

# REFRIGERANTE 134a SISTEMA INGLÉS

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APÉNDICE 2

**TABLA A.11E**

Refrigerante 134a saturado - Tabla de temperatura

Temp., $T$ °F	Pres., $P_{sat}$ psia	Volumen específico, ft <sup>3</sup> /lbm		Energía interna, Btu/lbm		Entalpía, Btu/lbm			Entropía, Btu/lbm · R	
		Líqu. sat., $v_f$	Vap. sat., $v_g$	Líqu. sat., $u_f$	Vap. sat., $u_g$	Líqu. sat., $h_f$	Evap., $h_{fg}$	Vap. sat., $h_g$	Líqu. sat., $s_f$	Vap. sat., $s_g$
-40	7.490	0.01130	5.7173	-0.02	87.90	0.00	95.82	95.82	0.0000	0.2283
-30	9.920	0.01143	4.3911	2.81	89.26	2.83	94.49	97.32	0.0067	0.2266
-20	12.949	0.01156	3.4173	5.69	90.62	5.71	93.10	98.81	0.0133	0.2250
-15	14.718	0.01163	3.0286	7.14	91.30	7.17	92.38	99.55	0.0166	0.2243
-10	16.674	0.01170	2.6918	8.61	91.98	8.65	91.64	100.29	0.0199	0.2236
-5	18.831	0.01178	2.3992	10.09	92.66	10.13	90.89	101.02	0.0231	0.2230
0	21.203	0.01185	2.1440	11.58	93.33	11.63	90.12	101.75	0.0264	0.2224
5	23.805	0.01193	1.9208	13.09	94.01	13.14	89.33	102.47	0.0296	0.2219
10	26.651	0.01200	1.7251	14.60	94.68	14.66	88.53	103.19	0.0329	0.2214
15	29.756	0.01208	1.5529	16.13	95.35	16.20	87.71	103.90	0.0361	0.2209
20	33.137	0.01216	1.4009	17.67	96.02	17.74	86.87	104.61	0.0393	0.2205
25	36.809	0.01225	1.2666	19.22	96.69	19.30	86.02	105.32	0.0426	0.2200
30	40.788	0.01233	1.1474	20.78	97.35	20.87	85.14	106.01	0.0458	0.2196
40	49.738	0.01251	0.9470	23.94	98.67	24.05	83.34	107.39	0.0522	0.2189
50	60.125	0.01270	0.7871	27.14	99.98	27.28	81.46	108.74	0.0585	0.2183
60	72.092	0.01290	0.6584	30.39	101.27	30.56	79.49	110.05	0.0648	0.2178
70	85.788	0.01311	0.5538	33.68	102.54	33.89	77.44	111.33	0.0711	0.2173
80	101.37	0.01334	0.4682	37.02	103.78	37.27	75.29	112.56	0.0774	0.2169
85	109.92	0.01346	0.4312	38.72	104.39	38.99	74.17	113.16	0.0805	0.2167
90	118.99	0.01358	0.3975	40.42	105.00	40.72	73.03	113.75	0.0836	0.2165
95	128.62	0.01371	0.3668	42.14	105.60	42.47	71.86	114.33	0.0867	0.2163
100	138.83	0.01385	0.3388	43.87	106.18	44.23	70.66	114.89	0.0898	0.2161
105	149.63	0.01399	0.3131	45.62	106.76	46.01	69.42	115.43	0.0930	0.2159
110	161.04	0.01414	0.2896	47.39	107.33	47.81	68.15	115.96	0.0961	0.2157
115	173.10	0.01429	0.2680	49.17	107.88	49.63	66.84	116.47	0.0992	0.2155
120	185.82	0.01445	0.2481	50.97	108.42	51.47	65.48	116.95	0.1023	0.2153
140	243.86	0.01520	0.1827	58.39	110.41	59.08	59.57	118.65	0.1150	0.2143
160	314.63	0.01617	0.1341	66.26	111.97	67.20	52.58	119.78	0.1280	0.2128
180	400.22	0.01758	0.0964	74.83	112.77	76.13	43.78	119.91	0.1417	0.2101
200	503.52	0.02014	0.0647	84.90	111.66	86.77	30.92	117.69	0.1575	0.2044
210	563.51	0.02329	0.0476	91.84	108.48	94.27	19.18	113.45	0.1684	0.1971

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Fuente: Las tablas A.11E a A.13E: M. J. Moran y H. N. Shapiro, *Fundamentals of Engineering Thermodynamics*, 2a. ed. (Nueva York: John Wiley & Sons, 1992), pp. 754-758. Basadas originalmente en las ecuaciones de D. P. Wilson y R. S. Basu, "Thermodynamics Properties of a New Stratospherically Safe Working Fluid-Refrigerant 134a", *ASHRAE Trans.* 94, Pt. 2 (1988), pp. 2095-2118. Empleadas con permiso de los autores.

**TABLA A.12E**

Refrigerante 134a saturado - Tabla de presiones

Pres., <i>P</i> psia	Temp., <i>T</i> <sub>sat</sub> °F	Volumen específico, ft <sup>3</sup> /lbm		Energía interna, Btu/lbm		Entalpía, Btu/lbm			Entropía, Btu/lbm · R	
		Líquido, <i>v</i> <sub>f</sub>	Vapor, <i>v</i> <sub>g</sub>	Líquido, <i>u</i> <sub>f</sub>	Vapor, <i>u</i> <sub>g</sub>	Líquido, <i>h</i> <sub>f</sub>	Evapor., <i>h</i> <sub>fg</sub>	Vapor, <i>h</i> <sub>g</sub>	Líquido, <i>s</i> <sub>f</sub>	Vapor, <i>s</i> <sub>g</sub>
5	-53.48	0.01113	8.3508	-3.74	86.07	-3.73	97.53	93.79	-0.0090	0.2311
10	-29.71	0.01143	4.3581	2.89	89.30	2.91	94.45	97.37	0.0068	0.2265
15	-14.25	0.01164	2.9747	7.36	91.40	7.40	92.27	99.66	0.0171	0.2242
20	-2.48	0.01181	2.2661	10.84	93.00	10.89	90.50	101.39	0.0248	0.2227
30	15.38	0.01209	1.5408	16.24	95.40	16.31	87.65	103.96	0.0364	0.2209
40	29.04	0.01232	1.1692	20.48	97.23	20.57	85.31	105.88	0.0452	0.2197
50	40.27	0.01252	0.9422	24.02	98.71	24.14	83.29	107.43	0.0523	0.2189
60	49.89	0.01270	0.7887	27.10	99.96	27.24	81.48	108.72	0.0584	0.2183
70	58.35	0.01286	0.6778	29.85	101.05	30.01	79.82	109.83	0.0638	0.2179
80	65.93	0.01302	0.5938	32.33	102.02	32.53	78.28	110.81	0.0686	0.2175
90	72.83	0.01317	0.5278	34.62	102.89	34.84	76.84	111.68	0.0729	0.2172
100	79.17	0.01332	0.4747	36.75	103.68	36.99	75.47	112.46	0.0768	0.2169
120	90.54	0.01360	0.3941	40.61	105.06	40.91	72.91	113.82	0.0839	0.2165
140	100.56	0.01386	0.3358	44.07	106.25	44.43	70.52	114.95	0.0902	0.2161
160	109.56	0.01412	0.2916	47.23	107.28	47.65	68.26	115.91	0.0958	0.2157
180	117.74	0.01438	0.2569	50.16	108.18	50.64	66.10	116.74	0.1009	0.2154
200	125.28	0.01463	0.2288	52.90	108.98	53.44	64.01	117.44	0.1057	0.2151
220	132.27	0.01489	0.2056	55.48	109.68	56.09	61.96	118.05	0.1101	0.2147
240	138.79	0.01515	0.1861	57.93	110.30	58.61	59.96	118.56	0.1142	0.2144
260	144.92	0.01541	0.1695	60.28	110.84	61.02	57.97	118.99	0.1181	0.2140
280	150.70	0.01568	0.1550	62.53	111.31	63.34	56.00	119.35	0.1219	0.2136
300	156.17	0.01596	0.1424	64.71	111.72	65.59	54.03	119.62	0.1254	0.2132
350	168.72	0.01671	0.1166	69.88	112.45	70.97	49.03	120.00	0.1338	0.2118
400	179.95	0.01758	0.0965	74.81	112.77	76.11	43.80	119.91	0.1417	0.2102
450	190.12	0.01863	0.0800	79.63	112.60	81.18	38.08	119.26	0.1493	0.2079
500	199.38	0.02002	0.0657	84.54	111.76	86.39	31.44	117.83	0.1570	0.2047

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**TABLA A.13E**

Refrigerante 134a sobrecalentado

<i>T</i> °F	<i>v</i> ft <sup>3</sup> /lbm	<i>u</i> Btu/lbm	<i>h</i> Btu/lbm	<i>s</i> Btu/lbm · R	<i>v</i> ft <sup>3</sup> /lbm	<i>u</i> Btu/lbm	<i>h</i> Btu/lbm	<i>s</i> Btu/lbm · R	<i>v</i> ft <sup>3</sup> /lbm	<i>u</i> Btu/lbm	<i>h</i> Btu/lbm	<i>s</i> Btu/lbm · R
<i>P</i> = 10 psia ( <i>T</i> <sub>sat</sub> = -29.71°F)				<i>P</i> = 15 psia ( <i>T</i> <sub>sat</sub> = -14.25°F)				<i>P</i> = 20 psia ( <i>T</i> <sub>sat</sub> = -2.48°F)				
Sat.	4.3581	89.30	97.37	0.2265	2.9747	91.40	99.66	0.2242	2.2661	93.00	101.39	0.2227
-20	4.4718	90.89	99.17	0.2307								
0	4.7026	94.24	102.94	0.2391	3.0893	93.84	102.42	0.2303	2.2816	93.43	101.88	0.2238
20	4.9297	97.67	106.79	0.2472	3.2468	97.33	106.34	0.2386	2.4046	96.98	105.88	0.2323
40	5.1539	101.19	110.72	0.2553	3.4012	100.89	110.33	0.2468	2.5244	100.59	109.94	0.2406
60	5.3758	104.80	114.74	0.2632	3.5533	104.54	114.40	0.2548	2.6416	104.28	114.06	0.2487
80	5.5959	108.50	118.85	0.2709	3.7034	108.28	118.56	0.2626	2.7569	108.05	118.25	0.2566
100	5.8145	112.29	123.05	0.2786	3.8520	112.10	122.79	0.2703	2.8705	111.90	122.52	0.2644
120	6.0318	116.18	127.34	0.2861	3.9993	116.01	127.11	0.2779	2.9829	115.83	126.87	0.2720
140	6.2482	120.16	131.72	0.2935	4.1456	120.00	131.51	0.2854	3.0942	119.85	131.30	0.2795
160	6.4638	124.23	136.19	0.3009	4.2911	124.09	136.00	0.2927	3.2047	123.95	135.81	0.2869
180	6.6786	128.38	140.74	0.3081	4.4359	128.26	140.57	0.3000	3.3144	128.13	140.40	0.2922
200	6.8929	132.63	145.39	0.3152	4.5801	132.52	145.23	0.3072	3.4236	132.40	145.07	0.3014
220									3.5323	136.76	149.83	0.3085
<i>P</i> = 30 psia ( <i>T</i> <sub>sat</sub> = 15.38°F)				<i>P</i> = 40 psia ( <i>T</i> <sub>sat</sub> = 29.04°F)				<i>P</i> = 50 psia ( <i>T</i> <sub>sat</sub> = 40.27°F)				
Sat.	1.5408	95.40	103.96	0.2209	1.1692	97.23	105.88	0.2197	0.9422	98.71	107.43	0.2189
20	1.5611	96.26	104.92	0.2229								
40	1.6465	99.98	109.12	0.2315	1.2065	99.33	108.26	0.2245				
60	1.7293	103.75	113.35	0.2398	1.2723	103.20	112.62	0.2331	0.9974	102.62	111.85	0.2276
80	1.8098	107.59	117.63	0.2478	1.3357	107.11	117.00	0.2414	1.0508	106.62	116.34	0.2361
100	1.8887	111.49	121.98	0.2558	1.3973	111.08	121.42	0.2494	1.1022	110.65	120.85	0.2443
120	1.9662	115.47	126.39	0.2635	1.4575	115.11	125.90	0.2573	1.1520	114.74	125.39	0.2523
140	2.0426	119.53	130.87	0.2711	1.5165	119.21	130.43	0.2650	1.2007	118.88	129.99	0.2601
160	2.1181	123.66	135.42	0.2786	1.5746	123.38	135.03	0.2725	1.2484	123.08	134.64	0.2677
180	2.1929	127.88	140.05	0.2859	1.6319	127.62	139.70	0.2799	1.2953	127.36	139.34	0.2752
200	2.2671	132.17	144.76	0.2932	1.6887	131.94	144.44	0.2872	1.3415	131.71	144.12	0.2825
220	2.3407	136.55	149.54	0.3003	1.7449	136.34	149.25	0.2944	1.3873	136.12	148.96	0.2897
240					1.8006	140.81	154.14	0.3015	1.4326	140.61	153.87	0.2969
260					1.8561	145.36	159.10	0.3085	1.4775	145.18	158.85	0.3039
280					1.9112	149.98	164.13	0.3154	1.5221	149.82	163.90	0.3108
<i>P</i> = 60 psia ( <i>T</i> <sub>sat</sub> = 49.89°F)				<i>P</i> = 70 psia ( <i>T</i> <sub>sat</sub> = 58.35°F)				<i>P</i> = 80 psia ( <i>T</i> <sub>sat</sub> = 65.93°F)				
Sat.	0.7887	99.96	108.72	0.2183	0.6778	101.05	109.83	0.2179	0.5938	102.02	110.81	0.2175
60	0.8135	102.03	111.06	0.2229	0.6814	101.40	110.23	0.2186				
80	0.8604	106.11	115.66	0.2316	0.7239	105.58	114.96	0.2276	0.6211	105.03	114.23	0.2239
100	0.9051	110.21	120.26	0.2399	0.7640	109.76	119.66	0.2361	0.6579	109.30	119.04	0.2327
120	0.9482	114.35	124.88	0.2480	0.8023	113.96	124.36	0.2444	0.6927	113.56	123.82	0.2411
140	0.9900	118.54	129.53	0.2559	0.8393	118.20	129.07	0.2524	0.7261	117.85	128.60	0.2492
160	1.0308	122.79	134.23	0.2636	0.8752	122.49	133.82	0.2601	0.7584	122.18	133.41	0.2570
180	1.0707	127.10	138.98	0.2712	0.9103	126.83	138.62	0.2678	0.7898	126.55	138.25	0.2647
200	1.1100	131.47	143.79	0.2786	0.9446	131.23	143.46	0.2752	0.8205	130.98	143.13	0.2722
220	1.1488	135.91	148.66	0.2859	0.9784	135.69	148.36	0.2825	0.8506	135.47	148.06	0.2796
240	1.1871	140.42	153.60	0.2930	1.0118	140.22	153.33	0.2897	0.8803	140.02	153.05	0.2868
260	1.2251	145.00	158.60	0.3001	1.0448	144.82	158.35	0.2968	0.9095	144.63	158.10	0.2940
280	1.2627	149.65	163.67	0.3070	1.0774	149.48	163.44	0.3038	0.9384	149.32	163.21	0.3010
300	1.3001	154.38	168.81	0.3139	1.1098	154.22	168.60	0.3107	0.9671	154.06	168.38	0.3079
320									0.9955	158.88	173.62	0.3147

**TABLA A.13E**

Refrigerante 134a sobrecalentado (Conclusión)

<i>T</i> °F	<i>v</i> ft <sup>3</sup> /lbm	<i>u</i> Btu/lbm	<i>h</i> Btu/lbm	<i>s</i> Btu/lbm · R	<i>v</i> ft <sup>3</sup> /lbm	<i>u</i> Btu/lbm	<i>h</i> Btu/lbm	<i>s</i> Btu/lbm · R	<i>v</i> ft <sup>3</sup> /lbm	<i>u</i> Btu/lbm	<i>h</i> Btu/lbm	<i>s</i> Btu/lbm · R
<i>P</i> = 90 psia ( <i>T</i> <sub>sat</sub> = 72.83°F)					<i>P</i> = 100 psia ( <i>T</i> <sub>sat</sub> = 79.17°F)				<i>P</i> = 120 psia ( <i>T</i> <sub>sat</sub> = 90.54°F)			
Sat.	0.5278	102.89	111.68	0.2172	0.4747	103.68	112.46	0.2169	0.3941	105.06	113.82	0.2165
80	0.5408	104.46	113.47	0.2205	0.4761	103.87	112.68	0.2173				
100	0.5751	108.82	118.39	0.2295	0.5086	108.32	117.73	0.2265	0.4080	107.26	116.32	0.2210
120	0.6073	113.15	123.27	0.2380	0.5388	112.73	122.70	0.2352	0.4355	111.84	121.52	0.2301
140	0.6380	117.50	128.12	0.2463	0.5674	117.13	127.63	0.2436	0.4610	116.37	126.61	0.2387
160	0.6675	121.87	132.98	0.2542	0.5947	121.55	132.55	0.2517	0.4852	120.89	131.66	0.2470
180	0.6961	126.28	137.87	0.2620	0.6210	125.99	137.49	0.2595	0.5082	125.42	136.70	0.2550
200	0.7239	130.73	142.79	0.2696	0.6466	130.48	142.45	0.2671	0.5305	129.97	141.75	0.2628
220	0.7512	135.25	147.76	0.2770	0.6716	135.02	147.45	0.2746	0.5520	134.56	146.82	0.2704
240	0.7779	139.82	152.77	0.2843	0.6960	139.61	152.49	0.2819	0.5731	139.20	151.92	0.2778
260	0.8043	144.45	157.84	0.2914	0.7201	144.26	157.59	0.2891	0.5937	143.89	157.07	0.2850
280	0.8303	149.15	162.97	0.2984	0.7438	148.98	162.74	0.2962	0.6140	148.63	162.26	0.2921
300	0.8561	153.91	168.16	0.3054	0.7672	153.75	167.95	0.3031	0.6339	153.43	167.51	0.2991
320	0.8816	158.73	173.42	0.3122	0.7904	158.59	173.21	0.3099	0.6537	158.29	172.81	0.3060
<i>P</i> = 140 psia ( <i>T</i> <sub>sat</sub> = 100.56°F)					<i>P</i> = 160 psia ( <i>T</i> <sub>sat</sub> = 109.55°F)				<i>P</i> = 180 psia ( <i>T</i> <sub>sat</sub> = 117.74°F)			
Sat.	0.3358	106.25	114.95	0.2161	0.2916	107.28	115.91	0.2157	0.2569	108.18	116.74	0.2154
120	0.3610	110.90	120.25	0.2254	0.3044	109.88	118.89	0.2209	0.2595	108.77	117.41	0.2166
140	0.3846	115.58	125.24	0.2344	0.3269	114.73	124.41	0.2303	0.2814	113.83	123.21	0.2264
160	0.4066	120.21	130.74	0.2429	0.3474	119.49	129.78	0.2391	0.3011	118.74	128.77	0.2355
180	0.4274	124.82	135.89	0.2511	0.3666	124.20	135.06	0.2475	0.3191	123.56	134.19	0.2441
200	0.4474	129.44	141.03	0.2590	0.3849	128.90	140.29	0.2555	0.3361	128.34	139.53	0.2524
220	0.4666	134.09	146.18	0.2667	0.4023	133.61	145.52	0.2633	0.3523	133.11	144.84	0.2603
240	0.4852	138.77	151.34	0.2742	0.4192	138.34	150.75	0.2709	0.3678	137.90	150.15	0.2680
260	0.5034	143.50	156.54	0.2815	0.4356	143.11	156.00	0.2783	0.3828	142.71	155.46	0.2755
280	0.5212	148.28	161.78	0.2887	0.4516	147.92	161.29	0.2856	0.3974	147.55	160.79	0.2828
300	0.5387	153.11	167.06	0.2957	0.4672	152.78	166.61	0.2927	0.4116	152.44	166.15	0.2899
320	0.5559	157.99	172.39	0.3026	0.4826	157.69	171.98	0.2996	0.4256	157.38	171.55	0.2969
340	0.5730	162.93	177.78	0.3094	0.4978	162.65	177.39	0.3065	0.4393	162.36	177.00	0.3038
360	0.5898	167.93	183.21	0.3162	0.5128	167.67	182.85	0.3132	0.4529	167.40	182.49	0.3106
<i>P</i> = 200 psia ( <i>T</i> <sub>sat</sub> = 125.28°F)					<i>P</i> = 300 psia ( <i>T</i> <sub>sat</sub> = 156.17°F)				<i>P</i> = 400 psia ( <i>T</i> <sub>sat</sub> = 179.95°F)			
Sat.	0.2288	108.98	117.44	0.2151	0.1424	111.72	119.62	0.2132	0.0965	112.77	119.91	0.2102
140	0.2446	112.87	121.92	0.2226								
160	0.2636	117.94	127.70	0.2321	0.1462	112.95	121.07	0.2155				
180	0.2809	122.88	133.28	0.2410	0.1633	118.93	128.00	0.2265	0.0965	112.79	119.93	0.2102
200	0.2970	127.76	138.75	0.2494	0.1777	124.47	134.34	0.2363	0.1143	120.14	128.60	0.2235
220	0.3121	132.60	144.15	0.2575	0.1905	129.79	140.36	0.2453	0.1275	126.35	135.79	0.2343
240	0.3266	137.44	149.53	0.2653	0.2021	134.99	146.21	0.2537	0.1386	132.12	142.38	0.2438
260	0.3405	142.30	154.90	0.2728	0.2130	140.12	151.95	0.2618	0.1484	137.65	148.64	0.2527
280	0.3540	147.18	160.28	0.2802	0.2234	145.23	157.63	0.2696	0.1575	143.06	154.72	0.2610
300	0.3671	152.10	165.69	0.2874	0.2333	150.33	163.28	0.2772	0.1660	148.39	160.67	0.2689
320	0.3799	157.07	171.13	0.2945	0.2428	155.44	168.92	0.2845	0.1740	153.69	166.57	0.2766
340	0.3926	162.07	176.60	0.3014	0.2521	160.57	174.56	0.2916	0.1816	158.97	172.42	0.2840
360	0.4050	167.13	182.12	0.3082	0.2611	165.74	180.23	0.2986	0.1890	164.26	178.26	0.2912
380					0.2699	170.94	185.92	0.3055	0.1962	169.57	184.09	0.2983
400					0.2786	176.18	191.64	0.3122	0.2032	174.90	189.94	0.3051

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