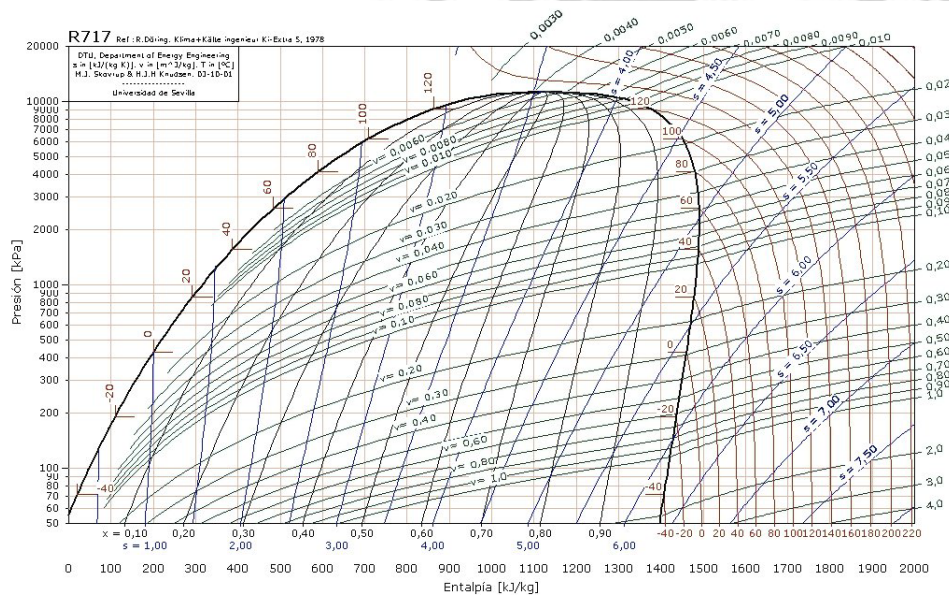




DPTO. INGENIERÍA ENERGÉTICA
Y MECÁNICA DE FLUIDOS
Grupo de Termodinámica

Colección de Tablas y Gráficas de Instalaciones Frío - Calor

Versión 1.1 (febrero de 2006)



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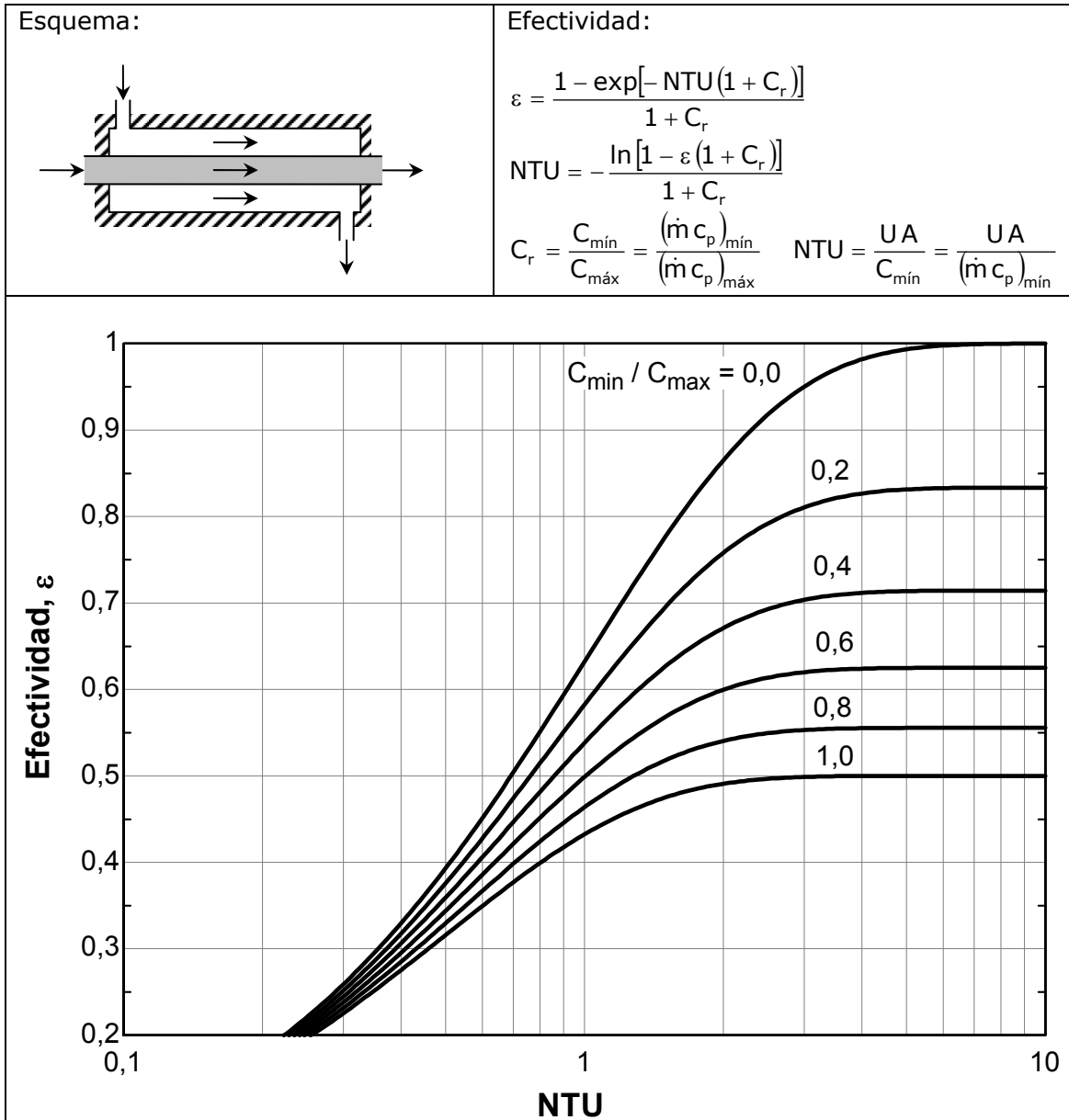
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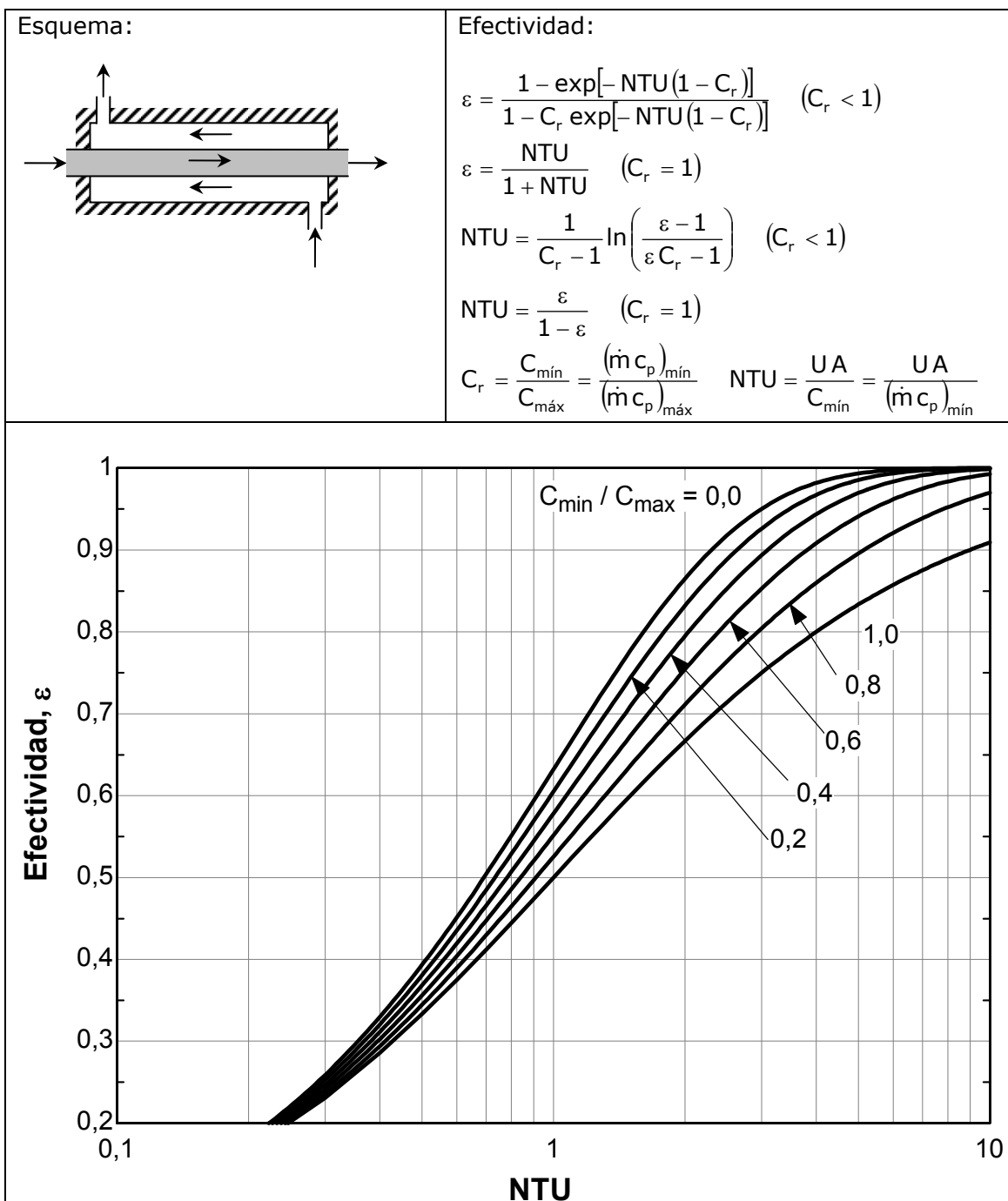
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1. Intercambiadores

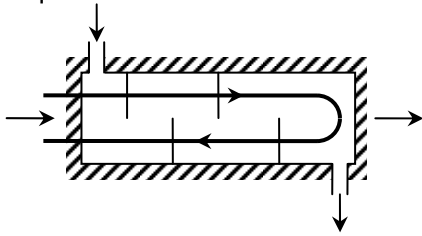
Gráfica 1.1: Intercambiador de doble tubo a equicorriente

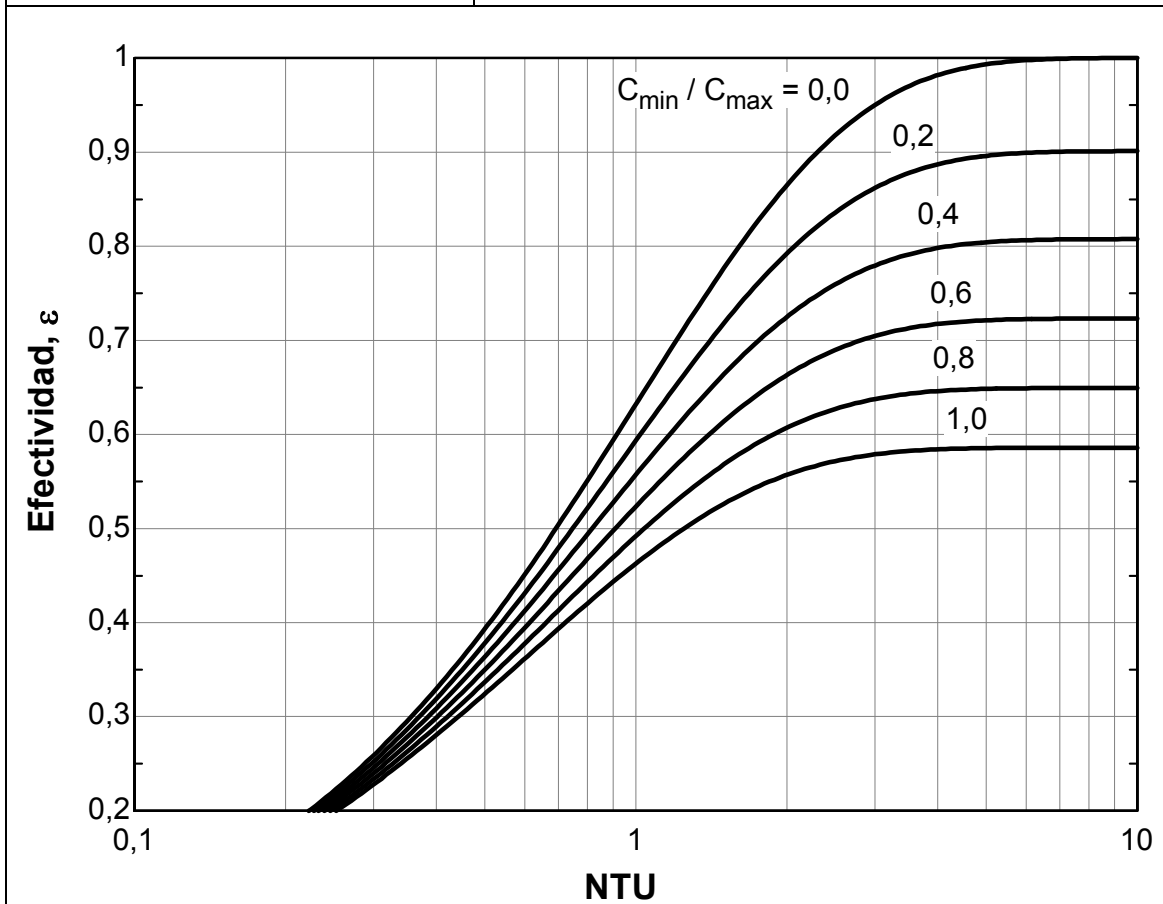


Gráfica 1.2: Intercambiador de doble tubo a contracorriente

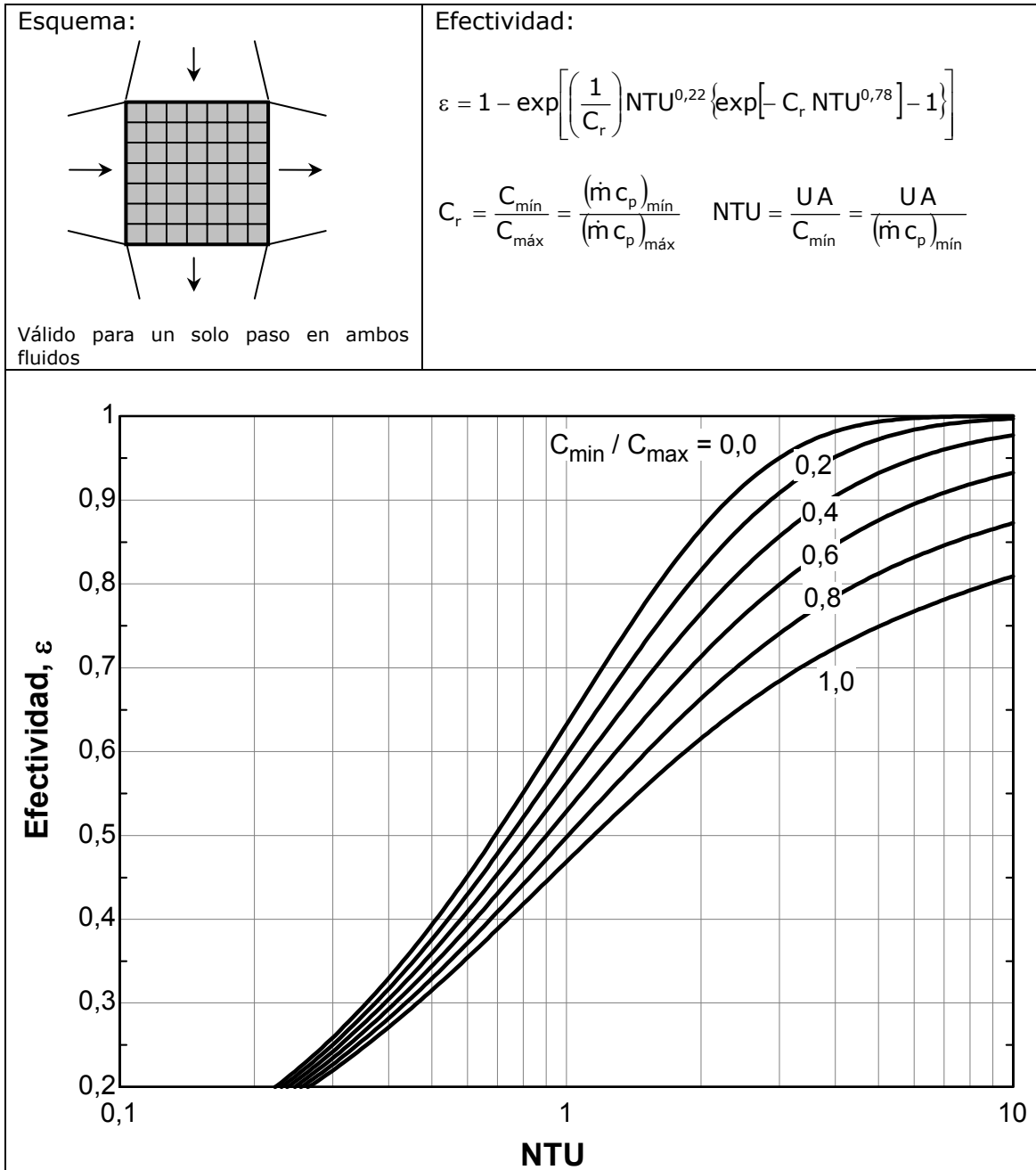


Gráfica 1.3: Intercambiador carcasa y tubo 1-2n

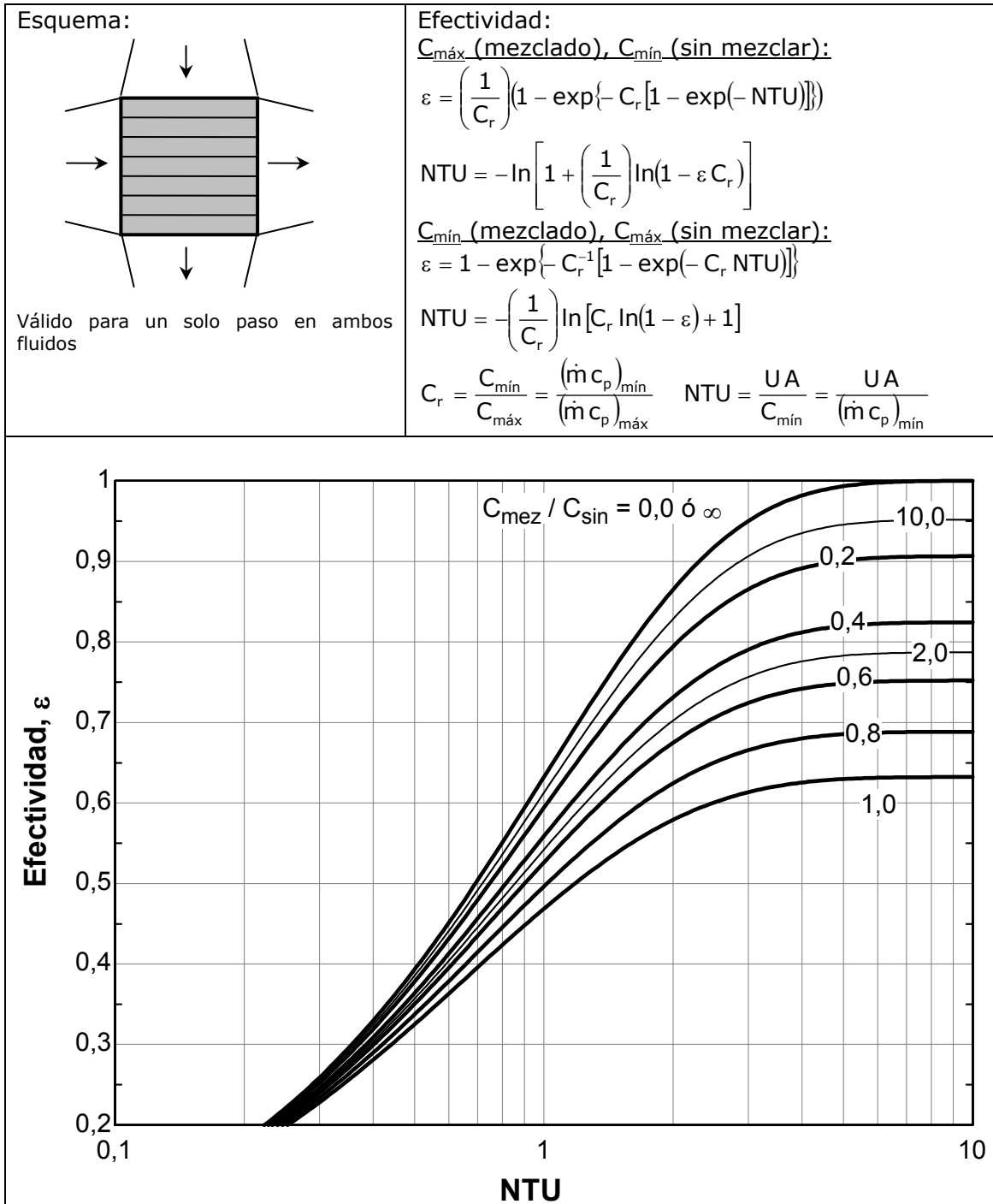
<p>Esquema:</p>  <p>Válido para un paso por carcasa y cualquier múltiplo de dos por tubos (2n)</p>	<p>Efectividad:</p> $\varepsilon = 2 \left\{ 1 + C_r + (1 + C_r^2)^{1/2} \frac{1 + \exp[-NTU(1 + C_r^2)^{1/2}]}{1 - \exp[-NTU(1 + C_r^2)^{1/2}]} \right\}^{-1}$ $NTU = -(1 + C_r^2)^{-1/2} \ln \left(\frac{E - 1}{E + 1} \right)$ $E = \frac{2 / \varepsilon - (1 + C_r)}{(1 + C_r^2)^{1/2}}$ $C_r = \frac{C_{\min}}{C_{\max}} = \frac{(\dot{m} c_p)_{\min}}{(\dot{m} c_p)_{\max}} \quad NTU = \frac{UA}{C_{\min}} = \frac{UA}{(\dot{m} c_p)_{\min}}$
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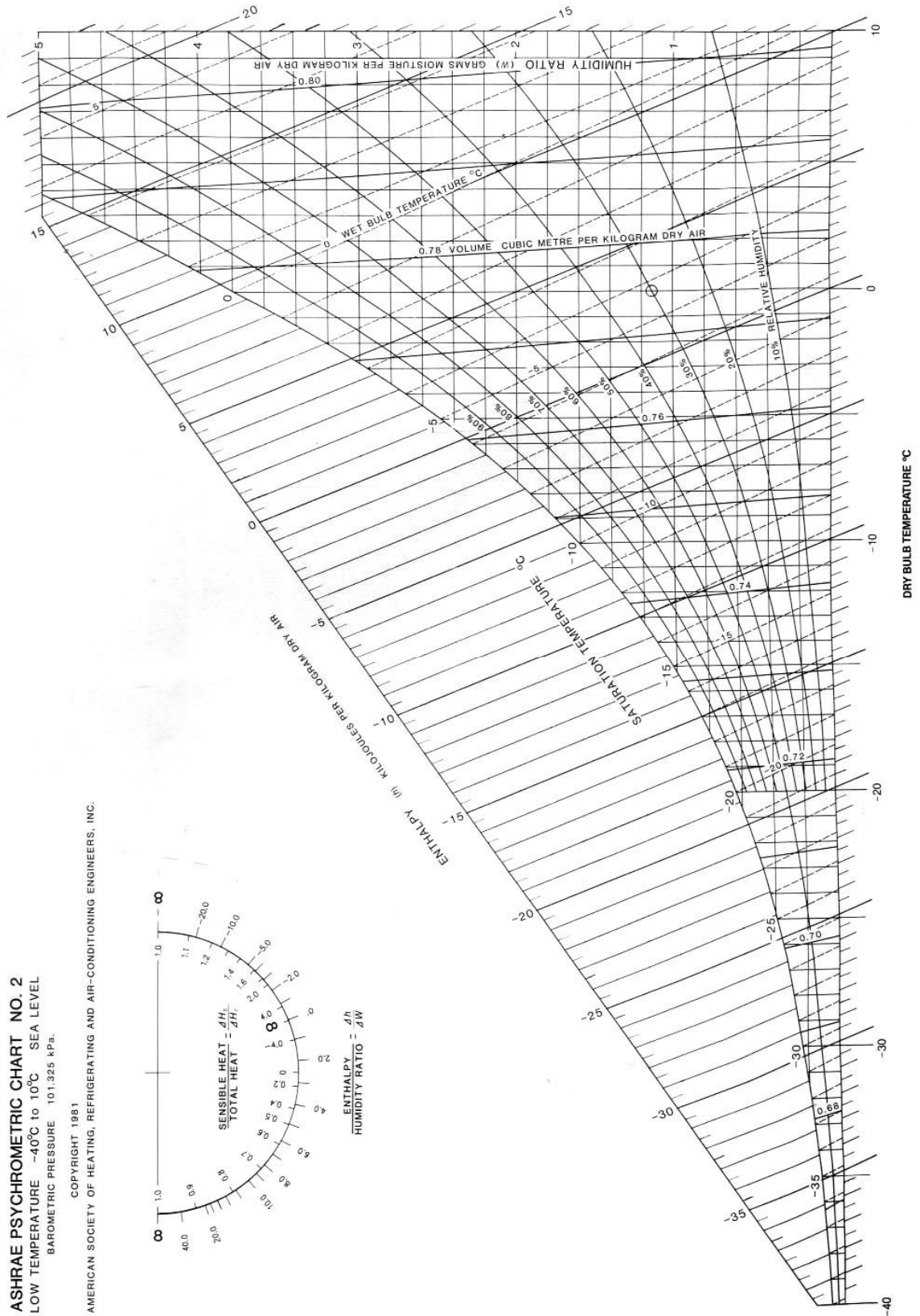
Gráfica 1.4: Intercambiador flujo cruzado ambos fluidos sin mezclar



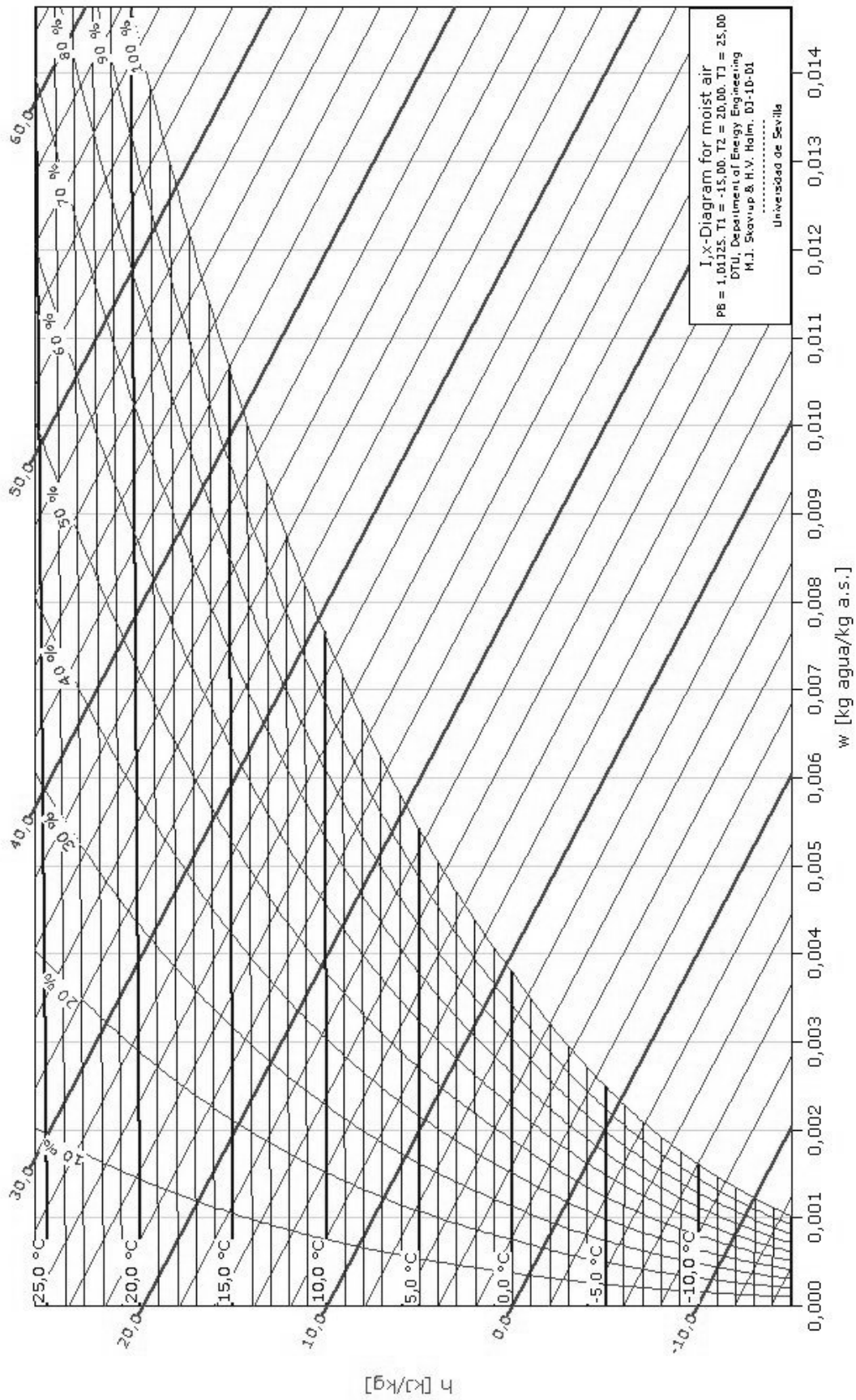
Gráfica 1.4: Intercambiador flujo cruzado con un fluido mezcla y otro sin mezclar



Gráfica 2.2: Diagrama Psicrométrico ASHRAE para bajas temp.



Gráfica 2.3: Diagrama Psicrométrico Mollier



3. Propiedades de los principales refrigerantes

Tabla 3.1: Propiedades del líquido y vapor saturados para el R-717

 R-717, NH₃, Amoniaco

t (°C)	P (kPa)	ρ_l (kg/ m ³)	v_g (m ³ /kg)	h_l (kJ/kg)	h_g (kJ/kg)	s_l (kJ/kg·K)	s_g (kJ/kg·K)
-50	40.8	702.1	2.6289	-24.7	1391.2	0.094	6.440
-48	45.9	699.7	2.3565	-16.0	1394.6	0.133	6.399
-46	51.5	697.4	2.1169	-7.2	1397.9	0.172	6.358
-44	57.6	695.0	1.9057	1.5	1401.3	0.211	6.319
-42	64.3	692.6	1.7191	10.3	1404.5	0.249	6.281
-40	71.7	690.2	1.5539	19.2	1407.8	0.287	6.243
-38	79.7	687.7	1.4073	28.0	1411.0	0.324	6.206
-36	88.4	685.3	1.2769	36.9	1414.1	0.362	6.170
-34	97.9	682.8	1.1607	45.8	1417.2	0.399	6.134
-32	108.2	680.3	1.0570	54.7	1420.3	0.436	6.099
-30	119.4	677.8	0.9642	63.6	1423.3	0.473	6.065
-28	131.5	675.3	0.8810	72.6	1426.3	0.510	6.032
-26	144.6	672.8	0.8062	81.5	1429.2	0.546	5.999
-24	158.6	670.3	0.7390	90.5	1432.1	0.582	5.967
-22	173.8	667.7	0.6784	99.5	1434.9	0.618	5.935
-20	190.1	665.1	0.6237	108.6	1437.7	0.654	5.904
-18	207.6	662.6	0.5742	117.6	1440.4	0.689	5.874
-16	226.3	660.0	0.5294	126.7	1443.1	0.725	5.844
-14	246.4	657.3	0.4888	135.8	1445.7	0.760	5.814
-12	267.9	654.7	0.4518	144.9	1448.2	0.795	5.785
-10	290.8	652.1	0.4182	154.0	1450.7	0.829	5.757
-8	315.2	649.4	0.3875	163.2	1453.1	0.864	5.729
-6	341.2	646.7	0.3596	172.3	1455.5	0.898	5.701
-4	368.9	644.0	0.3340	181.5	1457.8	0.932	5.674
-2	398.3	641.3	0.3106	190.8	1460.1	0.966	5.647
0	429.6	638.6	0.2892	200.0	1462.2	1.000	5.621
2	462.6	635.8	0.2695	209.3	1464.3	1.034	5.595
4	497.7	633.1	0.2514	218.6	1466.4	1.067	5.569
6	534.8	630.3	0.2348	227.9	1468.4	1.100	5.544
8	573.9	627.5	0.2195	237.2	1470.3	1.133	5.519
10	615.3	624.6	0.2053	246.6	1472.1	1.166	5.494
12	658.9	621.8	0.1923	256.0	1473.9	1.199	5.470
14	704.9	618.9	0.1802	265.4	1475.5	1.232	5.446
16	753.3	616.0	0.1691	274.8	1477.2	1.264	5.422
18	804.2	613.1	0.1587	284.3	1478.7	1.297	5.399
20	857.8	610.2	0.1491	293.8	1480.1	1.329	5.376
22	914.0	607.2	0.1402	303.3	1481.5	1.361	5.353
24	972.9	604.3	0.1320	312.9	1482.8	1.393	5.330
26	1034.8	601.3	0.1243	322.5	1484.0	1.425	5.307
28	1099.5	598.2	0.1171	332.1	1485.1	1.456	5.285
30	1167.4	595.2	0.1104	341.8	1486.2	1.488	5.263
32	1238.3	592.1	0.1042	351.5	1487.1	1.520	5.241
34	1312.5	589.0	0.0984	361.2	1488.0	1.551	5.219
36	1390.0	585.8	0.0930	371.0	1488.7	1.582	5.198
38	1470.9	582.6	0.0879	380.8	1489.4	1.613	5.176
40	1555.3	579.4	0.0831	390.6	1489.9	1.645	5.155
42	1643.3	576.2	0.0786	400.5	1490.4	1.676	5.134
44	1735.1	572.9	0.0745	410.5	1490.7	1.707	5.113
46	1830.6	569.6	0.0705	420.5	1491.0	1.737	5.092
48	1930.0	566.3	0.0668	430.5	1491.1	1.768	5.071
50	2033.5	562.9	0.0634	440.6	1491.1	1.799	5.050
52	2141.0	559.4	0.0601	450.8	1491.0	1.830	5.029
54	2252.8	556.0	0.0570	461.0	1490.8	1.860	5.008
56	2368.9	552.4	0.0541	471.2	1490.5	1.891	4.988
58	2489.4	548.9	0.0514	481.6	1490.0	1.922	4.967
60	2614.5	545.2	0.0488	492.0	1489.4	1.952	4.946
62	2744.2	541.6	0.0464	502.4	1488.6	1.983	4.926
64	2878.7	537.8	0.0441	513.0	1487.7	2.014	4.905
66	3018.1	534.1	0.0419	523.6	1486.6	2.044	4.884
68	3162.5	530.2	0.0398	534.3	1485.4	2.075	4.863
70	3312.0	526.3	0.0379	545.0	1484.1	2.105	4.842

 Fuente: Tillner-Roth, Harms-Watzenberg, and Baehr, *Eine neue Fundamentalgleichung für Ammoniak*, DKV-Tagungsbericht 20:167-181, 1993.

Tabla 3.2: Propiedades del líquido y vapor saturados para el R-22

R-22, CHClF₂, Clorodifluorometano

t (°C)	P (kPa)	ρ _l (kg/ m ³)	v _g (m ³ /kg)	h _l (kJ/kg)	h _g (kJ/kg)	s _l (kJ/kg·K)	s _g (kJ/kg·K)
-50	64.5	1435.4	0.3236	143.6	383.2	0.773	1.847
-48	71.4	1429.7	0.2943	145.8	384.1	0.783	1.842
-46	78.9	1423.9	0.2682	147.9	385.1	0.793	1.837
-44	87.0	1418.2	0.2448	150.1	386.0	0.802	1.832
-42	95.8	1412.4	0.2239	152.3	387.0	0.812	1.827
-40	105.2	1406.5	0.2051	154.5	387.9	0.821	1.822
-38	115.4	1400.7	0.1882	156.7	388.9	0.831	1.818
-36	126.3	1394.8	0.1729	159.0	389.8	0.840	1.813
-34	138.0	1388.9	0.1592	161.2	390.7	0.849	1.809
-32	150.5	1382.9	0.1467	163.4	391.6	0.859	1.805
-30	163.9	1376.9	0.1354	165.6	392.5	0.868	1.801
-28	178.2	1370.9	0.1252	167.9	393.4	0.877	1.797
-26	193.5	1364.8	0.1159	170.1	394.3	0.886	1.793
-24	209.7	1358.7	0.1074	172.4	395.2	0.895	1.789
-22	227.0	1352.6	0.0997	174.6	396.1	0.904	1.786
-20	245.4	1346.4	0.0926	176.9	396.9	0.913	1.782
-18	264.8	1340.1	0.0862	179.2	397.8	0.922	1.779
-16	285.5	1333.8	0.0802	181.4	398.6	0.931	1.775
-14	307.4	1327.5	0.0748	183.7	399.5	0.939	1.772
-12	330.5	1321.1	0.0698	186.0	400.3	0.948	1.769
-10	354.9	1314.7	0.0652	188.3	401.1	0.957	1.765
-8	380.6	1308.2	0.0610	190.6	401.9	0.966	1.762
-6	407.8	1301.6	0.0571	193.0	402.7	0.974	1.759
-4	436.4	1295.0	0.0535	195.3	403.5	0.983	1.756
-2	466.5	1288.3	0.0502	197.6	404.2	0.991	1.753
0	498.1	1281.6	0.0471	200.0	405.0	1.000	1.750
2	531.4	1274.8	0.0442	202.4	405.7	1.009	1.748
4	566.2	1268.0	0.0416	204.7	406.4	1.017	1.745
6	602.8	1261.0	0.0391	207.1	407.2	1.025	1.742
8	641.1	1254.0	0.0368	209.5	407.8	1.034	1.739
10	681.2	1247.0	0.0347	211.9	408.5	1.042	1.737
12	723.1	1239.8	0.0327	214.3	409.2	1.051	1.734
14	766.9	1232.6	0.0308	216.8	409.8	1.059	1.731
16	812.7	1225.2	0.0291	219.2	410.5	1.067	1.729
18	860.5	1217.8	0.0275	221.7	411.1	1.076	1.726
20	910.3	1210.3	0.0260	224.2	411.7	1.084	1.724
22	962.3	1202.7	0.0246	226.6	412.2	1.092	1.721
24	1016.4	1195.0	0.0232	229.1	412.8	1.101	1.719
26	1072.7	1187.2	0.0220	231.7	413.3	1.109	1.716
28	1131.3	1179.3	0.0208	234.2	413.8	1.117	1.714
30	1192.3	1171.2	0.0197	236.8	414.3	1.126	1.711
32	1255.6	1163.1	0.0187	239.3	414.7	1.134	1.709
34	1321.4	1154.8	0.0177	241.9	415.2	1.142	1.706
36	1389.8	1146.3	0.0168	244.5	415.6	1.150	1.704
38	1460.6	1137.8	0.0159	247.2	415.9	1.159	1.701
40	1534.1	1129.0	0.0151	249.8	416.3	1.167	1.699
42	1610.3	1120.2	0.0143	252.5	416.6	1.175	1.696
44	1689.3	1111.1	0.0136	255.2	416.9	1.184	1.693
46	1771.1	1101.8	0.0129	257.9	417.1	1.192	1.691
48	1855.7	1092.4	0.0122	260.6	417.3	1.200	1.688
50	1943.3	1082.7	0.0116	263.4	417.5	1.209	1.685
52	2034.0	1072.9	0.0110	266.2	417.6	1.217	1.683
54	2127.7	1062.7	0.0105	269.1	417.7	1.225	1.680
56	2224.6	1052.3	0.0099	271.9	417.7	1.234	1.677
58	2324.7	1041.7	0.0094	274.8	417.7	1.242	1.674
60	2428.1	1030.7	0.0090	277.8	417.6	1.251	1.671
62	2534.9	1019.3	0.0085	280.8	417.5	1.260	1.667
64	2645.2	1007.6	0.0081	283.8	417.3	1.268	1.664
66	2759.0	995.5	0.0076	286.9	417.0	1.277	1.661
68	2876.4	982.9	0.0072	290.0	416.6	1.286	1.657
70	2997.7	969.8	0.0068	293.2	416.1	1.295	1.653

Fuente: Wagner W., Marx V. y Prob A. , *A New Equation of State for Chlorodifluoromethane covering the entire fluid region from 116 K to 550 K at pressures up to 200 MPa*, Int. J. Refrig, 16:373, 1993.

Tabla 3.3: Propiedades del líquido y vapor saturados para el R-134a
 R-134a, CH₂F-CF₃, 1,1,1,2-Tetrafluoretano

t (°C)	P (kPa)	ρ _l (kg/ m ³)	v _g (m ³ /kg)	h _l (kJ/kg)	h _g (kJ/kg)	s _l (kJ/kg·K)	s _g (kJ/kg·K)
-50	29.5	1446.3	0.6056	135.7	367.6	0.741	1.780
-48	33.1	1440.6	0.5436	138.2	368.9	0.752	1.777
-46	37.0	1434.9	0.4891	140.6	370.2	0.763	1.774
-44	41.4	1429.2	0.4410	143.1	371.5	0.774	1.770
-42	46.1	1423.5	0.3985	145.6	372.7	0.785	1.767
-40	51.2	1417.7	0.3608	148.1	374.0	0.796	1.764
-38	56.9	1411.9	0.3273	150.7	375.3	0.806	1.761
-36	62.9	1406.1	0.2975	153.2	376.5	0.817	1.759
-34	69.6	1400.2	0.2709	155.7	377.8	0.828	1.756
-32	76.7	1394.3	0.2471	158.2	379.1	0.838	1.754
-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

Fuente: R. Tillner-Roth and H.D. Baehr, *An International Standard Formulation for the Thermodynamic Properties of 1,1,1,2-Tetrafluoroethane (HFC-134a) for Temperatures from 170 K to 455 K and Pressures up to 70 MPa*, J. Phys. Chem, Ref. Data, Vol. 23, No. 5, 1994.

Tabla 3.4: Entalpía del líquido subenfriado y el vapor sobrecalentado para el R-717

h (kJ/kg), R-717, NH₃, Amoniaco

t _{sat} (°C)	P (kPa)	t (°C)															
		-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100
70	3312.0	-21.8	21.9	66.2	110.9	156.2	201.9	248.1	294.9	342.5	391.0	440.6	491.8		1527.4	1565.6	1600.6
65	2947.8	-22.1	21.6	65.9	110.7	155.9	201.6	247.9	294.8	342.4	390.9	440.6	491.9	1508.5	1547.2	1582.3	1615.1
60	2614.5	-22.4	21.3	65.6	110.4	155.7	201.4	247.7	294.6	342.3	390.8	440.6		1528.7	1564.1	1596.8	1627.8
55	2310.3	-22.7	21.1	65.4	110.2	155.4	201.2	247.5	294.5	342.2	390.8	440.6	1510.0	1545.7	1578.5	1609.5	1639.0
50	2033.5	-22.9	20.8	65.2	110.0	155.2	201.0	247.4	294.3	342.1	390.7		1527.2	1560.2	1591.1	1620.5	1648.9
45	1782.3	-23.2	20.6	65.0	109.8	155.1	200.9	247.2	294.2	342.0	390.7	1508.7	1541.8	1572.7	1602.0	1630.2	1657.6
40	1555.3	-23.4	20.4	64.8	109.6	154.9	200.7	247.1	294.1	341.9		1523.4	1554.3	1583.5	1611.6	1638.7	1665.3
35	1350.8	-23.6	20.3	64.6	109.4	154.8	200.6	247.0	294.0	341.8	1504.8	1535.8	1565.0	1592.9	1619.9	1646.2	1672.1
30	1167.4	-23.7	20.1	64.5	109.3	154.6	200.5	246.9	293.9		1517.3	1546.5	1574.3	1601.1	1627.2	1652.8	1678.1
25	1003.5	-23.9	20.0	64.3	109.2	154.5	200.4	246.8	293.9	1498.8	1528.0	1555.6	1582.3	1608.2	1633.6	1658.6	1683.3
20	857.8	-24.0	19.8	64.2	109.1	154.4	200.3	246.7		1509.4	1537.0	1563.5	1589.2	1614.4	1639.1	1663.6	1688.0
15	728.8	-24.1	19.7	64.1	109.0	154.3	200.2	246.6	1490.8	1518.3	1544.7	1570.2	1595.2	1619.7	1644.0	1668.0	1692.0
10	615.3	-24.2	19.6	64.0	108.9	154.2	200.1		1499.7	1525.9	1551.3	1576.0	1600.3	1624.4	1648.2	1671.9	1695.5
5	516.0	-24.3	19.5	63.9	108.8	154.2	200.1	1481.0	1507.2	1532.4	1556.9	1581.0	1604.8	1628.4	1651.8	1675.2	1698.6
0	429.6	-24.4	19.5	63.9	108.7	154.1		1488.4	1513.5	1537.8	1561.7	1585.3	1608.6	1631.8	1654.9	1678.1	1701.2
-5	354.9	-24.4	19.4	63.8	108.7	154.1	1469.5	1494.5	1518.7	1542.4	1565.8	1588.9	1611.9	1634.8	1657.6	1680.5	1703.5
-10	290.8	-24.5	19.4	63.7	108.6		1475.6	1499.7	1523.2	1546.3	1569.2	1592.0	1614.6	1637.3	1659.9	1682.6	1705.4
-15	236.2	-24.6	19.3	63.7	108.6	1456.7	1480.6	1503.9	1526.9	1549.6	1572.1	1594.5	1617.0	1639.4	1661.9	1684.4	1707.0
-20	190.1	-24.6	19.3	63.7		1461.5	1484.7	1507.5	1530.0	1552.3	1574.5	1596.7	1618.9	1641.2	1663.5	1685.9	1708.4
-25	151.5	-24.6	19.2	63.6	1442.4	1465.5	1488.1	1510.4	1532.5	1554.6	1576.5	1598.5	1620.5	1642.6	1664.8	1687.1	1709.6
-30	119.4	-24.7	19.2		1446.3	1468.7	1490.9	1512.8	1534.6	1556.4	1578.2	1600.0	1621.9	1643.9	1666.0	1688.2	1710.5
-35	93.1	-24.7	19.2	1427.0	1449.3	1471.3	1493.1	1514.7	1536.3	1557.9	1579.5	1601.2	1623.0	1644.9	1666.9	1689.0	1711.3
-40	71.7	-24.7		1430.0	1451.8	1473.4	1494.9	1516.3	1537.7	1559.1	1580.6	1602.2	1623.9	1645.7	1667.6	1689.7	1711.9
-45	54.5	-24.7	1410.6	1432.3	1453.8	1475.1	1496.3	1517.6	1538.8	1560.1	1581.5	1603.0	1624.6	1646.3	1668.2	1690.3	1712.5
-50	40.8		1412.8	1434.1	1455.3	1476.4	1497.5	1518.5	1539.7	1560.9	1582.2	1603.6	1625.2	1646.9	1668.7	1690.7	1712.9

Fuente: Tillner-Roth, Harms-Watzenberg, and Baehr, *Eine neue Fundamentalgleichung für Ammoniak*, DKV-Tagungsbericht 20:167-181, 1993.

Tabla 3.5: Entropía del líquido subenfriado y el vapor sobrecalentado para el R-717

s (kJ/kg·K), R-717, NH₃, Amoniac

t _{sat} (°C)	P (kPa)	t (°C)															
		-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100
70	3312.0	0.087	0.279	0.464	0.645	0.820	0.990	1.157	1.319	1.479	1.636	1.792	1.948		4.967	5.073	5.168
65	2947.8	0.088	0.279	0.465	0.646	0.821	0.992	1.158	1.321	1.480	1.638	1.794	1.950	4.957	5.068	5.166	5.255
60	2614.5	0.088	0.280	0.466	0.647	0.822	0.993	1.159	1.322	1.482	1.639	1.796		5.063	5.164	5.256	5.340
55	2310.3	0.089	0.281	0.467	0.648	0.823	0.994	1.160	1.323	1.483	1.641	1.797	5.057	5.162	5.257	5.343	5.423
50	2033.5	0.090	0.282	0.468	0.648	0.824	0.995	1.161	1.324	1.484	1.642		5.160	5.258	5.346	5.428	5.506
45	1782.3	0.090	0.282	0.469	0.649	0.825	0.995	1.162	1.325	1.485	1.643	5.158	5.259	5.350	5.434	5.513	5.588
40	1555.3	0.091	0.283	0.469	0.650	0.825	0.996	1.163	1.326	1.486		5.260	5.354	5.441	5.521	5.597	5.670
35	1350.8	0.091	0.283	0.470	0.650	0.826	0.997	1.164	1.327	1.487	5.262	5.359	5.448	5.531	5.608	5.682	5.752
30	1167.4	0.092	0.284	0.470	0.651	0.827	0.998	1.164	1.328		5.364	5.456	5.541	5.620	5.695	5.766	5.835
25	1003.5	0.092	0.284	0.471	0.651	0.827	0.998	1.165	1.328	5.370	5.465	5.552	5.633	5.709	5.782	5.852	5.919
20	857.8	0.093	0.285	0.471	0.652	0.828	0.999	1.165		5.474	5.563	5.647	5.725	5.799	5.871	5.939	6.005
15	728.8	0.093	0.285	0.471	0.652	0.828	0.999	1.166	5.484	5.576	5.662	5.742	5.818	5.891	5.960	6.028	6.093
10	615.3	0.093	0.285	0.472	0.653	0.828	0.999		5.590	5.678	5.761	5.838	5.912	5.983	6.052	6.118	6.182
5	516.0	0.093	0.286	0.472	0.653	0.829	1.000	5.605	5.696	5.780	5.860	5.936	6.008	6.078	6.145	6.211	6.274
0	429.6	0.094	0.286	0.472	0.653	0.829		5.715	5.802	5.884	5.961	6.035	6.106	6.175	6.241	6.306	6.369
-5	354.9	0.094	0.286	0.472	0.653	0.829	5.735	5.825	5.909	5.988	6.064	6.137	6.207	6.275	6.340	6.404	6.467
-10	290.8	0.094	0.286	0.473	0.653		5.850	5.936	6.018	6.095	6.170	6.241	6.310	6.377	6.442	6.506	6.568
-15	236.2	0.094	0.286	0.473	0.654	5.876	5.965	6.049	6.129	6.205	6.278	6.349	6.417	6.483	6.548	6.611	6.672
-20	190.1	0.094	0.286	0.473		5.996	6.083	6.165	6.243	6.318	6.390	6.460	6.527	6.593	6.657	6.720	6.781
-25	151.5	0.094	0.287	0.473	6.030	6.119	6.203	6.284	6.360	6.434	6.506	6.575	6.642	6.707	6.771	6.833	6.894
-30	119.4	0.094	0.287		6.158	6.245	6.327	6.406	6.482	6.555	6.626	6.694	6.761	6.826	6.889	6.951	7.012
-35	93.1	0.094	0.287	6.199	6.289	6.374	6.455	6.533	6.608	6.680	6.751	6.819	6.885	6.950	7.013	7.075	7.135
-40	71.7	0.094		6.336	6.424	6.508	6.588	6.665	6.739	6.811	6.881	6.949	7.015	7.079	7.142	7.204	7.264
-45	54.5	0.094	6.386	6.477	6.564	6.647	6.726	6.802	6.876	6.947	7.017	7.084	7.150	7.214	7.277	7.339	7.399
-50	40.8		6.535	6.624	6.709	6.791	6.870	6.946	7.019	7.090	7.159	7.227	7.292	7.356	7.419	7.481	7.541

Fuente: Tillner-Roth, Harms-Watzenberg, and Baehr, *Eine neue Fundamentalgleichung für Ammoniak*, DKV-Tagungsbericht 20:167-181, 1993.

Tabla 3.6: Volumen específico del líquido subenfriado y el vapor sobrecalentado para el R-717

v (m³/kg), R-717, NH₃, Amoniaco

t_{sat} (°C)	P (kPa)	t (°C)															
		-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100
70	3312.0	0.0014	0.0014	0.0015	0.0015	0.0015	0.0016	0.0016	0.0016	0.0017	0.0017	0.0018	0.0018		0.0408	0.0435	0.0459
65	2947.8	0.0014	0.0014	0.0015	0.0015	0.0015	0.0016	0.0016	0.0016	0.0017	0.0017	0.0018	0.0018	0.0446	0.0476	0.0503	0.0528
60	2614.5	0.0014	0.0014	0.0015	0.0015	0.0015	0.0016	0.0016	0.0016	0.0017	0.0017	0.0018		0.0522	0.0553	0.0581	0.0608
55	2310.3	0.0014	0.0014	0.0015	0.0015	0.0015	0.0016	0.0016	0.0016	0.0017	0.0017	0.0018	0.0575	0.0609	0.0642	0.0672	0.0701
50	2033.5	0.0014	0.0014	0.0015	0.0015	0.0015	0.0016	0.0016	0.0016	0.0017	0.0017		0.0674	0.0711	0.0745	0.0778	0.0810
45	1782.3	0.0014	0.0014	0.0015	0.0015	0.0015	0.0016	0.0016	0.0016	0.0017	0.0017	0.0747	0.0789	0.0829	0.0866	0.0902	0.0937
40	1555.3	0.0014	0.0014	0.0015	0.0015	0.0015	0.0016	0.0016	0.0016	0.0017		0.0880	0.0925	0.0968	0.1009	0.1048	0.1087
35	1350.8	0.0014	0.0014	0.0015	0.0015	0.0015	0.0016	0.0016	0.0016	0.0017	0.0984	0.1036	0.1085	0.1132	0.1177	0.1222	0.1265
30	1167.4	0.0014	0.0014	0.0015	0.0015	0.0015	0.0016	0.0016	0.0016		0.1165	0.1222	0.1276	0.1328	0.1379	0.1429	0.1477
25	1003.5	0.0014	0.0014	0.0015	0.0015	0.0015	0.0016	0.0016	0.0016	0.1315	0.1381	0.1444	0.1505	0.1563	0.1621	0.1677	0.1733
20	857.8	0.0014	0.0014	0.0015	0.0015	0.0015	0.0016	0.0016		0.1569	0.1642	0.1713	0.1781	0.1848	0.1913	0.1978	0.2041
15	728.8	0.0014	0.0014	0.0015	0.0015	0.0015	0.0016	0.0016	0.1790	0.1877	0.1959	0.2040	0.2118	0.2194	0.2270	0.2344	0.2418
10	615.3	0.0014	0.0014	0.0015	0.0015	0.0015	0.0016		0.2155	0.2253	0.2348	0.2440	0.2530	0.2619	0.2707	0.2793	0.2879
5	516.0	0.0014	0.0014	0.0015	0.0015	0.0015	0.0016	0.2489	0.2606	0.2718	0.2827	0.2935	0.3040	0.3144	0.3247	0.3348	0.3449
0	429.6	0.0014	0.0014	0.0015	0.0015	0.0015		0.3031	0.3166	0.3296	0.3425	0.3550	0.3675	0.3797	0.3919	0.4040	0.4160
-5	354.9	0.0014	0.0014	0.0015	0.0015	0.0015	0.3548	0.3711	0.3868	0.4023	0.4174	0.4324	0.4472	0.4619	0.4764	0.4909	0.5053
-10	290.8	0.0014	0.0014	0.0015	0.0015		0.4379	0.4571	0.4759	0.4943	0.5125	0.5304	0.5482	0.5659	0.5835	0.6010	0.6184
-15	236.2	0.0014	0.0014	0.0015	0.0015	0.5206	0.5441	0.5671	0.5897	0.6120	0.6340	0.6559	0.6775	0.6991	0.7205	0.7419	0.7632
-20	190.1	0.0014	0.0014	0.0015		0.6528	0.6813	0.7092	0.7368	0.7641	0.7911	0.8179	0.8446	0.8712	0.8977	0.9240	0.9503
-25	151.5	0.0014	0.0014	0.0015	0.7898	0.8254	0.8604	0.8948	0.9289	0.9627	0.9963	1.0297	1.0629	1.0960	1.1290	1.1619	1.1948
-30	119.4	0.0014	0.0014		1.0092	1.0533	1.0969	1.1399	1.1827	1.2251	1.2673	1.3093	1.3512	1.3930	1.4346	1.4762	1.5177
-35	93.1	0.0014	0.0014	1.2458	1.3023	1.3579	1.4130	1.4676	1.5219	1.5759	1.6296	1.6832	1.7367	1.7900	1.8432	1.8964	1.9494
-40	71.7	0.0014		1.6270	1.6991	1.7704	1.8411	1.9113	1.9812	2.0509	2.1203	2.1896	2.2587	2.3277	2.3966	2.4654	2.5341
-45	54.5	0.0014	2.0557	2.1503	2.2438	2.3365	2.4287	2.5205	2.6119	2.7030	2.7940	2.8847	2.9754	3.0659	3.1563	3.2466	3.3368
-50	40.8		2.7547	2.8791	3.0025	3.1252	3.2473	3.3691	3.4904	3.6115	3.7324	3.8532	3.9738	4.0942	4.2146	4.3349	4.4551

Fuente: Tillner-Roth, Harms-Watzenberg, and Baehr, *Eine neue Fundamentalgleichung für Ammoniak*, DKV-Tagungsbericht 20:167-181, 1993.

Tabla 3.7: Entalpía del líquido subenfriado y el vapor sobrecalentado para el R-22

h (kJ/kg), R-22, CHClF₂, Clorodifluorometano

t _{sat} (°C)	P (kPa)	t (°C)															
		-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100
70	2997.7	144.7	155.6	166.6	177.7	189.1	200.6	212.3	224.3	236.7	249.5	262.9	277.2		430.0	441.6	452.2
65	2701.6	144.6	155.5	166.5	177.7	189.0	200.5	212.2	224.3	236.7	249.5	263.0	277.5	423.8	435.5	446.0	456.0
60	2428.1	144.5	155.4	166.4	177.6	188.9	200.4	212.2	224.2	236.7	249.6	263.2		429.4	439.9	449.8	459.3
55	2175.7	144.4	155.3	166.3	177.5	188.8	200.4	212.1	224.2	236.7	249.6	263.3	423.4	433.9	443.7	453.0	462.1
50	1943.3	144.3	155.2	166.2	177.4	188.8	200.3	212.1	224.2	236.7	249.7		428.0	437.7	446.9	455.9	464.7
45	1729.8	144.2	155.1	166.2	177.3	188.7	200.3	212.1	224.2	236.7	249.7	422.1	431.7	440.8	449.7	458.3	466.9
40	1534.1	144.1	155.1	166.1	177.3	188.6	200.2	212.0	224.2	236.7		425.9	434.9	443.6	452.1	460.5	468.9
35	1355.3	144.1	155.0	166.0	177.2	188.6	200.2	212.0	224.2	236.7	420.0	429.0	437.5	445.9	454.2	462.4	470.6
30	1192.3	144.0	154.9	166.0	177.2	188.6	200.1	212.0	224.2		423.1	431.6	439.8	448.0	456.1	464.1	472.2
25	1044.3	144.0	154.9	165.9	177.1	188.5	200.1	212.0	224.2	417.4	425.7	433.8	441.8	449.8	457.7	465.6	473.6
20	910.3	143.9	154.8	165.9	177.1	188.5	200.1	212.0		419.9	427.9	435.8	443.6	451.4	459.1	467.0	474.8
15	789.6	143.9	154.8	165.8	177.1	188.4	200.1	211.9	414.2	422.1	429.8	437.5	445.1	452.8	460.4	468.1	475.9
10	681.2	143.8	154.7	165.8	177.0	188.4	200.0		416.3	423.9	431.4	438.9	446.4	454.0	461.5	469.2	476.9
5	584.3	143.8	154.7	165.8	177.0	188.4	200.0	410.6	418.1	425.5	432.9	440.2	447.6	455.0	462.5	470.1	477.7
0	498.1	143.7	154.7	165.7	177.0	188.4		412.4	419.6	426.8	434.1	441.3	448.6	456.0	463.4	470.9	478.4
-5	421.9	143.7	154.7	165.7	176.9	188.4	406.7	413.8	420.9	428.0	435.1	442.3	449.5	456.8	464.1	471.6	479.1
-10	354.9	143.7	154.6	165.7	176.9		408.1	415.1	422.0	429.0	436.0	443.1	450.3	457.5	464.8	472.2	479.7
-15	296.3	143.7	154.6	165.7	176.9	402.5	409.3	416.1	423.0	429.9	436.8	443.8	450.9	458.1	465.4	472.7	480.2
-20	245.4	143.6	154.6	165.7		403.7	410.3	417.0	423.8	430.6	437.5	444.4	451.5	458.6	465.9	473.2	480.6
-25	201.5	143.6	154.6	165.6	398.1	404.6	411.2	417.8	424.5	431.2	438.1	445.0	452.0	459.1	466.3	473.6	481.0
-30	163.9	143.6	154.6		399.0	405.4	411.9	418.4	425.1	431.8	438.5	445.4	452.4	459.5	466.6	473.9	481.3
-35	132.0	143.6	154.5	393.4	399.7	406.1	412.5	419.0	425.5	432.2	438.9	445.8	452.7	459.8	466.9	474.2	481.5
-40	105.2	143.6		394.1	400.4	406.6	413.0	419.4	425.9	432.6	439.3	446.1	453.0	460.1	467.2	474.4	481.8
-45	82.9	143.6	388.6	394.7	400.9	407.1	413.4	419.8	426.3	432.9	439.6	446.4	453.3	460.3	467.4	474.6	481.9
-50	64.5		389.2	395.2	401.3	407.5	413.7	420.1	426.6	433.1	439.8	446.6	453.5	460.5	467.6	474.8	482.1

Fuente: Wagner W., Marx V. y Prob A. , A New Equation of State for Chlorodifluoromethane covering the entire fluid region from 116 K to 550 K at pressures up to 200 MPa, Int. J. Refrig, 16:373, 1993.

Tabla 3.8: Entropía del líquido subenfriado y el vapor sobrecalentado para el R-22

s (kJ/kg·K), R-22, CHClF₂, Clorodifluormetano

t _{sat} (°C)	P (kPa)	t (°C)															
		-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100
70	2997.7	0.769	0.817	0.863	0.908	0.952	0.995	1.037	1.079	1.120	1.162	1.204	1.248		1.693	1.725	1.754
65	2701.6	0.770	0.818	0.864	0.909	0.953	0.995	1.038	1.080	1.121	1.163	1.205	1.249	1.682	1.716	1.745	1.772
60	2428.1	0.770	0.818	0.864	0.909	0.953	0.996	1.038	1.080	1.122	1.164	1.206		1.706	1.736	1.763	1.789
55	2175.7	0.771	0.818	0.865	0.910	0.954	0.997	1.039	1.081	1.123	1.165	1.208	1.696	1.727	1.755	1.781	1.806
50	1943.3	0.771	0.819	0.865	0.910	0.954	0.997	1.039	1.081	1.123	1.165		1.717	1.746	1.773	1.798	1.821
45	1729.8	0.771	0.819	0.865	0.910	0.954	0.997	1.040	1.082	1.124	1.166	1.708	1.737	1.764	1.790	1.814	1.837
40	1534.1	0.771	0.819	0.866	0.911	0.955	0.998	1.040	1.083	1.125		1.729	1.756	1.782	1.806	1.830	1.853
35	1355.3	0.772	0.820	0.866	0.911	0.955	0.998	1.041	1.083	1.125	1.720	1.748	1.774	1.799	1.823	1.846	1.868
30	1192.3	0.772	0.820	0.866	0.911	0.955	0.999	1.041	1.083		1.740	1.767	1.792	1.816	1.839	1.861	1.883
25	1044.3	0.772	0.820	0.866	0.912	0.956	0.999	1.042	1.084	1.732	1.759	1.784	1.809	1.832	1.855	1.877	1.899
20	910.3	0.772	0.820	0.867	0.912	0.956	0.999	1.042		1.751	1.777	1.802	1.826	1.849	1.871	1.893	1.914
15	789.6	0.772	0.820	0.867	0.912	0.956	0.999	1.042	1.744	1.771	1.796	1.820	1.843	1.866	1.888	1.909	1.930
10	681.2	0.773	0.820	0.867	0.912	0.956	1.000		1.764	1.789	1.814	1.837	1.860	1.882	1.904	1.925	1.946
5	584.3	0.773	0.821	0.867	0.912	0.956	1.000	1.757	1.783	1.808	1.832	1.855	1.877	1.899	1.921	1.942	1.963
0	498.1	0.773	0.821	0.867	0.912	0.957		1.777	1.802	1.826	1.850	1.873	1.895	1.917	1.938	1.959	1.979
-5	421.9	0.773	0.821	0.867	0.913	0.957	1.771	1.797	1.821	1.845	1.868	1.891	1.913	1.934	1.955	1.976	1.997
-10	354.9	0.773	0.821	0.867	0.913		1.792	1.817	1.841	1.864	1.887	1.909	1.931	1.952	1.973	1.994	2.014
-15	296.3	0.773	0.821	0.868	0.913	1.787	1.812	1.837	1.861	1.884	1.906	1.928	1.950	1.971	1.992	2.012	2.033
-20	245.4	0.773	0.821	0.868		1.808	1.833	1.857	1.881	1.903	1.926	1.948	1.969	1.990	2.011	2.031	2.052
-25	201.5	0.773	0.821	0.868	1.804	1.830	1.854	1.878	1.901	1.924	1.946	1.968	1.989	2.010	2.031	2.051	2.071
-30	163.9	0.773	0.821		1.827	1.852	1.876	1.900	1.922	1.945	1.967	1.989	2.010	2.031	2.051	2.072	2.092
-35	132.0	0.773	0.821	1.824	1.850	1.875	1.898	1.922	1.944	1.967	1.989	2.010	2.031	2.052	2.073	2.093	2.113
-40	105.2	0.773		1.848	1.874	1.898	1.922	1.945	1.967	1.989	2.011	2.033	2.054	2.075	2.095	2.115	2.135
-45	82.9	0.773	1.847	1.873	1.898	1.922	1.946	1.968	1.991	2.013	2.035	2.056	2.077	2.098	2.118	2.139	2.159
-50	64.5		1.873	1.899	1.923	1.947	1.970	1.993	2.016	2.038	2.059	2.081	2.102	2.122	2.143	2.163	2.183

Fuente: Wagner W., Marx V. y Prob A. , *A New Equation of State for Chlorodifluoromethane covering the entire fluid region from 116 K to 550 K at pressures up to 200 MPa*, Int. J. Refrig, 16:373, 1993.

Tabla 3.9: Volumen específico del líquido subenfriado y el vapor sobrecalentado para el R-22

v (m³/kg), R-22, CHClF₂, Clorodifluorometano

t_{sat} (°C)	P (kPa)	t (°C)															
		-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100
70	2997.7	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0010		0.0078	0.0085	0.0091
65	2701.6	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0010	0.0083	0.0091	0.0098	0.0105
60	2428.1	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009		0.0099	0.0107	0.0114	0.0120
55	2175.7	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0107	0.0116	0.0124	0.0131	0.0138
50	1943.3	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009		0.0126	0.0135	0.0143	0.0151	0.0158
45	1729.8	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0138	0.0148	0.0157	0.0165	0.0173	0.0181
40	1534.1	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0009		0.0162	0.0172	0.0182	0.0191	0.0200	0.0208
35	1355.3	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0009	0.0179	0.0190	0.0201	0.0211	0.0221	0.0230	0.0239
30	1192.3	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008		0.0210	0.0222	0.0234	0.0245	0.0255	0.0265	0.0275
25	1044.3	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0233	0.0247	0.0260	0.0272	0.0284	0.0296	0.0307	0.0318
20	910.3	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008		0.0275	0.0290	0.0304	0.0318	0.0331	0.0344	0.0357	0.0369
15	789.6	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0308	0.0325	0.0341	0.0357	0.0372	0.0387	0.0401	0.0416	0.0430
10	681.2	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008		0.0366	0.0385	0.0403	0.0420	0.0437	0.0454	0.0470	0.0486	0.0502
5	584.3	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0414	0.0436	0.0456	0.0477	0.0496	0.0515	0.0534	0.0553	0.0571	0.0589
0	498.1	0.0007	0.0007	0.0007	0.0007	0.0008		0.0496	0.0520	0.0543	0.0566	0.0588	0.0610	0.0632	0.0653	0.0675	0.0696
-5	421.9	0.0007	0.0007	0.0007	0.0007	0.0008	0.0567	0.0595	0.0623	0.0649	0.0676	0.0701	0.0727	0.0752	0.0777	0.0801	0.0826
-10	354.9	0.0007	0.0007	0.0007	0.0007		0.0686	0.0718	0.0749	0.0780	0.0811	0.0841	0.0870	0.0900	0.0929	0.0958	0.0987
-15	296.3	0.0007	0.0007	0.0007	0.0007	0.0794	0.0833	0.0870	0.0907	0.0943	0.0979	0.1014	0.1049	0.1084	0.1118	0.1153	0.1187
-20	245.4	0.0007	0.0007	0.0007		0.0972	0.1017	0.1061	0.1105	0.1147	0.1190	0.1232	0.1274	0.1315	0.1356	0.1397	0.1438
-25	201.5	0.0007	0.0007	0.0007	0.1143	0.1198	0.1251	0.1303	0.1355	0.1407	0.1457	0.1508	0.1558	0.1608	0.1658	0.1707	0.1757
-30	163.9	0.0007	0.0007		0.1421	0.1486	0.1550	0.1613	0.1676	0.1738	0.1800	0.1861	0.1923	0.1983	0.2044	0.2105	0.2165
-35	132.0	0.0007	0.0007	0.1700	0.1780	0.1859	0.1937	0.2015	0.2091	0.2168	0.2244	0.2319	0.2394	0.2469	0.2544	0.2619	0.2693
-40	105.2	0.0007		0.2151	0.2250	0.2348	0.2444	0.2540	0.2635	0.2730	0.2825	0.2919	0.3012	0.3106	0.3199	0.3293	0.3386
-45	82.9	0.0007	0.2625	0.2750	0.2873	0.2995	0.3116	0.3237	0.3357	0.3476	0.3595	0.3714	0.3832	0.3950	0.4068	0.4186	0.4303
-50	64.5		0.3396	0.3554	0.3710	0.3865	0.4019	0.4173	0.4326	0.4478	0.4630	0.4782	0.4933	0.5084	0.5235	0.5386	0.5537

Fuente: Wagner W., Marx V. y Prob A. , *A New Equation of State for Chlorodifluoromethane covering the entire fluid region from 116 K to 550 K at pressures up to 200 MPa*, Int. J. Refrig, 16:373, 1993.

Tabla 3.10: Entalpía del líquido subenfriado y el vapor sobrecalentado para el R-134a

h (kJ/kg), R-134a, CH₂F-CF₃, 1,1,1,2-Tetrafluoretano

t _{sat} (°C)	P (kPa)	t (°C)															
		-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100
70	2118.2	136.5	148.9	161.5	174.3	187.2	200.4	213.9	227.6	241.7	256.2	271.3	287.2		443.3	456.3	468.7
65	1891.0	136.4	148.8	161.4	174.2	187.2	200.4	213.8	227.6	241.7	256.3	271.4	287.3	434.9	447.9	460.2	472.0
60	1682.8	136.3	148.8	161.3	174.1	187.1	200.3	213.8	227.6	241.7	256.3	271.5		439.7	451.8	463.4	474.8
55	1492.3	136.2	148.7	161.3	174.1	187.1	200.3	213.8	227.6	241.7	256.3	271.5	431.5	443.5	455.0	466.2	477.3
50	1318.6	136.2	148.6	161.2	174.0	187.0	200.2	213.7	227.5	241.7	256.4		435.4	446.7	457.7	468.6	479.4
45	1160.5	136.1	148.6	161.2	174.0	187.0	200.2	213.7	227.5	241.7	256.4	427.3	438.6	449.4	460.1	470.7	481.3
40	1017.1	136.1	148.5	161.1	173.9	186.9	200.2	213.7	227.5	241.7		430.5	441.2	451.7	462.2	472.6	483.0
35	887.5	136.0	148.5	161.1	173.9	186.9	200.1	213.7	227.5	241.7	422.6	433.2	443.5	453.7	463.9	474.2	484.5
30	770.6	136.0	148.4	161.0	173.8	186.9	200.1	213.6	227.5		425.2	435.4	445.4	455.5	465.5	475.6	485.8
25	665.8	135.9	148.4	161.0	173.8	186.8	200.1	213.6	227.5	417.4	427.4	437.3	447.1	457.0	466.9	476.8	486.9
20	572.1	135.9	148.3	161.0	173.8	186.8	200.1	213.6		419.6	429.3	438.9	448.6	458.3	468.0	477.9	487.9
15	488.7	135.9	148.3	160.9	173.7	186.8	200.0	213.6	411.9	421.4	430.8	440.3	449.8	459.4	469.1	478.9	488.8
10	414.9	135.8	148.3	160.9	173.7	186.8	200.0		413.7	422.9	432.2	441.5	450.9	460.4	470.0	479.7	489.6
5	349.9	135.8	148.3	160.9	173.7	186.7	200.0	406.1	415.1	424.2	433.3	442.5	451.8	461.2	470.8	480.4	490.2
0	293.0	135.8	148.2	160.9	173.7	186.7		407.5	416.4	425.3	434.3	443.4	452.6	462.0	471.4	481.1	490.8
-5	243.5	135.8	148.2	160.8	173.7	186.7	400.0	408.7	417.4	426.2	435.1	444.2	453.3	462.6	472.0	481.6	491.3
-10	200.7	135.7	148.2	160.8	173.7		401.2	409.7	418.3	427.0	435.9	444.8	453.9	463.1	472.5	482.1	491.7
-15	164.0	135.7	148.2	160.8	173.6	393.8	402.1	410.5	419.1	427.7	436.5	445.4	454.4	463.6	473.0	482.5	492.1
-20	132.8	135.7	148.2	160.8		394.7	402.9	411.2	419.7	428.2	437.0	445.8	454.8	464.0	473.3	482.8	492.4
-25	106.5	135.7	148.2	160.8	387.4	395.5	403.6	411.8	420.2	428.7	437.4	446.2	455.2	464.3	473.6	483.1	492.7
-30	84.4	135.7	148.2		388.1	396.1	404.1	412.3	420.6	429.1	437.7	446.5	455.5	464.6	473.9	483.3	492.9
-35	66.2	135.7	148.1	381.0	388.7	396.6	404.5	412.7	421.0	429.4	438.0	446.8	455.7	464.8	474.1	483.5	493.1
-40	51.2	135.7		381.5	389.2	397.0	404.9	413.0	421.2	429.7	438.3	447.0	455.9	465.0	474.2	483.7	493.2
-45	39.1	135.7	374.5	382.0	389.5	397.3	405.2	413.2	421.5	429.9	438.4	447.2	456.1	465.2	474.4	483.8	493.3
-50	29.5		374.9	382.3	389.8	397.5	405.4	413.4	421.7	430.0	438.6	447.3	456.2	465.3	474.5	483.9	493.4

Fuente: R. Tillner-Roth and H.D. Baehr, *An International Standard Formulation for the Thermodynamic Properties of 1,1,1,2-Tetrafluoroethane (HFC-134a) for Temperatures from 170 K to 455 K and Pressures up to 70 MPa*, J. Phys. Chem, Ref. Data, Vol. 23, No. 5, 1994.

Tabla 3.11: Entropía del líquido subenfriado y el vapor sobrecalentado para el R-134a

s (kJ/kg·K), R-134a, CH₂F-CF₃, 1,1,1,2-Tetrafluoretano

t _{sat} (°C)	P (kPa)	t (°C)															
		-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100
70	2118.2	0.738	0.793	0.846	0.897	0.947	0.996	1.045	1.092	1.140	1.187	1.234	1.283		1.738	1.774	1.808
65	1891.0	0.739	0.793	0.846	0.897	0.948	0.997	1.045	1.093	1.140	1.188	1.235	1.284	1.720	1.758	1.792	1.824
60	1682.8	0.739	0.793	0.846	0.898	0.948	0.997	1.046	1.094	1.141	1.188	1.236		1.741	1.776	1.808	1.839
55	1492.3	0.739	0.794	0.846	0.898	0.948	0.998	1.046	1.094	1.141	1.189	1.237	1.724	1.760	1.793	1.824	1.854
50	1318.6	0.739	0.794	0.847	0.898	0.949	0.998	1.046	1.094	1.142	1.189		1.744	1.777	1.809	1.839	1.869
45	1160.5	0.739	0.794	0.847	0.899	0.949	0.998	1.047	1.095	1.142	1.190	1.727	1.762	1.794	1.824	1.854	1.883
40	1017.1	0.740	0.794	0.847	0.899	0.949	0.999	1.047	1.095	1.143		1.746	1.779	1.810	1.840	1.869	1.897
35	887.5	0.740	0.794	0.847	0.899	0.949	0.999	1.047	1.095	1.143	1.730	1.763	1.795	1.825	1.854	1.883	1.911
30	770.6	0.740	0.795	0.848	0.899	0.950	0.999	1.048	1.096		1.748	1.780	1.811	1.840	1.869	1.897	1.925
25	665.8	0.740	0.795	0.848	0.899	0.950	0.999	1.048	1.096	1.733	1.766	1.797	1.827	1.856	1.884	1.912	1.939
20	572.1	0.740	0.795	0.848	0.900	0.950	0.999	1.048		1.751	1.782	1.813	1.842	1.871	1.899	1.927	1.954
15	488.7	0.740	0.795	0.848	0.900	0.950	1.000	1.048	1.736	1.768	1.799	1.829	1.858	1.886	1.914	1.941	1.968
10	414.9	0.740	0.795	0.848	0.900	0.950	1.000		1.754	1.786	1.816	1.845	1.874	1.902	1.929	1.956	1.983
5	349.9	0.741	0.795	0.848	0.900	0.950	1.000	1.741	1.772	1.803	1.832	1.861	1.889	1.917	1.945	1.972	1.998
0	293.0	0.741	0.795	0.848	0.900	0.950		1.759	1.790	1.820	1.849	1.878	1.906	1.933	1.961	1.987	2.014
-5	243.5	0.741	0.795	0.848	0.900	0.951	1.746	1.777	1.808	1.837	1.866	1.894	1.922	1.950	1.977	2.004	2.030
-10	200.7	0.741	0.795	0.848	0.900		1.765	1.796	1.826	1.855	1.883	1.912	1.939	1.967	1.994	2.020	2.047
-15	164.0	0.741	0.795	0.849	0.900	1.753	1.784	1.814	1.844	1.873	1.901	1.929	1.957	1.984	2.011	2.037	2.064
-20	132.8	0.741	0.795	0.849		1.773	1.803	1.833	1.863	1.891	1.920	1.948	1.975	2.002	2.029	2.055	2.081
-25	106.5	0.741	0.796	0.849	1.762	1.793	1.823	1.853	1.882	1.911	1.939	1.966	1.994	2.021	2.048	2.074	2.100
-30	84.4	0.741	0.796		1.783	1.814	1.844	1.873	1.902	1.930	1.958	1.986	2.013	2.040	2.067	2.093	2.119
-35	66.2	0.741	0.796	1.773	1.804	1.835	1.865	1.894	1.923	1.951	1.979	2.007	2.034	2.061	2.087	2.114	2.140
-40	51.2	0.741		1.796	1.827	1.857	1.886	1.916	1.944	1.972	2.000	2.028	2.055	2.082	2.108	2.135	2.161
-45	39.1	0.741	1.788	1.819	1.850	1.880	1.909	1.938	1.967	1.995	2.023	2.050	2.077	2.104	2.131	2.157	2.183
-50	29.5		1.812	1.843	1.874	1.904	1.933	1.962	1.990	2.018	2.046	2.074	2.101	2.127	2.154	2.180	2.206

Fuente: R. Tillner-Roth and H.D. Baehr, *An International Standard Formulation for the Thermodynamic Properties of 1,1,1,2-Tetrafluoroethane (HFC-134a) for Temperatures from 170 K to 455 K and Pressures up to 70 MPa*, J. Phys. Chem, Ref. Data, Vol. 23, No. 5, 1994.

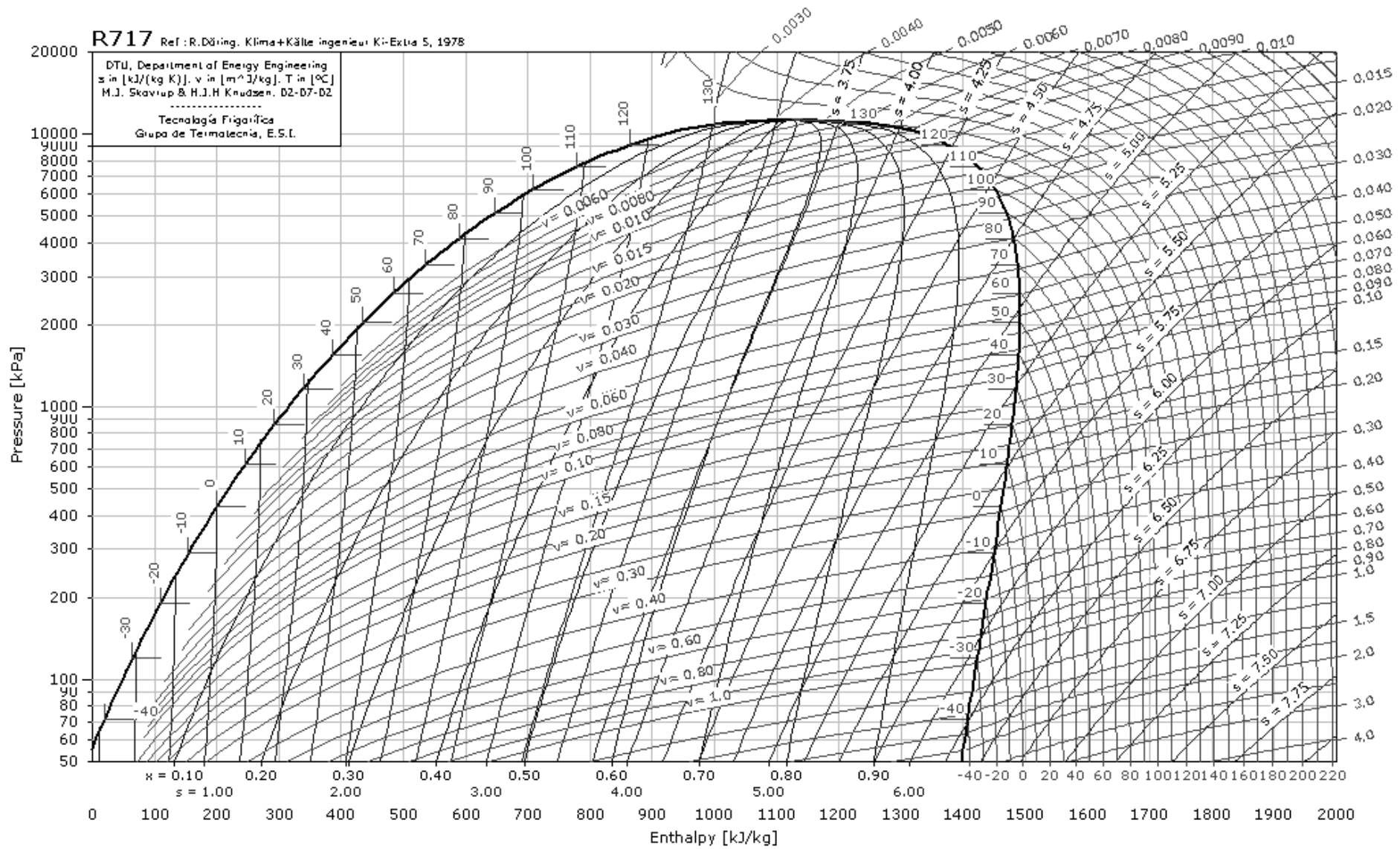
Tabla 3.12: Volumen específico del líquido subenfriado y el vapor sobrecalentado para el R-134a

v (m³/kg), R-134a, CH₂F-CF₃, 1,1,1,2-Tetrafluoretano

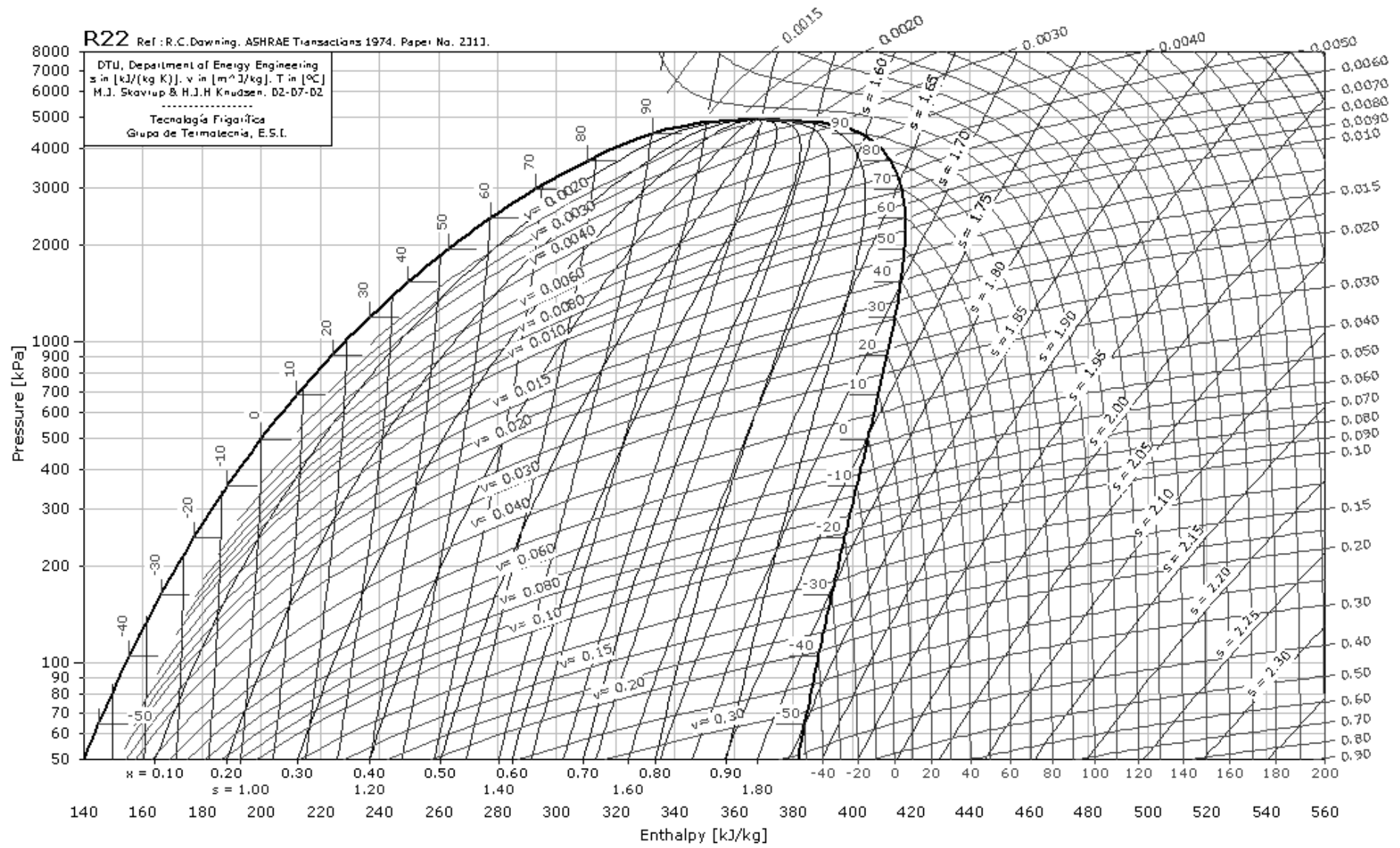
t_{sat} (°C)	P (kPa)	t (°C)															
		-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100
70	2118.2	0.0007	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0009		0.0097	0.0105	0.0112
65	1891.0	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0009	0.0009	0.0105	0.0114	0.0123	0.0130
60	1682.8	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0009		0.0125	0.0134	0.0143	0.0151
55	1492.3	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0009	0.0137	0.0148	0.0157	0.0166	0.0174
50	1318.6	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0009		0.0163	0.0173	0.0183	0.0193	0.0201	
45	1160.5	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0009	0.0180	0.0192	0.0203	0.0214	0.0224	0.0233	
40	1017.1	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008		0.0213	0.0226	0.0238	0.0249	0.0260	0.0270	
35	887.5	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0238	0.0252	0.0266	0.0279	0.0291	0.0303	0.0314	
30	770.6	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008		0.0283	0.0298	0.0313	0.0327	0.0340	0.0354	0.0366	
25	665.8	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0318	0.0336	0.0353	0.0369	0.0384	0.0400	0.0414	0.0429	
20	572.1	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008		0.0380	0.0400	0.0418	0.0436	0.0454	0.0471	0.0487	0.0504	
15	488.7	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0432	0.0455	0.0476	0.0497	0.0517	0.0537	0.0557	0.0576	0.0595	
10	414.9	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008		0.0520	0.0546	0.0570	0.0594	0.0617	0.0639	0.0662	0.0684	0.0705
5	349.9	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0599	0.0628	0.0657	0.0685	0.0712	0.0738	0.0765	0.0791	0.0816	0.0842
0	293.0	0.0007	0.0007	0.0007	0.0007	0.0008		0.0728	0.0762	0.0794	0.0827	0.0858	0.0889	0.0920	0.0950	0.0981	0.1011
-5	243.5	0.0007	0.0007	0.0007	0.0007	0.0008	0.0848	0.0889	0.0928	0.0966	0.1004	0.1041	0.1078	0.1114	0.1150	0.1186	0.1222
-10	200.7	0.0007	0.0007	0.0007	0.0007		0.1044	0.1091	0.1137	0.1183	0.1228	0.1272	0.1316	0.1359	0.1402	0.1445	0.1488
-15	164.0	0.0007	0.0007	0.0007	0.0007	0.1235	0.1293	0.1349	0.1404	0.1458	0.1512	0.1565	0.1618	0.1671	0.1723	0.1775	0.1827
-20	132.8	0.0007	0.0007	0.0007		0.1544	0.1612	0.1680	0.1747	0.1813	0.1878	0.1943	0.2007	0.2072	0.2135	0.2199	0.2262
-25	106.5	0.0007	0.0007	0.0007	0.1859	0.1944	0.2028	0.2110	0.2192	0.2273	0.2354	0.2434	0.2513	0.2593	0.2672	0.2751	0.2829
-30	84.4	0.0007	0.0007		0.2365	0.2470	0.2574	0.2676	0.2778	0.2879	0.2979	0.3079	0.3179	0.3278	0.3377	0.3476	0.3575
-35	66.2	0.0007	0.0007	0.2906	0.3039	0.3171	0.3301	0.3430	0.3558	0.3686	0.3813	0.3939	0.4065	0.4191	0.4317	0.4442	0.4567
-40	51.2	0.0007		0.3780	0.3948	0.4116	0.4282	0.4446	0.4611	0.4774	0.4937	0.5099	0.5261	0.5423	0.5585	0.5746	0.5907
-45	39.1	0.0007	0.4755	0.4975	0.5193	0.5409	0.5624	0.5838	0.6051	0.6263	0.6475	0.6687	0.6898	0.7109	0.7320	0.7530	0.7740
-50	29.5		0.6347	0.6635	0.6921	0.7205	0.7488	0.7771	0.8052	0.8333	0.8613	0.8893	0.9172	0.9452	0.9730	1.0009	1.0287

Fuente: R. Tillner-Roth and H.D. Baehr, *An International Standard Formulation for the Thermodynamic Properties of 1,1,1,2-Tetrafluoroethane (HFC-134a) for Temperatures from 170 K to 455 K and Pressures up to 70 MPa*, J. Phys. Chem, Ref. Data, Vol. 23, No. 5, 1994.

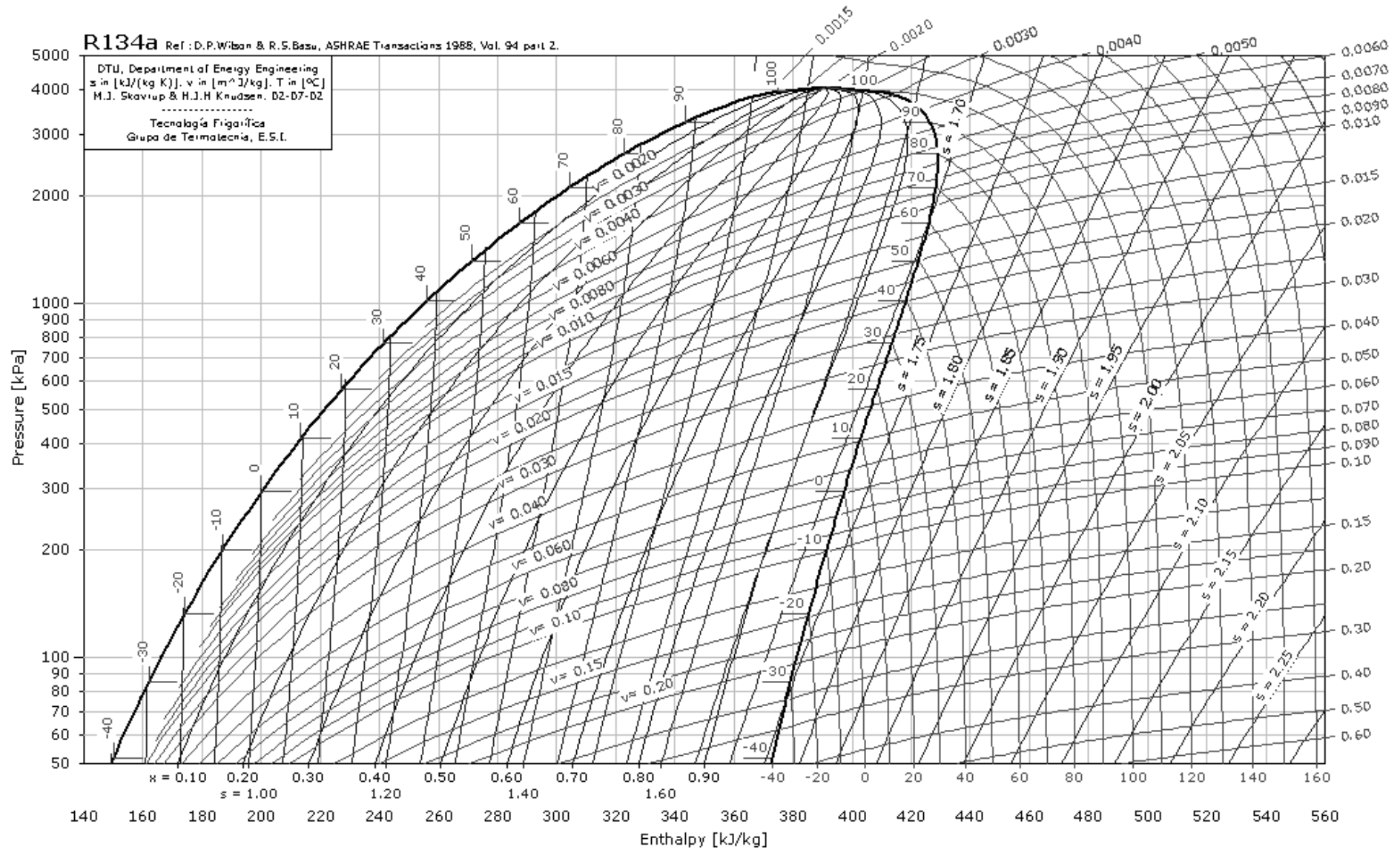
Gráfica 3.1: Diagrama p-h del R-717



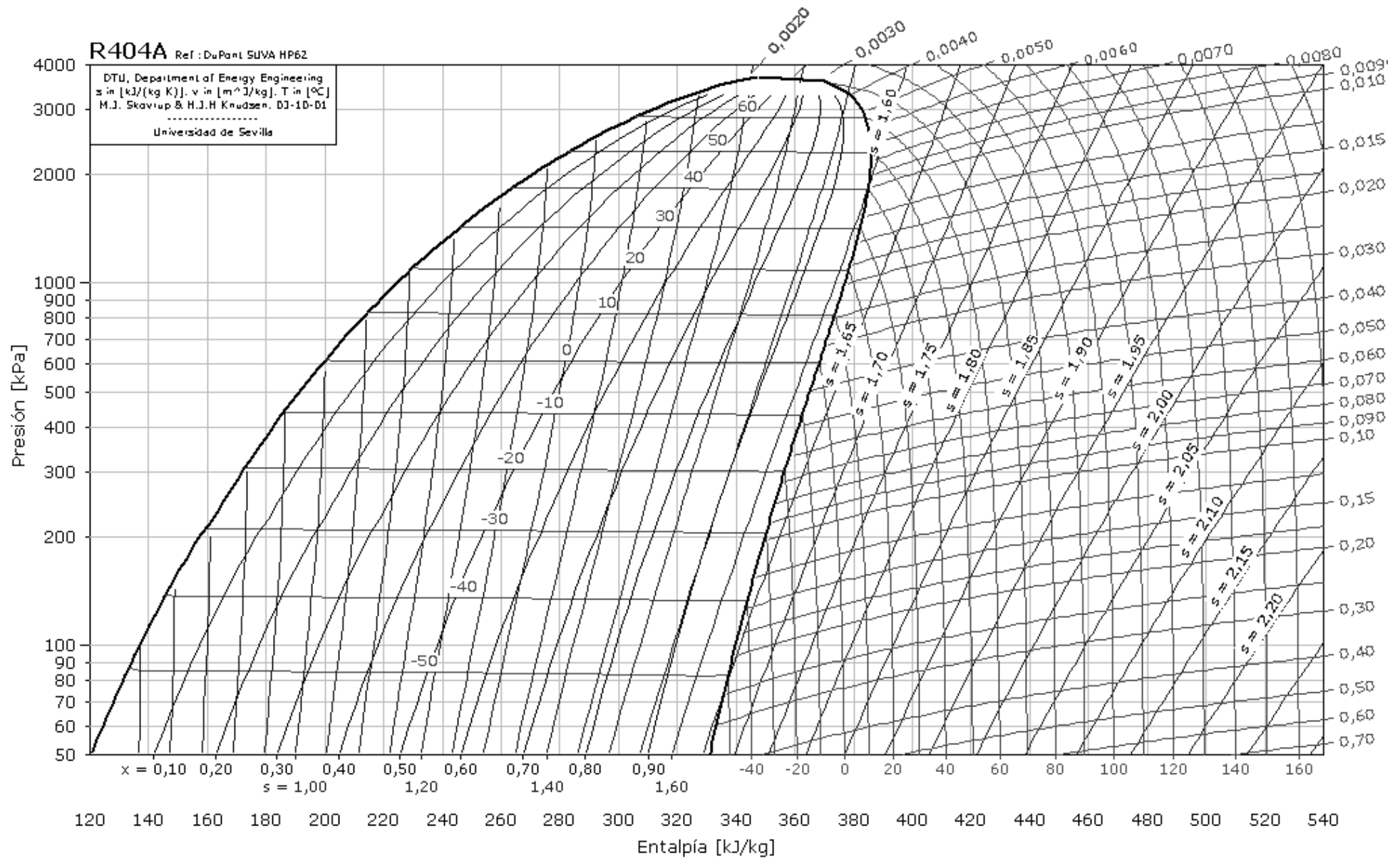
Gráfica 3.2: Diagrama p-h del R-22



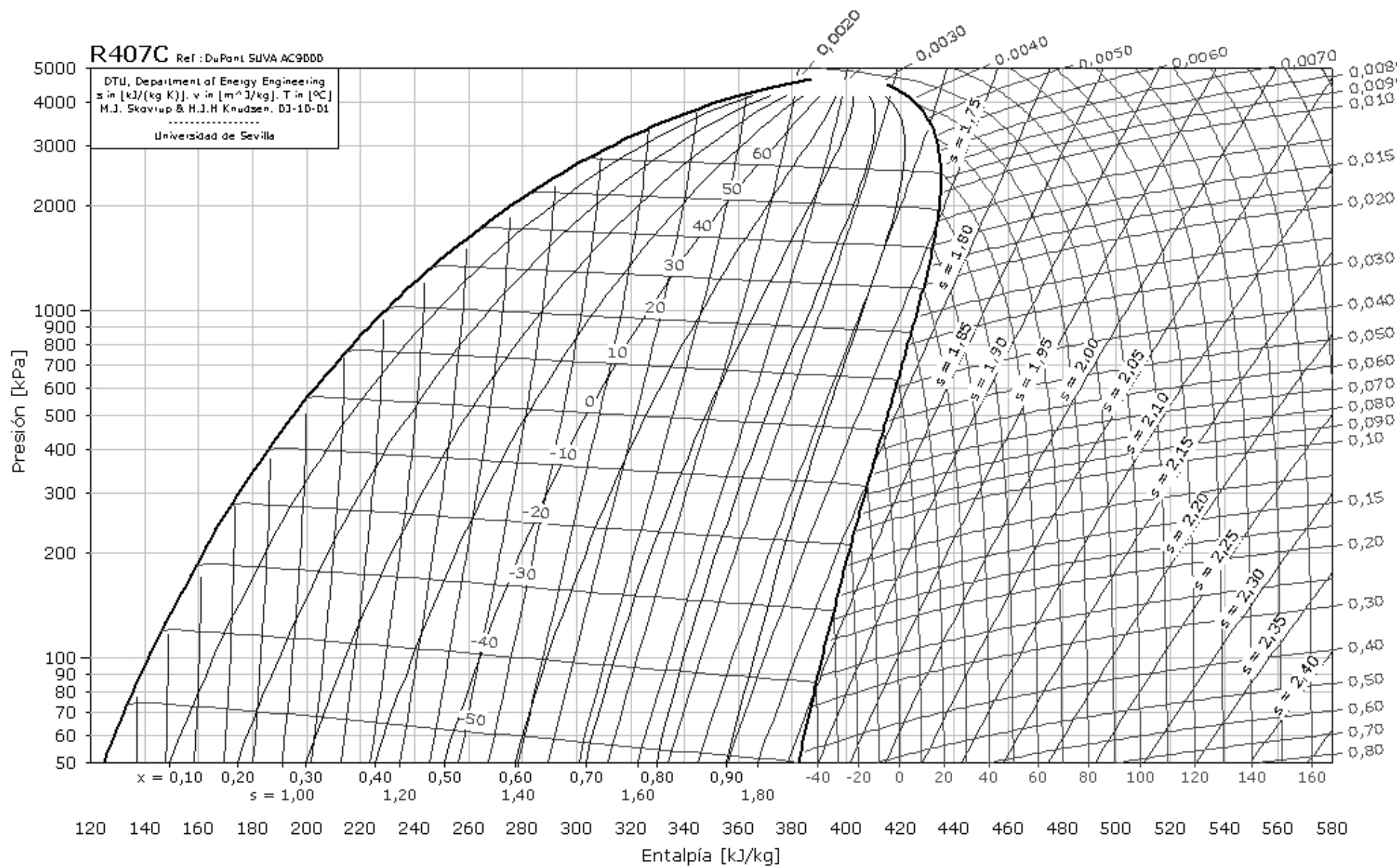
Gráfica 3.3: Diagrama p-h del R-134a



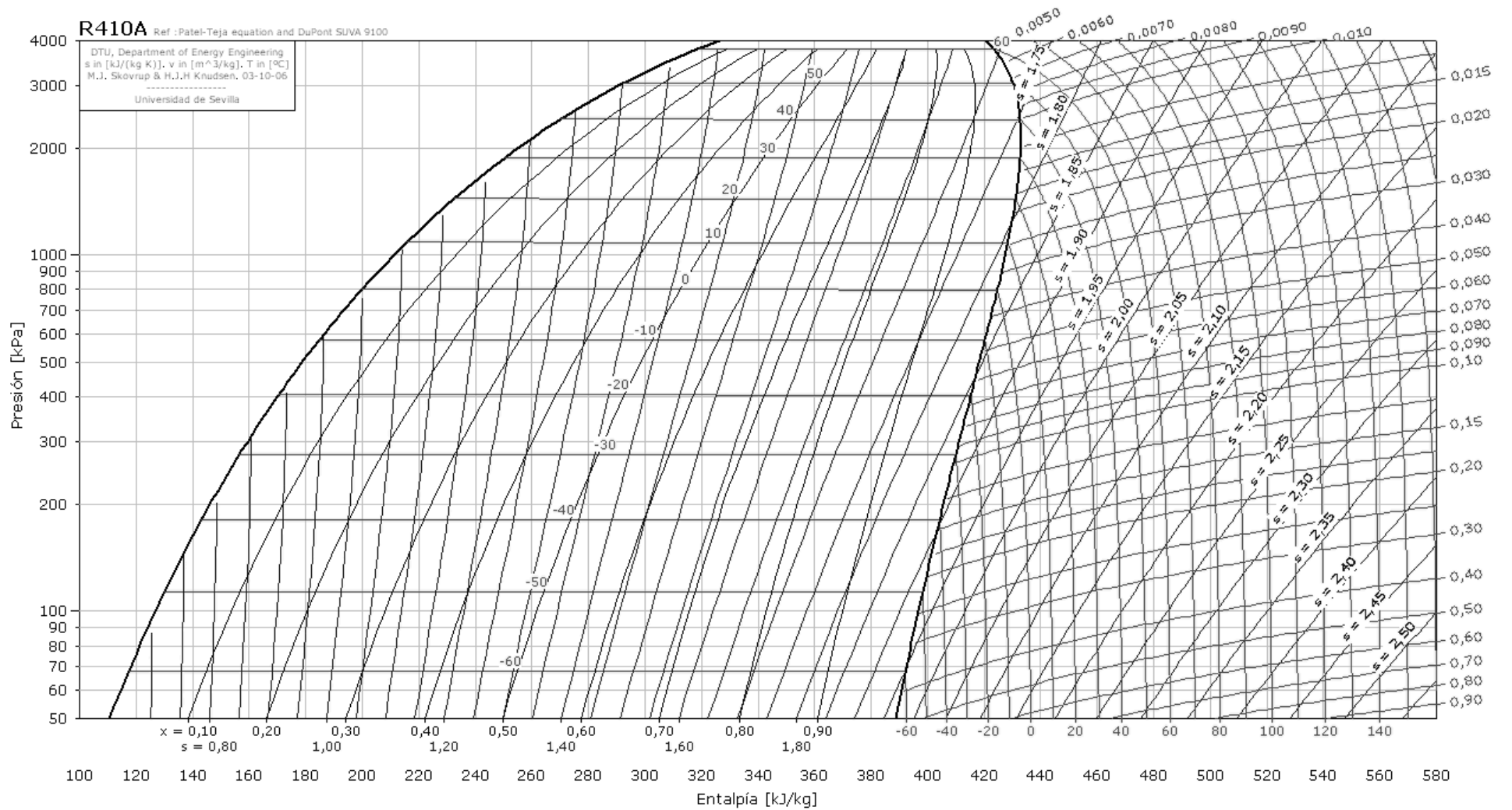
Gráfica 3.4: Diagrama p-h del R-404A



Gráfica 3.5: Diagrama p-h del R-407C



Gráfica 3.6: Diagrama p-h del R-410A



4. Tuberías y accesorios para refrigerantes

Tabla 4.1: Dimensiones normalizadas en tuberías comerciales de cobre para refrigerantes

Medida	Dext (pulgada)	Dext (mm)	Rollo de tubo				Barra de tubo			
			esp (pulgada)	esp (mm)	Dint (pulgada)	Dint (mm)	esp (pulgada)	esp (mm)	Dint (pulgada)	Dint (mm)
3/16"	0.1875	4.763	0.030	0.762	0.1275	3.239				
1/4"	0.2500	6.350	0.030	0.762	0.1900	4.826				
5/16"	0.3125	7.938	0.030	0.762	0.2525	6.414				
3/8"	0.3750	9.525	0.030	0.762	0.3150	8.001	0.030	0.762	0.315	8.001
1/2"	0.5000	12.700	0.030	0.762	0.4400	11.176	0.030	0.762	0.440	11.176
5/8"	0.6250	15.875	0.032	0.813	0.5610	14.249	0.030	0.762	0.565	14.351
3/4"	0.7500	19.050	0.035	0.889	0.6800	17.272	0.032	0.813	0.686	17.424
7/8"	0.8750	22.225	0.035	0.889	0.8050	20.447	0.032	0.813	0.811	20.599
1"	1.0000	25.400					0.035	0.889	0.930	23.622
1-1/8"	1.1250	28.575					0.040	1.016	1.045	26.543
1-3/8"	1.3750	34.925					0.042	1.067	1.291	32.791
1-5/8"	1.6250	41.275					0.050	1.270	1.525	38.735
2-1/8"	2.1250	53.975					0.060	1.524	2.005	50.927
2-5/8"	2.6250	66.675					0.071	1.803	2.483	63.068
3-1/8"	3.1250	79.375					0.071	1.803	2.983	75.768
3-5/8"	3.6250	92.075					0.080	2.032	3.465	88.011

Fuente: Tarifas Salvador Escoda S.A., Mayo 2001

Tabla 4.2: Dimensiones normalizadas en tuberías comerciales de acero para refrigerantes

Medida	Dext (mm)	esp (mm)	Dint (mm)
1/8"	10.2	2.00	6.2
1/4"	13.5	2.35	8.8
3/8"	17.2	2.35	12.5
1/2"	21.3	2.65	16.0
3/4"	26.9	2.65	21.6
1"	33.7	3.25	27.2
1-1/4"	42.4	3.25	35.9
1-1/2"	48.3	3.25	41.8
2"	60.3	3.65	53.0
2-1/2"	76.1	3.65	68.8
3"	88.9	4.05	80.8
3-1/2"	101.6	4.05	93.5
4"	114.3	4.50	105.3
5"	139.7	4.85	130.0
6"	165.1	4.85	155.4

Fuente: Acero norma DIN 2440

Gráfica 4.1: Ábaco de Moody

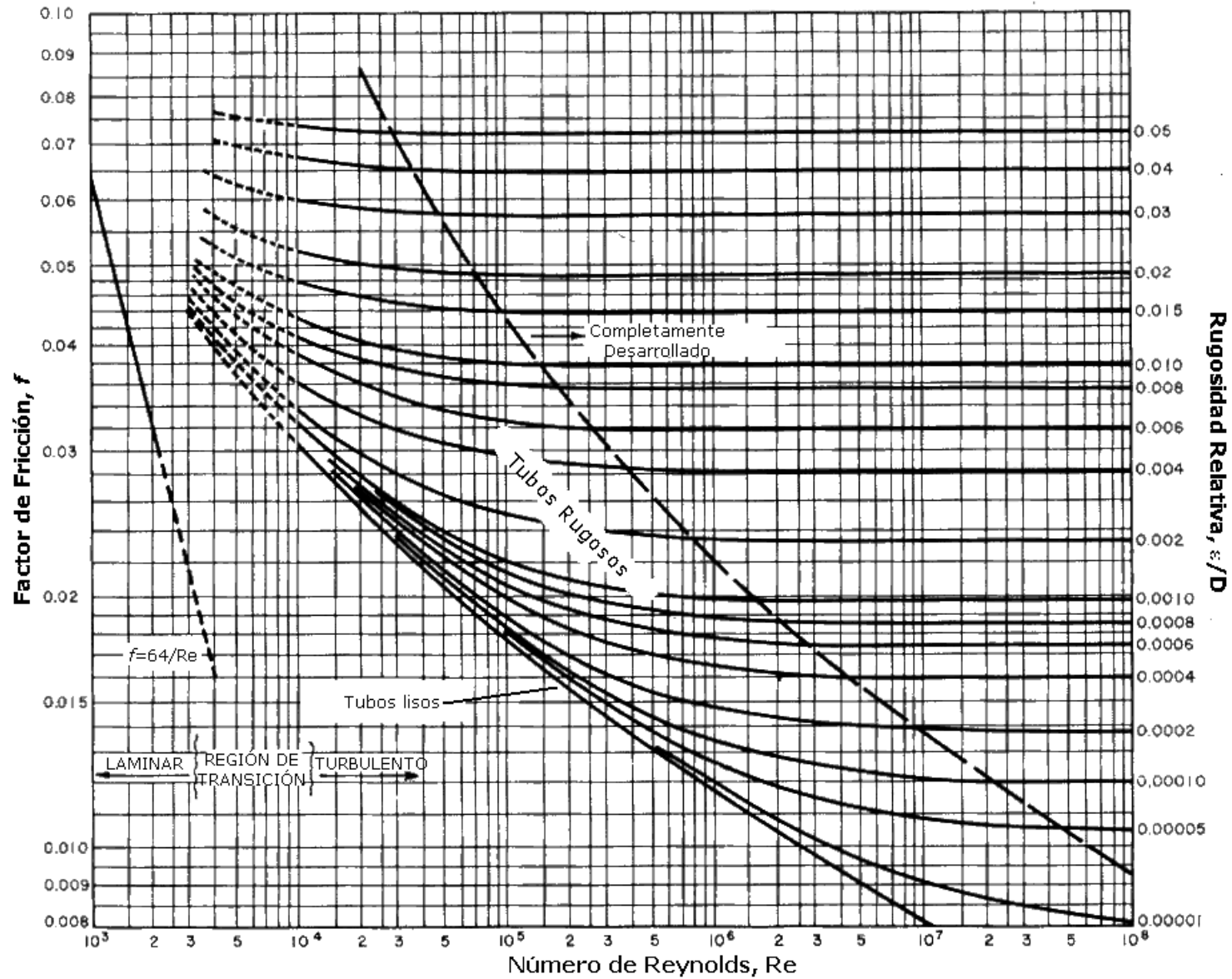


Tabla 4.3: Coeficiente K de pérdida de presión en válvulas y accesorios

Tuberías roscadas

Diámetro nóminal (mm)	Codo 90°	Curva 90°	Codo 45°	Codo doble 180°	T en ramas alineadas	T en ramas de derivación	Válvula esférica	Válvula de compuerta	Válvula de ángulo	Válvula de retención
10	2.50	-	0.38	2.50	0.90	2.70	20.00	0.40	-	8.00
15	2.10	-	0.37	2.10	0.90	2.40	14.00	0.33	-	5.50
20	1.70	0.92	0.35	1.70	0.90	2.10	10.00	0.28	6.10	3.70
25	1.50	0.78	0.34	1.50	0.90	1.80	9.00	0.24	4.60	3.00
32	1.30	0.65	0.33	1.30	0.90	1.70	8.50	0.22	3.60	2.70
40	1.20	0.54	0.32	1.20	0.90	1.60	8.00	0.19	2.90	2.50
50	1.00	0.42	0.31	1.00	0.90	1.40	7.00	0.17	2.10	2.30
65	0.85	0.35	0.30	0.85	0.90	1.30	6.50	0.16	1.60	2.20
80	0.80	0.31	0.29	0.80	0.90	1.20	6.00	0.14	1.30	2.10
100	0.70	0.24	0.28	0.70	0.90	1.10	5.70	0.12	1.00	2.00

Tuberías soldadas

Diámetro nóminal (mm)	Codo 90°	Curva 90°	Curva 45°	Codo doble 180°	T en ramas alineadas	T en ramas de derivación	Válvula esférica	Válvula de compuerta	Válvula de ángulo	Válvula de retención
25	0.43	0.41	0.22	0.43	0.26	1.00	13.00	-	4.80	2.00
32	0.41	0.37	0.22	0.41	0.25	0.95	12.00	-	3.70	2.00
40	0.40	0.35	0.21	0.40	0.23	0.90	10.00	-	3.00	2.00
50	0.38	0.30	0.20	0.38	0.20	0.84	9.00	0.34	2.50	2.00
65	0.35	0.28	0.19	0.35	0.18	0.79	8.00	0.27	2.30	2.00
80	0.34	0.25	0.18	0.34	0.17	0.76	7.00	0.22	2.20	2.00
100	0.31	0.22	0.18	0.31	0.15	0.70	6.50	0.16	2.10	2.00
150	0.29	0.18	0.17	0.29	0.12	0.62	6.00	0.10	2.10	2.00
200	0.27	0.16	0.17	0.27	0.10	0.58	5.70	0.08	2.10	2.00
250	0.25	0.14	0.16	0.25	0.09	0.53	5.70	0.06	2.10	2.00
300	0.24	0.13	0.16	0.24	0.08	0.50	5.70	0.05	2.10	2.00

Fuente: Fundamentals ASHRAE - 1997, Capítulo 33.

Tabla 4.4: Longitudes equivalentes (m) de pérdida de presión en válvulas y accesorios

Tuberías de acero comercial

Diámetro nóminal (mm)	Codo 90°	Curva 90°	Codo 45°	Codo doble 180°	T en ramas alineadas	T en ramas de derivación	Válvula esférica	Válvula de compuerta	Válvula de ángulo	Válvula de retención
1/2"	0.48	0.24	0.25	0.80	0.33	0.98	5.44	0.13	2.40	1.60
3/4"	0.65	0.32	0.35	1.08	0.44	1.33	7.34	0.17	3.24	2.15
1"	0.82	0.41	0.43	1.36	0.55	1.64	9.25	0.22	4.08	2.72
1-1/4"	1.01	0.54	0.57	1.80	0.74	2.22	12.21	0.29	5.39	3.59
1-1/2"	1.25	0.63	0.67	2.09	0.86	2.57	14.21	0.33	6.27	4.18
2"	1.59	0.79	0.85	2.65	1.04	3.12	18.02	0.42	7.95	5.30
2-1/2"	2.06	1.03	1.10	3.44	1.36	4.08	23.39	0.55	10.32	6.87
3"	2.42	1.21	1.29	4.04	1.66	4.98	27.47	0.65	12.12	8.07
4"	3.16	1.58	1.68	5.27	2.17	6.51	35.80	0.84	15.80	10.52
5"	3.90	1.95	2.08	6.50	2.64	7.92	44.20	1.04	19.50	13.00
6"	4.66	2.33	2.49	7.70	3.07	9.22	52.84	1.24	23.31	15.54

Tuberías de cobre

Diámetro nóminal (mm)	Codo 90°	Curva 90°	Curva 45°	Codo doble 180°	T en ramas alineadas	T en ramas de derivación	Válvula esférica	Válvula de compuerta	Válvula de ángulo	Válvula de retención
1/2"	0.33	0.17	0.10	0.56	0.22	0.67	3.79	0.09	1.67	1.12
5/8"	0.43	0.22	0.13	0.72	0.29	0.87	4.92	0.12	2.17	1.45
7/8"	0.62	0.31	0.19	1.04	0.42	1.25	7.07	0.17	3.12	2.08
1-1/8"	0.83	0.41	0.26	1.38	0.55	1.66	9.39	0.22	4.14	2.76
1-3/8"	1.01	0.51	0.31	1.69	0.68	2.03	11.49	0.27	5.07	3.38
1-5/8"	1.21	0.60	0.37	2.02	0.81	2.42	13.72	0.32	6.05	4.03
2-1/8"	1.61	0.80	0.49	2.68	1.07	3.21	18.21	0.43	8.03	5.35
2-5/8"	2.01	1.00	0.62	3.35	1.34	4.02	22.78	0.54	10.05	6.70

Fuente: "Cálculos en Instalaciones Frigoríficas", J.M. Pinazo Ojer, Universidad Politécnica de Valencia

Tabla 4.5: Velocidades máximas recomendadas (m/s) en depósitos de separación líquido/vapor

Refrigerante	Distancia Vertical (m)	Temperatura de saturación (°C)				
		-57	-40	-23	-7	10
R-22	0.25	0.33	0.21	0.14	0.10	0.07
	0.61	1.36	0.88	0.61	0.44	0.31
	0.91	1.57	1.04	0.72	0.52	0.39
Amoniaco	0.25	0.80	0.48	0.31	0.21	0.15
	0.61	3.30	1.99	1.29	0.88	0.64
	0.91	3.54	2.17	1.43	0.99	0.71

Nota: La distancia vertical es la distancia en vertical entre la entrada al depósito y la salida del mismo

Fuente: ASHRAE Handbook, Refrigeration Systems and Applications

Gráfica 4.2: Variación de la presión asociada a la variación de temperatura de saturación en refrigerantes

