4	174.2	187.2	200.4	213.8	227.6	241.7	256.3	271.4	287.3	434.9	447.9
60	1682.8	161.3	174.1	187.1	200.3	213.8	227.6	241.7	256.3	271.5		439.7	451.8
55	1492.3	161.3	174.1	187.1	200.3	213.8	227.6	241.7	256.3	271.5	431.5	443.5	455.0
50	1318.6	161.2	174.0	187.0	200.2	213.7	227.5	241.7	256.4		435.4	446.7	457.7
45	1160.5	161.2	174.0	187.0	200.2	213.7	227.5	241.7	256.4	427.3	438.6	449.4	460.1
40	1017.1	161.1	173.9	186.9	200.2	213.7	227.5	241.7		430.5	441.2	451.7	462.2
35	887.5	161.1	173.9	186.9	200.1	213.7	227.5	241.7	422.6	433.2	443.5	453.7	463.9
30	770.6	161.0	173.8	186.9	200.1	213.6	227.5		425.2	435.4	445.4	455.5	465.5
25	665.8	161.0	173.8	186.8	200.1	213.6	227.5	417.4	427.4	437.3	447.1	457.0	466.9
20	572.1	161.0	173.8	186.8	200.1	213.6		419.6	429.3	438.9	448.6	458.3	468.0
15	488.7	160.9	173.7	186.8	200.0	213.6	411.9	421.4	430.8	440.3	449.8	459.4	469.1
10	414.9	160.9	173.7	186.8	200.0		413.7	422.9	432.2	441.5	450.9	460.4	470.0
5	349.9	160.9	173.7	186.7	200.0	406.1	415.1	424.2	433.3	442.5	451.8	461.2	470.8
0	293.0	160.9	173.7	186.7		407.5	416.4	425.3	434.3	443.4	452.6	462.0	471.4
-5	243.5	160.8	173.7	186.7	400.0	408.7	417.4	426.2	435.1	444.2	453.3	462.6	472.0
-10	200.7	160.8	173.7		401.2	409.7	418.3	427.0	435.9	444.8	453.9	463.1	472.5
-15	164.0	160.8	173.6	393.8	402.1	410.5	419.1	427.7	436.5	445.4	454.4	463.6	473.0
-20	132.8	160.8		394.7	402.9	411.2	419.7	428.2	437.0	445.8	454.8	464.0	473.3

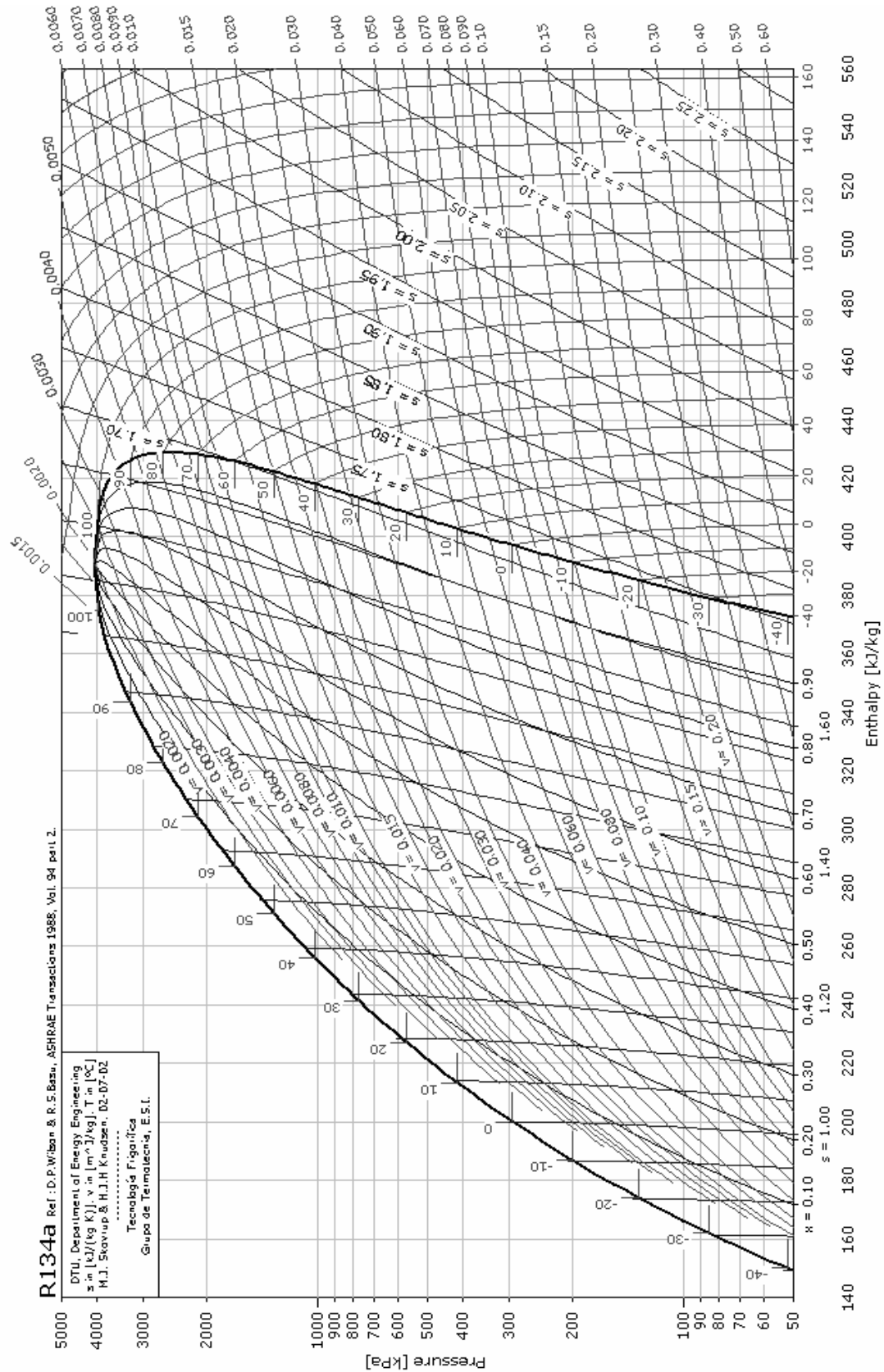
III.1.3. Entropía específica del líquido subenfriado y vapor sobrecalentado

T_{sat} (°C)	P (kPa)	T (°C)											
		-30	-20	-10	0	10	20	30	40	50	60	70	80
70	2118.2	0.846	0.897	0.947	0.996	1.045	1.092	1.140	1.187	1.234	1.283		1.738
65	1891.0	0.846	0.897	0.948	0.997	1.045	1.093	1.140	1.188	1.235	1.284	1.720	1.758
60	1682.8	0.846	0.898	0.948	0.997	1.046	1.094	1.141	1.188	1.236		1.741	1.776
55	1492.3	0.846	0.898	0.948	0.998	1.046	1.094	1.141	1.189	1.237	1.724	1.760	1.793
50	1318.6	0.847	0.898	0.949	0.998	1.046	1.094	1.142	1.189		1.744	1.777	1.809
45	1160.5	0.847	0.899	0.949	0.998	1.047	1.095	1.142	1.190	1.727	1.762	1.794	1.824
40	1017.1	0.847	0.899	0.949	0.999	1.047	1.095	1.143		1.746	1.779	1.810	1.840
35	887.5	0.847	0.899	0.949	0.999	1.047	1.095	1.143	1.730	1.763	1.795	1.825	1.854
30	770.6	0.848	0.899	0.950	0.999	1.048	1.096		1.748	1.780	1.811	1.840	1.869
25	665.8	0.848	0.899	0.950	0.999	1.048	1.096	1.733	1.766	1.797	1.827	1.856	1.884
20	572.1	0.848	0.900	0.950	0.999	1.048		1.751	1.782	1.813	1.842	1.871	1.899
15	488.7	0.848	0.900	0.950	1.000	1.048	1.736	1.768	1.799	1.829	1.858	1.886	1.914
10	414.9	0.848	0.900	0.950	1.000		1.754	1.786	1.816	1.845	1.874	1.902	1.929
5	349.9	0.848	0.900	0.950	1.000	1.741	1.772	1.803	1.832	1.861	1.889	1.917	1.945
0	293.0	0.848	0.900	0.950		1.759	1.790	1.820	1.849	1.878	1.906	1.933	1.961
-5	243.5	0.848	0.900	0.951	1.746	1.777	1.808	1.837	1.866	1.894	1.922	1.950	1.977
-10	200.7	0.848	0.900		1.765	1.796	1.826	1.855	1.883	1.912	1.939	1.967	1.994
-15	164.0	0.849	0.900	1.753	1.784	1.814	1.844	1.873	1.901	1.929	1.957	1.984	2.011
-20	132.8	0.849		1.773	1.803	1.833	1.863	1.891	1.920	1.948	1.975	2.002	2.029

III.1.4. Volumen específico del líquido subenfriado y vapor sobrecalentado

T_{sat} (°C)	P (kPa)	T (°C)											
		-30	-20	-10	0	10	20	30	40	50	60	70	80
70	2118.2	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0009		0.0097
65	1891.0	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0009	0.0105	0.0114
60	1682.8	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009		0.0125	0.0134
55	1492.3	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0137	0.0148	0.0157
50	1318.6	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008	0.0009		0.0163	0.0173	0.0183
45	1160.5	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008	0.0009	0.0180	0.0192	0.0203	0.0214
40	1017.1	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008		0.0213	0.0226	0.0238	0.0249
35	887.5	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008	0.0238	0.0252	0.0266	0.0279	0.0291
30	770.6	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008		0.0283	0.0298	0.0313	0.0327	0.0340
25	665.8	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0318	0.0336	0.0353	0.0369	0.0384	0.0400
20	572.1	0.0007	0.0007	0.0008	0.0008	0.0008		0.0380	0.0400	0.0418	0.0436	0.0454	0.0471
15	488.7	0.0007	0.0007	0.0008	0.0008	0.0008	0.0432	0.0455	0.0476	0.0497	0.0517	0.0537	0.0557
10	414.9	0.0007	0.0007	0.0008	0.0008		0.0520	0.0546	0.0570	0.0594	0.0617	0.0639	0.0662
5	349.9	0.0007	0.0007	0.0008	0.0008	0.0599	0.0628	0.0657	0.0685	0.0712	0.0738	0.0765	0.0791
0	293.0	0.0007	0.0007	0.0008		0.0728	0.0762	0.0794	0.0827	0.0858	0.0889	0.0920	0.0950
-5	243.5	0.0007	0.0007	0.0008	0.0848	0.0889	0.0928	0.0966	0.1004	0.1041	0.1078	0.1114	0.1150
-10	200.7	0.0007	0.0007		0.1044	0.1091	0.1137	0.1183	0.1228	0.1272	0.1316	0.1359	0.1402
-15	164.0	0.0007	0.0007	0.1235	0.1293	0.1349	0.1404	0.1458	0.1512	0.1565	0.1618	0.1671	0.1723
-20	132.8	0.0007		0.1544	0.1612	0.1680	0.1747	0.1813	0.1878	0.1943	0.2007	0.2072	0.2135

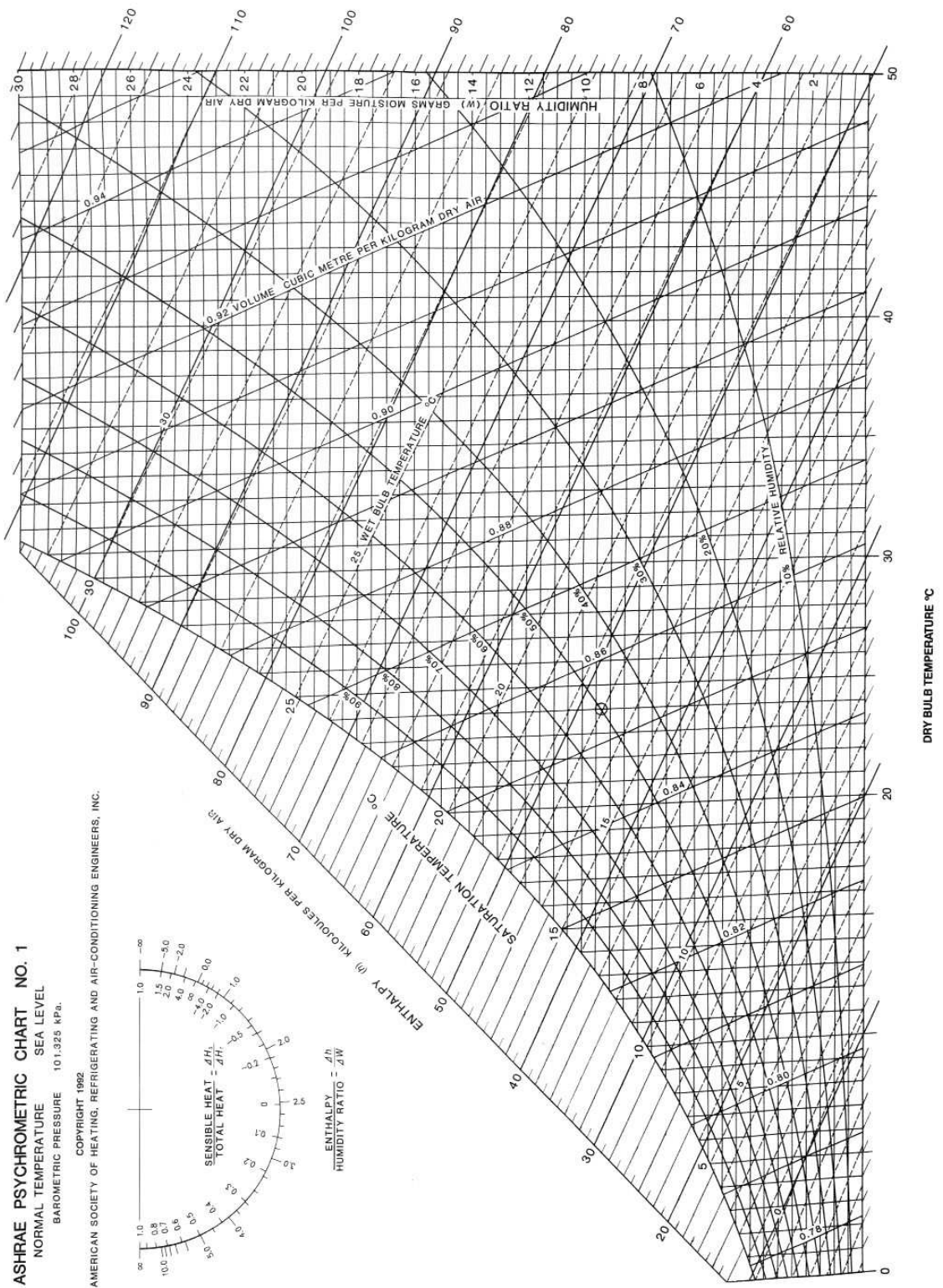
III.2. Diagrama p-h del refrigerante R-134a



III.3. Propiedades del aire seco a presión atmosférica

T (°C)	ρ (kg/m ³)	c_p (kJ/kgK)	$\mu \cdot 10^6$ (kg/ms)	$\nu \cdot 10^6$ (m ² /s)	$k \cdot 10^3$ (W/mK)	$\alpha \cdot 10^6$ (m ² /s)	Pr -
0	1.2920	1.006	17.29	13.38	23.64	18.17	0.7362
5	1.2690	1.006	17.54	13.82	24.01	18.80	0.7350
10	1.2470	1.006	17.78	14.26	24.39	19.44	0.7336
15	1.2250	1.007	18.02	14.71	24.76	20.08	0.7323
20	1.2040	1.007	18.25	15.16	25.14	20.74	0.7309
25	1.1840	1.007	18.49	15.61	25.51	21.40	0.7296
30	1.1640	1.007	18.72	16.08	25.88	22.08	0.7282
35	1.1460	1.007	18.95	16.54	26.25	22.76	0.7268
40	1.1270	1.007	19.18	17.02	26.62	23.45	0.7255
45	1.1100	1.007	19.41	17.49	26.99	24.16	0.7241
50	1.0920	1.007	19.63	17.97	27.35	24.87	0.7228
55	1.0760	1.007	19.86	18.46	27.72	25.59	0.7215
60	1.0600	1.007	20.08	18.95	28.08	26.31	0.7202
65	1.0440	1.007	20.30	19.45	28.45	27.05	0.7190
70	1.0290	1.007	20.52	19.95	28.81	27.79	0.7177
75	1.0140	1.008	20.74	20.45	29.17	28.55	0.7166
80	0.9996	1.008	20.96	20.97	29.53	29.31	0.7154
85	0.9857	1.008	21.17	21.48	29.88	30.07	0.7143
90	0.9721	1.008	21.39	22.00	30.24	30.85	0.7132
95	0.9589	1.009	21.60	22.52	30.60	31.63	0.7121
100	0.9460	1.009	21.81	23.05	30.95	32.42	0.7111
110	0.9213	1.010	22.23	24.12	31.65	34.02	0.7092
120	0.8979	1.011	22.64	25.21	32.35	35.64	0.7073
130	0.8756	1.012	23.05	26.32	33.05	37.30	0.7057
140	0.8544	1.013	23.45	27.44	33.74	38.98	0.7041
150	0.8343	1.014	23.85	28.59	34.43	40.68	0.7027

III.4. Diagrama ASHRAE del aire húmedo



III.5. Correlaciones en convección libre, flujo externo

Se proporcionan únicamente las correlaciones asociadas a la convección libre, flujo externo, sobre una placa plana vertical; las correlaciones asociadas a otros tipos de geometrías no han sido necesarias en el cálculo de cualquiera de los coeficientes de película obtenidos.

<i>Nº</i>	<i>Correlación</i>	<i>Condiciones</i>	<i>Prop.</i>
<i>I</i>	$\overline{Nu}_L = C \cdot Ra^n$	Valor medio Tª superficie constante	T_{mp}
<i>II</i>	$\overline{Nu}_L = \left\{ 0.825 + \frac{0.387 \cdot Ra^{1/6}}{\left[1 + (0.492 / Pr)^{9/16} \right]^{8/27}} \right\}^2$	Valor medio Tª superficie constante 10-1 < Ra < 1012	T_{mp}
<i>III</i>	$\overline{Nu}_L = 0.68 + \frac{0.67 \cdot Ra^{0.25}}{\left[1 + (0.492 / Pr)^{9/16} \right]^{4/9}}$	Valor medio Tª superficie constante Régimen laminar 10-1 < Ra < 109	T_{mp}

Para la *Correlación I*, se tendrán los coeficientes dados por:

<i>Flujo</i>	<i>Ra</i>	<i>C</i>	<i>n</i>
<i>Laminar</i>	$10^4 \div 10^9$	0.59	0.25
<i>Turbulento</i>	$10^9 \div 10^{13}$	0.10	1/3

III.6. Tablas de calibración de termómetros

III.6.1. Calibración de termómetros secos

<i>Ref</i> (Nº3) <i>T</i> (°C)	<i>Nº1</i>	<i>Nº2</i>	<i>Nº4</i>	<i>Nº5</i>	<i>Nº6</i>	<i>Nº7</i>	<i>Nº8</i>	<i>Nº9</i>	<i>Nº10</i>	<i>Nº11</i>
	<i>T</i> (°C)									
49.8	49.6	50.1	50.3	50.0	49.8	49.4	49.2	48.8	49.1	49.6
47.6	47.4	47.9	48.2	47.8	47.6	47.2	47.2	46.7	46.9	47.4
45.4	45.2	45.7	45.9	45.6	45.4	45.1	44.9	44.4	44.8	45.2
43.8	43.6	44.1	44.3	44.0	43.8	43.5	43.3	43.0	43.2	43.7
41.8	41.6	42.1	41.3	42.0	41.9	41.5	41.4	41.1	41.4	41.7
40.0	39.7	40.3	40.5	40.2	40.1	39.8	39.6	39.3	39.7	40.0
38.2	38.1	38.4	38.7	38.4	38.4	37.9	37.8	37.6	38.0	38.2
36.0	35.9	36.2	36.5	36.2	36.1	35.7	35.6	35.4	35.8	36.0
33.6	33.5	33.8	34.1	33.8	33.8	33.4	33.2	33.0	33.4	33.6
32.1	32.0	32.3	32.5	32.3	32.3	31.9	31.8	31.6	32.1	32.1
30.1	30.0	30.3	30.5	30.3	30.4	29.9	29.8	29.9	30.1	30.1
27.8	27.7	28.0	28.2	28.0	28.0	27.6	27.5	27.6	27.8	27.8
26.2	26.1	26.3	26.6	26.4	26.4	26.0	25.9	26.1	26.2	26.2
24.2	24.1	24.3	24.6	24.4	24.4	24.0	23.9	24.2	24.2	24.1
22.2	22.1	22.0	22.5	22.3	22.4	22.0	21.9	22.2	22.2	22.1
19.8	19.7	19.8	20.1	19.9	20.0	19.6	19.5	19.8	19.9	19.8
18.9	18.8	18.9	19.2	19.0	19.1	18.8	18.6	19.1	19.1	18.9
17.0	16.9	17.0	17.2	17.1	17.2	16.9	16.8	17.2	17.1	16.8
14.6	14.4	14.6	14.9	14.6	14.8	14.4	14.3	15.0	14.7	14.4
12.4	12.3	12.4	12.7	12.4	12.6	12.3	12.1	12.8	12.6	12.2
10.4	10.2	10.4	10.7	10.4	10.6	10.3	10.1	10.9	10.6	10.2
8.6	8.4	8.6	8.8	8.6	8.8	8.5	8.4	9.1	8.8	8.3
5.8	5.6	5.8	6.0	5.7	6.0	5.7	5.6	6.4	6.0	5.5
3.8	3.6	3.8	4.0	3.7	4.0	3.7	3.6	4.6	4.1	3.5
2.0	1.9	2.2	2.2	2.0	2.2	2.0	1.9	2.7	2.3	1.6
1.5	1.3	1.6	1.7	1.4	1.7	1.4	1.3	2.2	1.8	1.1

III.6.2. Calibración de termómetros húmedos

<i>Ref</i> (Nº3) <i>T</i> (°C)	<i>Nº H1</i>	<i>Nº H2</i>	<i>Nº H3</i>	<i>Nº H4</i>
	<i>T</i> (°C)			
31.3	31.6	31.5	31.7	31.3
30.0	30.3	30.2	30.4	30.0
27.8	28.1	27.9	28.2	27.8
27.5	27.7	27.6	27.8	27.5
25.1	25.3	25.2	25.4	25.0
23.7	23.9	23.8	24.0	23.6
21.0	21.2	21.1	21.3	20.9
19.0	19.2	19.1	19.3	18.9
16.5	16.7	16.6	16.8	16.4
14.6	14.7	14.6	14.8	14.5
12.2	12.3	12.2	12.4	12.1
10.4	10.5	10.4	10.6	10.3
8.8	9.0	8.8	9.0	8.7
7.0	7.0	7.0	7.2	6.8