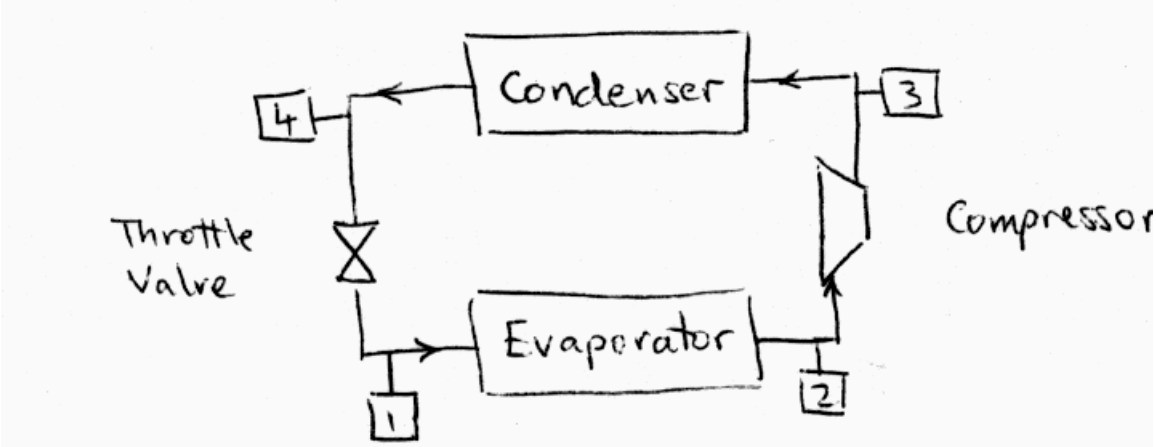
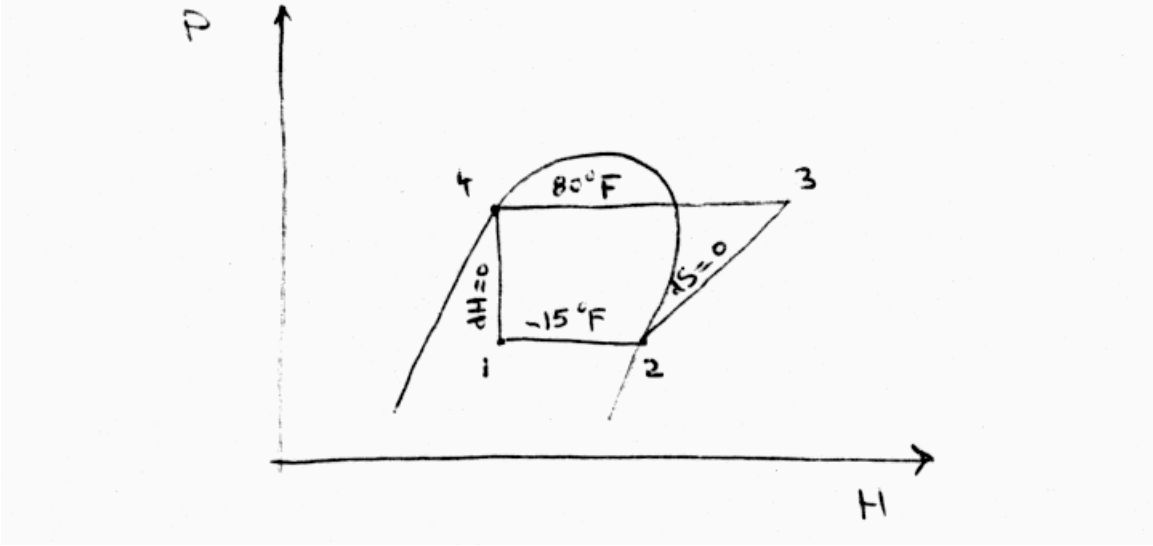
Problem 12 **10.213**

a) Circulation rate of refrigerant for a cycle that has a throttle valve



Here is the PH diagram.



So to get the circulation rate, we use

$\dot{Q} = \dot{m} Q_c$ where Q is the cooling rate of the cycle (the total amount of heat that the refrigerant extracts from the room in the evaporator per unit time), m is the flow rate of the refrigerant in the cycle (mass per unit time) and Q_c is the heat given to the evaporator per unit mass of refrigerant. (Note that the nomenclature is slightly different than the book)

Since there is no work done in the evaporator,
$Q_c = \Delta H = H_2 - H_1$

Point 2 is saturated vapor at –15 °F. So we can use the table at page 300 to get
H_2 = 100.799 Btu/lb

The enthalpy of point 1 is the same as that of point 4 since the expansion process through the throttle valve is isenthalpic. Point 4 is saturated liquid at 80 °F. Therefore,
$H_1 = H_4$ = 37.978 Btu/lb

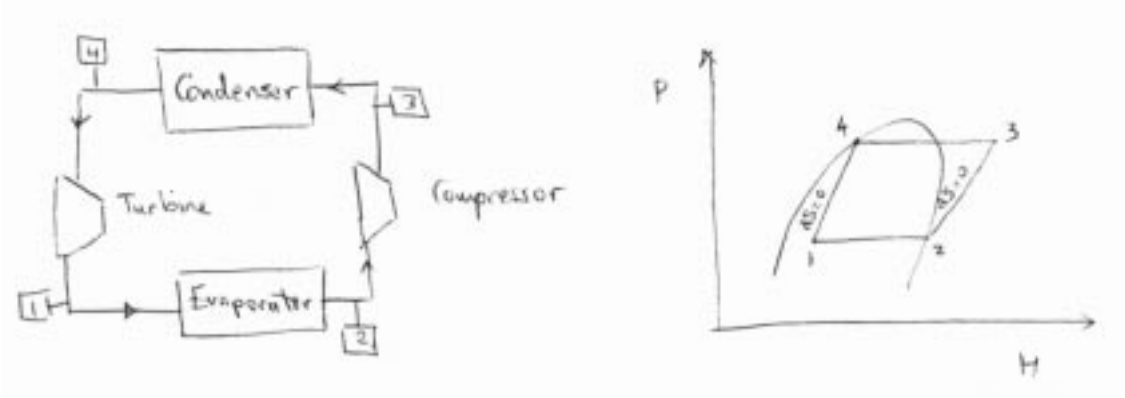
Q_c = 100.799 – 37.978 = 62.821 Btu/lb.

Since
Q = 5 Btu/s

Therefore,
m = 5 / 62.821 = 0.0796 lb/s

b) Circulation rate for a cycle with a turbine

The refrigerant expands in the turbine isentropically. So the entropy of point 4 is equal to the entropy of point 1. The PH diagram of the cycle looks like this.



Entropy of point 4 from the table
$S_4 = S_1$ = 0.07892 Btu/lb R

Method 1
Get the entropy of point 2 from the table (sat. vap. at –15 °F)
S_2 = 0.22714 Btu/lb R

Therefore the change in entropy across the evaporator
$\Delta S = S_2 – S_1$ = 0.22714 – 0.07892 = 0.14822 Btu/lb R

Assuming that the process is reversible (a good assumption for evaporation at constant temperature)
$\Delta S = Q_c / T_c$

Tc = -15 + 459.67 = 444.67 R

Therefore,
Q_c = 0.14822 * 444.67 = 65.909 Btu/lb
m = 5 / 65.909 = 0.0759 lb/s

Method 2

Since we know the values of the entropy of saturated liquid and vapor at –15 °F, we can get the mass fraction of the vapor in the stream at point 1.

S^l = 0.01733 Btu/lb

$S^v = S_2$ = 0.22714 Btu/lb

Using the lever-arm principle, we get

$$x^v = \frac{S - S^l}{S^v - S^l}$$

Therefore,

x^v =(0.07892 – 0.01733) / (0.22714 – 0.01733) = 0.2936

We now can calculate the enthalpy of point 1,

$H_1 = x^v H^v + (1 - x^v) H^l$

At –15 F,

H^l=7.505 Btu/lb

$H^v = H_2$ = 100.799 Btu/lb

Therefore,

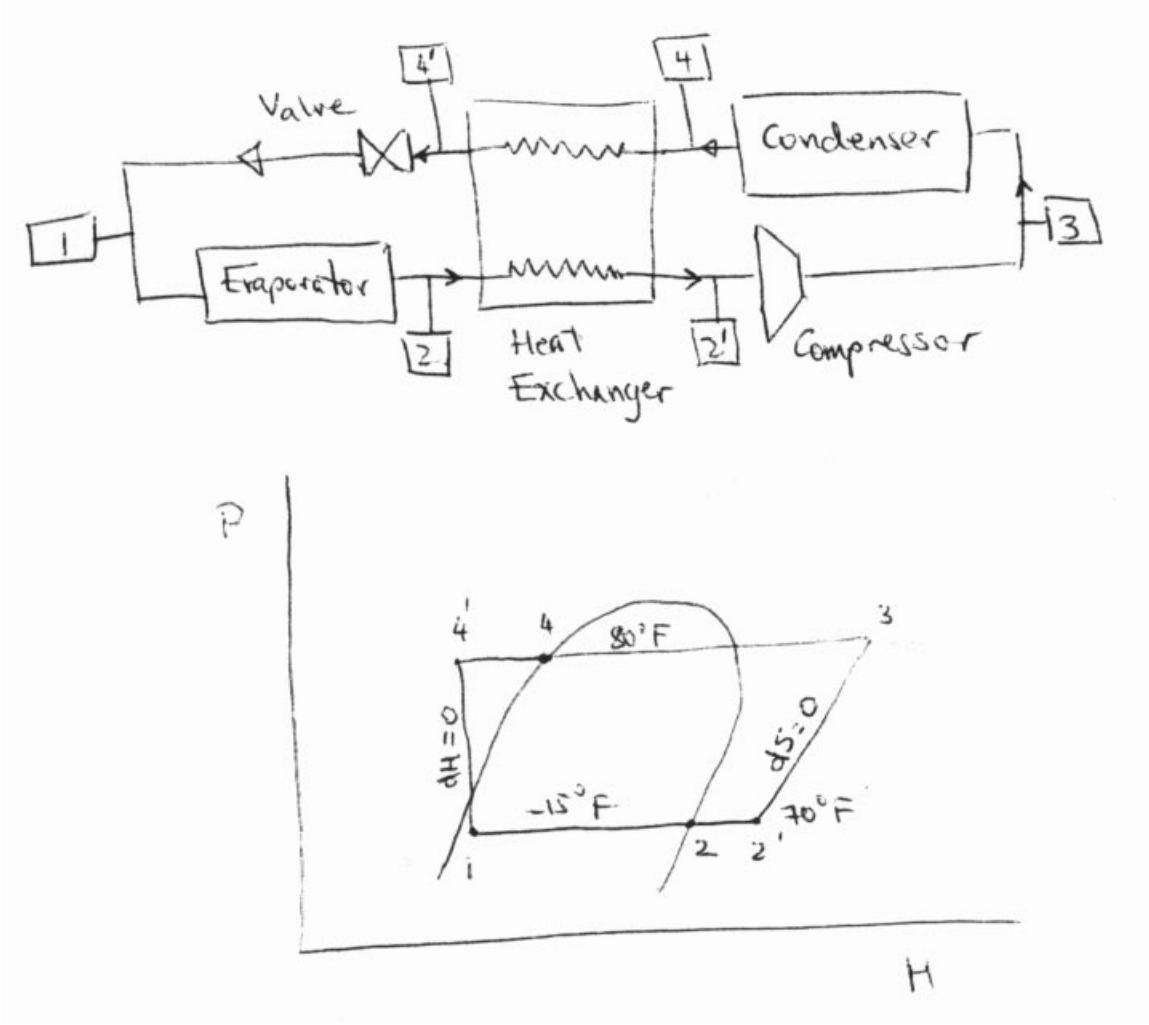
H_1 = 0.2936 *100.799 + (1 – 0.2936) * 7.505 = 34.892 Btu/lb

Q_c = 100.799 – 34.892 = 65.907 Btu/lb

m = 5 / 65.907 = 0.0759 lb/s

c) Circulation rate for a cycle with a heat exchanger

The cycle is modified to include a heat exchanger that cools down the liquid coming out of the condenser by heating up the vapor coming out of the evaporator. The cycle and the PH diagram are shown.



We need to get the enthalpy of point 4'. We can assume that the heat exchanger is well insulated. From an energy balance on the heat exchanger (energy in = energy out),

$H_4 + H_2 = H_{4'} + H_{2'}$

$H_1 = H_{4'} = H_4 + H_2 - H_{2'}$

We assume that the pressure drop though the heat exchanger is negligible. That makes the pressure of point 2' equals the pressure of point 2, which we can get from the table.

$P_2 = 14.667$ psia $= P_{2'}$

We can either use the chart to determine the location of point 2' or we can use the tables of superheated vapor given in problem 8 (attached) at P = 14.696 psia. From the table, we get,
$H_{2'} = 117.5$ Btu/lb

Therefore,
$H_1 = 37.978 + 100.799 – 117.5 = 21.277$ Btu/lb
$Q_c = H_2 – H_1 = 100.799 – 21.277 = 79.522$ Btu/lb
$m = 5 / 79.522 = 0.0629$ lb/s

d) COP of the cycle

The coefficient of performance is defined as
$\omega = Q_c / W_s$

We need to get the net shaft work for the three different processes. For part a, work is given to the compressor. Therefore,
$W_s = W_{compressor} = H_3 – H_2$

The entropy of point 3 is the same as the entropy of point 2.
$S_3 = S_2 = 0.22714$ Btu/lb R

If we assume that the pressure drop in the condenser is negligible, therefore the pressure of point 3 is the same as the pressure of point 4, which we can get from the table.
$P_3 = P_4 = 101.37$ psia

We can get more tables for this refrigerant from the web page stated in problem 8. http://www.dupont.com/suva/na/usa/sa/techinfo/engg.html. Knowing the pressure and the entropy of point 3, we locate the point and get the enthalpy (See attached table). Interpolating, we get
$H_3 = 116.6 + (0.22714 – 0.2248) / (0.2291 – 0.2248) * (119.0 – 116.6) = 117.9$ Btu/lb

Therefore,
$W_{compressor} = 117.9 – 100.799 = 17.1$ Btu/lb

$$\omega = \mathbf{62.821 / 17.1 = 3.672}$$

For part b, the net work equals
$W_s = W_{compressor} + W_{turbine}$
$W_{turbine} = H_1 – H_4 = 34.892 – 37.978 = -3.086$ Btu/lb
$W_s = 17.1 – 3.086 = 14.014$ Btu/lb

$$\omega = \mathbf{65.907 / 14.014 = 4.703}$$

For part c, the compressor work equals
$W_{compressor} = H_3 – H_2$,

We get H_3 using the fact that the process is isentropic.
$S_3 = S_2$, $= 0.2614$ Btu/lb R

Using the same table at P = 100 psia and interpolating for H_3, we get,
$H_3 = 137.9 + (0.2614 – 0.2608) / (0.2645 – 0.2608) * (140.3 – 137.9) = 138.3$ Btu/lb

Therefore,
$W_{compressor} = 138.3 – 117.5 = 20.8$ Btu/lb

$$\omega = \mathbf{79.522 / 20.8 = 3.823}$$

TABLE 2 (continued)
HFC-134a Superheated Vapor—Constant Pressure Tables

V = Volume in ft³/lb H = Enthalpy in Btu/lb S = Entropy in Btu/(lb) (°R) v_s = Velocity of Sound in ft/sec
Cp = Heat Capacity at Constant Pressure in Btu/(lb) (°F) Cp/Cv = Heat Capacity Ratio (Dimensionless)

TEMP	PRESSURE = 13.00 PSIA							PRESSURE = 14.00 PSIA						TEMP
°F	V	H	S	Cp	Cp/Cv	v_s		V	H	S	Cp	Cp/Cv	v_s	°F
−19.7	0.01159	6.1	0.0142	0.3026	1.5041	2484.1	SAT LIQ	0.01163	7.0	0.0161	0.3035	1.5044	2459.9	−16.8
−19.7	3.41763	100.2	0.2281	0.1864	1.1527	476.9	SAT VAP	3.18776	100.7	0.2277	0.1876	1.1535	477.6	−16.8
−10	3.50508	102.0	0.2322	0.1876	1.1476	482.9		3.24570	101.9	0.2305	0.1885	1.1498	481.8	−10
0	3.59454	103.9	0.2363	0.1891	1.1429	488.8		3.32889	103.8	0.2347	0.1898	1.1448	487.9	0
10	3.68460	105.8	0.2404	0.1907	1.1387	494.7		3.41180	105.7	0.2388	0.1913	1.1404	493.8	10
20	3.77216	107.7	0.2444	0.1924	1.1349	500.4		3.49406	107.7	0.2429	0.1929	1.1363	499.5	20
30	3.85951	109.7	0.2484	0.1941	1.1314	506.0		3.57654	109.6	0.2468	0.1946	1.1327	505.2	30
40	3.94633	111.6	0.2523	0.1959	1.1282	511.5		3.65764	111.5	0.2508	0.1964	1.1294	510.7	40
50	4.03226	113.6	0.2562	0.1978	1.1253	516.8		3.73832	113.5	0.2547	0.1982	1.1263	516.1	50
60	4.11862	115.6	0.2601	0.1997	1.1225	522.1		3.81825	115.5	0.2586	0.2001	1.1235	521.5	60
70	4.20345	117.6	0.2639	0.2017	1.1200	527.3		3.89712	117.5	0.2624	0.2020	1.1209	526.7	70
80	4.28816	119.6	0.2677	0.2037	1.1177	532.4		3.97614	119.6	0.2662	0.2040	1.1185	531.9	80
90	4.37254	121.7	0.2715	0.2057	1.1155	537.5		4.05515	121.6	0.2700	0.2060	1.1162	536.9	90
100	4.45831	123.7	0.2752	0.2077	1.1134	542.5		4.13394	123.7	0.2737	0.2080	1.1141	541.9	100
110	4.54133	125.8	0.2789	0.2097	1.1115	547.4		4.21408	125.8	0.2774	0.2100	1.1121	546.9	110
120	4.62535	127.9	0.2826	0.2118	1.1097	552.2		4.29185	127.9	0.2811	0.2120	1.1102	551.7	120
130	4.71032	130.0	0.2862	0.2138	1.1079	557.0		4.36872	130.0	0.2847	0.2140	1.1084	556.6	130
140	4.79386	132.2	0.2898	0.2159	1.1063	561.7		4.44642	132.2	0.2883	0.2161	1.1068	561.3	140
150	4.87567	134.4	0.2934	0.2179	1.1047	566.4		4.52489	134.3	0.2919	0.2181	1.1052	566.0	150
160	4.96032	136.5	0.2970	0.2200	1.1033	571.0		4.60193	136.5	0.2955	0.2202	1.1037	570.6	160
170	5.04286	138.8	0.3005	0.2220	1.1018	575.6		4.67946	138.7	0.2990	0.2222	1.1022	575.2	170
180	5.12558	141.0	0.3040	0.2241	1.1005	580.1		4.75737	141.0	0.3026	0.2242	1.1008	579.8	180
190	5.20833	143.2	0.3075	0.2261	1.0992	584.6		4.83325	143.2	0.3060	0.2262	1.0995	584.3	190
200	5.29101	145.5	0.3110	0.2281	1.0980	589.0		4.91159	145.5	0.3095	0.2283	1.0983	588.7	200
210	5.37346	147.8	0.3144	0.2302	1.0968	593.4		4.98753	147.8	0.3130	0.2303	1.0971	593.1	210
220	5.45852	150.1	0.3179	0.2322	1.0956	597.8		5.06329	150.1	0.3164	0.2323	1.0959	597.5	220
230	5.54017	152.4	0.3213	0.2342	1.0945	602.1		5.14139	152.4	0.3198	0.2343	1.0948	601.9	230
240	5.62114	154.8	0.3247	0.2362	1.0935	606.4		5.21921	154.8	0.3232	0.2362	1.0937	606.1	240
250	5.70451	157.2	0.3280	0.2381	1.0925	610.7		5.29381	157.1	0.3266	0.2382	1.0927	610.4	250
260	5.78704	159.6	0.3314	0.2401	1.0915	614.9		5.37057	159.5	0.3299	0.2402	1.0917	614.6	260
270	5.86854	162.0	0.3347	0.2420	1.0905	619.0		5.44662	161.9	0.3332	0.2421	1.0908	618.8	270
280	5.95238	164.4	0.3380	0.2440	1.0896	623.2		5.52486	164.4	0.3365	0.2440	1.0898	623.0	280
290	6.03500	166.9	0.3413	0.2459	1.0887	627.3		5.59910	166.8	0.3398	0.2460	1.0889	627.1	290

TEMP	PRESSURE = 14.696 PSIA							PRESSURE = 15.00 PSIA						TEMP
°F	V	H	S	Cp	Cp/Cv	v_s		V	H	S	Cp	Cp/Cv	v_s	°F
−14.9	0.01166	7.5	0.0174	0.3041	1.5046	2443.9	SAT LIQ	0.01167	7.8	0.0180	0.3043	1.5047	2437.1	−14.1
−14.9	3.04507	100.9	0.2274	0.1885	1.1540	478.0	SAT VAP	2.98686	101.1	0.2273	0.1888	1.1543	478.1	−14.1
−10	3.08547	101.9	0.2295	0.1891	1.1513	481.0		3.01932	101.8	0.2290	0.1893	1.1520	480.7	−10
0	3.16556	103.8	0.2336	0.1904	1.1461	487.2		3.09885	103.7	0.2332	0.1906	1.1467	486.9	0
10	3.24465	105.7	0.2378	0.1918	1.1415	493.1		3.17662	105.6	0.2373	0.1920	1.1420	492.8	10
20	3.32336	107.6	0.2418	0.1934	1.1374	498.9		3.25415	107.6	0.2414	0.1935	1.1378	498.7	20
30	3.40136	109.5	0.2458	0.1950	1.1336	504.6		3.33111	109.5	0.2454	0.1952	1.1340	504.4	30
40	3.47947	111.5	0.2498	0.1967	1.1302	510.2		3.40716	111.5	0.2494	0.1969	1.1306	510.0	40
50	3.55619	113.5	0.2537	0.1985	1.1271	515.7		3.48189	113.5	0.2533	0.1987	1.1274	515.5	50
60	3.63240	115.5	0.2576	0.2004	1.1242	521.0		3.55745	115.4	0.2571	0.2005	1.1245	520.8	60
70	3.70920	117.5	0.2614	0.2023	1.1215	526.3		3.63240	117.5	0.2610	0.2024	1.1218	526.1	70
80	3.78501	119.5	0.2652	0.2042	1.1190	531.5		3.70645	119.5	0.2648	0.2043	1.1193	531.3	80
90	3.85951	121.6	0.2690	0.2062	1.1167	536.6		3.78072	121.5	0.2686	0.2063	1.1169	536.4	90
100	3.93546	123.6	0.2727	0.2082	1.1145	541.6		3.85356	123.6	0.2723	0.2082	1.1147	541.4	100
110	4.01123	125.7	0.2764	0.2102	1.1125	546.5		3.92773	125.7	0.2760	0.2102	1.1127	546.4	110
120	4.08497	127.8	0.2801	0.2122	1.1106	551.4		4.00160	127.8	0.2797	0.2122	1.1108	551.3	120
130	4.15973	130.0	0.2837	0.2142	1.1088	556.2		4.07332	130.0	0.2833	0.2142	1.1090	556.1	130
140	4.23370	132.1	0.2874	0.2162	1.1071	561.0		4.14594	132.1	0.2869	0.2163	1.1072	560.9	140
150	4.30849	134.3	0.2910	0.2182	1.1055	565.7		4.21941	134.3	0.2905	0.2183	1.1056	565.6	150
160	4.38212	136.5	0.2945	0.2203	1.1039	570.4		4.29185	136.5	0.2941	0.2203	1.1041	570.3	160
170	4.45633	138.7	0.2981	0.2223	1.1025	575.0		4.36300	138.7	0.2977	0.2223	1.1026	574.9	170
180	4.52899	140.9	0.3016	0.2243	1.1011	579.5		4.43656	140.9	0.3012	0.2244	1.1012	579.4	180
190	4.60193	143.2	0.3051	0.2263	1.0998	584.1		4.50857	143.2	0.3047	0.2264	1.0999	584.0	190
200	4.67727	145.5	0.3086	0.2284	1.0985	588.5		4.58085	145.5	0.3081	0.2284	1.0986	588.4	200
210	4.74834	147.8	0.3120	0.2304	1.0973	592.9		4.65333	147.7	0.3116	0.2304	1.0974	592.8	210
220	4.82393	150.1	0.3154	0.2324	1.0961	597.3		4.72367	150.1	0.3150	0.2324	1.0962	597.2	220
230	4.89476	152.4	0.3188	0.2343	1.0950	601.7		4.79616	152.4	0.3184	0.2344	1.0951	601.6	230
240	4.97018	154.8	0.3222	0.2363	1.0939	606.0		4.86618	154.7	0.3218	0.2363	1.0940	605.9	240
250	5.04286	157.1	0.3256	0.2383	1.0929	610.2		4.93827	157.1	0.3252	0.2383	1.0929	610.2	250
260	5.11509	159.5	0.3289	0.2402	1.0919	614.5		5.01002	159.5	0.3285	0.2403	1.0919	614.4	260
270	5.18672	161.9	0.3323	0.2422	1.0909	618.7		5.08130	161.9	0.3319	0.2422	1.0910	618.6	270
280	5.26039	164.4	0.3356	0.2441	1.0900	622.8		5.15198	164.4	0.3352	0.2441	1.0900	622.8	280
290	5.33333	166.8	0.3389	0.2460	1.0891	627.0		5.22466	166.8	0.3385	0.2460	1.0891	626.9	290

TABLE 2 (continued)
HFC-134a Superheated Vapor—Constant Pressure Tables

V = Volume in ft^3/lb H = Enthalpy in Btu/lb S = Entropy in Btu/(lb) (°R) v_s = Velocity of Sound in ft/sec
Cp = Heat Capacity at Constant Pressure in Btu/(lb) (°F) Cp/Cv = Heat Capacity Ratio (Dimensionless)

TEMP °F	PRESSURE = 100.00 PSIA V	H	S	Cp	Cp/Cv	v_s		PRESSURE = 110.00 PSIA V	H	S	Cp	Cp/Cv	v_s	TEMP °F
79.1	0.01333	37.8	0.0787	0.3433	1.5646	1654.2	SAT LIQ	0.01347	39.8	0.0824	0.3469	1.5726	1604.1	85
79.1	0.47803	113.9	0.2199	0.2446	1.2317	472.8	SAT VAP	0.43391	114.6	0.2196	0.2496	1.2420	470.4	85
80	0.47952	114.1	0.2203	0.2442	1.2300	473.6		—	—	—	—	—	—	80
90	0.49552	116.6	0.2248	0.2413	1.2129	482.9		0.44156	115.9	0.2219	0.2477	1.2319	475.4	90
100	0.51093	119.0	0.2291	0.2393	1.1989	491.7		0.45627	118.3	0.2264	0.2446	1.2146	484.8	100
110	0.52587	121.4	0.2333	0.2379	1.1871	499.9		0.47043	120.8	0.2307	0.2425	1.2004	493.6	110
120	0.54037	123.7	0.2375	0.2370	1.1770	507.8		0.48414	123.2	0.2349	0.2410	1.1884	502.0	120
130	0.55451	126.1	0.2415	0.2366	1.1683	515.3		0.49746	125.6	0.2390	0.2401	1.1782	509.9	130
140	0.56838	128.5	0.2455	0.2365	1.1608	522.5		0.51044	128.0	0.2430	0.2395	1.1694	517.5	140
150	0.58194	130.8	0.2494	0.2366	1.1541	529.4		0.52309	130.4	0.2470	0.2394	1.1618	524.7	150
160	0.59527	133.2	0.2533	0.2370	1.1482	536.1		0.53562	132.8	0.2509	0.2395	1.1550	531.7	160
170	0.60835	135.6	0.2570	0.2376	1.1430	542.5		0.54786	135.2	0.2547	0.2399	1.1491	538.5	170
180	0.62135	137.9	0.2608	0.2384	1.1383	548.8		0.55979	137.6	0.2585	0.2404	1.1438	545.0	180
190	0.63416	140.3	0.2645	0.2393	1.1340	554.9		0.57166	140.0	0.2622	0.2411	1.1390	551.3	190
200	0.64675	142.7	0.2682	0.2403	1.1301	560.9		0.58340	142.4	0.2659	0.2420	1.1347	557.4	200
210	0.65924	145.1	0.2718	0.2414	1.1266	566.7		0.59503	144.8	0.2696	0.2429	1.1308	563.4	210
220	0.67155	147.6	0.2754	0.2426	1.1234	572.3		0.60643	147.3	0.2732	0.2440	1.1272	569.3	220
230	0.68385	150.0	0.2789	0.2439	1.1204	577.9		0.61774	149.7	0.2768	0.2452	1.1239	575.0	230
240	0.69604	152.4	0.2825	0.2452	1.1177	583.3		0.62893	152.2	0.2803	0.2464	1.1209	580.5	240
250	0.70806	154.9	0.2859	0.2466	1.1151	588.6		0.64012	154.6	0.2838	0.2477	1.1181	586.0	250
260	0.72015	157.4	0.2894	0.2480	1.1128	593.9		0.65121	157.1	0.2873	0.2490	1.1156	591.4	260
270	0.73196	159.9	0.2928	0.2495	1.1106	599.0		0.66212	159.6	0.2907	0.2504	1.1132	596.6	270
280	0.74388	162.4	0.2962	0.2509	1.1085	604.1		0.67308	162.1	0.2941	0.2518	1.1109	601.8	280
290	0.75569	164.9	0.2996	0.2524	1.1066	609.0		0.68385	164.6	0.2975	0.2533	1.1088	606.9	290
300	0.76740	167.4	0.3030	0.2540	1.1047	613.9		0.69464	167.2	0.3009	0.2547	1.1069	611.9	300
310	0.77906	170.0	0.3063	0.2555	1.1030	618.7		0.70542	169.7	0.3042	0.2562	1.1050	616.8	310
320	0.79064	172.5	0.3096	0.2571	1.1014	623.5		0.71613	172.3	0.3076	0.2577	1.1033	621.6	320
330	0.80225	175.1	0.3129	0.2586	1.0999	628.2		0.72680	174.9	0.3109	0.2593	1.1017	626.4	330
340	0.81387	177.7	0.3162	0.2602	1.0984	632.8		0.73725	177.5	0.3141	0.2608	1.1001	631.1	340
350	0.82535	180.3	0.3194	0.2618	1.0970	637.4		0.74783	180.1	0.3174	0.2624	1.0987	635.8	350
360	0.83675	182.9	0.3226	0.2634	1.0957	641.9		0.75832	182.7	0.3206	0.2639	1.0973	640.4	360
370	0.84818	185.6	0.3258	0.2649	1.0945	646.4		0.76870	185.4	0.3238	0.2655	1.0959	644.9	370
380	0.85955	188.2	0.3290	0.2665	1.0933	650.8		0.77924	188.0	0.3270	0.2670	1.0947	649.4	380
390	—	—	—	—	—	—		0.78958	190.7	0.3302	0.2686	1.0935	653.8	390

TEMP °F	PRESSURE = 120.00 PSIA V	H	S	Cp	Cp/Cv	v_s		PRESSURE = 130.00 PSIA V	H	S	Cp	Cp/Cv	v_s	TEMP °F
90.5	0.01361	41.8	0.0858	0.3504	1.5808	1557.1	SAT LIQ	0.01374	43.6	0.0890	0.3540	1.5893	1512.8	95.6
90.5	0.39689	115.3	0.2194	0.2546	1.2528	467.9	SAT VAP	0.36538	115.8	0.2192	0.2596	1.2640	465.4	95.6
100	0.41044	117.7	0.2238	0.2506	1.2326	477.6		0.37136	117.0	0.2212	0.2573	1.2531	470.1	100
110	0.42402	120.2	0.2282	0.2475	1.2153	487.1		0.38453	119.5	0.2257	0.2531	1.2321	480.3	110
120	0.43710	122.6	0.2324	0.2453	1.2010	496.0		0.39712	122.0	0.2301	0.2501	1.2150	489.8	120
130	0.44976	125.1	0.2366	0.2438	1.1890	504.4		0.40925	124.5	0.2344	0.2479	1.2009	498.7	130
140	0.46206	127.5	0.2407	0.2428	1.1788	512.4		0.42100	127.0	0.2385	0.2464	1.1890	507.1	140
150	0.47405	129.9	0.2447	0.2423	1.1700	520.0		0.43241	129.5	0.2426	0.2454	1.1788	515.1	150
160	0.48577	132.3	0.2487	0.2421	1.1623	527.3		0.44350	131.9	0.2466	0.2448	1.1701	522.7	160
170	0.49724	134.8	0.2525	0.2422	1.1555	534.3		0.45442	134.4	0.2505	0.2446	1.1624	530.0	170
180	0.50860	137.2	0.2564	0.2425	1.1495	541.1		0.46507	136.8	0.2544	0.2447	1.1557	537.1	180
190	0.51967	139.6	0.2601	0.2430	1.1442	547.6		0.47556	139.2	0.2582	0.2450	1.1497	543.9	190
200	0.53064	142.0	0.2639	0.2437	1.1394	554.0		0.48584	141.7	0.2619	0.2455	1.1444	550.5	200
210	0.54139	144.5	0.2675	0.2445	1.1351	560.1		0.49601	144.2	0.2656	0.2461	1.1396	556.8	210
220	0.55206	146.9	0.2712	0.2454	1.1311	566.2		0.50602	146.6	0.2692	0.2469	1.1352	563.0	220
230	0.56268	149.4	0.2747	0.2465	1.1275	572.0		0.51597	149.1	0.2729	0.2478	1.1313	569.1	230
240	0.57307	151.9	0.2783	0.2476	1.1243	577.8		0.52576	151.6	0.2764	0.2489	1.1277	575.0	240
250	0.58350	154.4	0.2818	0.2488	1.1212	583.4		0.53550	154.1	0.2800	0.2500	1.1244	580.7	250
260	0.59379	156.8	0.2853	0.2501	1.1184	588.9		0.54511	156.6	0.2835	0.2511	1.1214	586.3	260
270	0.60394	159.4	0.2888	0.2514	1.1158	594.2		0.55460	159.1	0.2870	0.2524	1.1186	591.8	270
280	0.61406	161.9	0.2922	0.2527	1.1134	599.5		0.56408	161.6	0.2904	0.2536	1.1160	597.2	280
290	0.62414	164.4	0.2956	0.2541	1.1112	604.7		0.57353	164.2	0.2938	0.2550	1.1136	602.5	290
300	0.63408	167.0	0.2990	0.2555	1.1091	609.8		0.58282	166.7	0.2972	0.2563	1.1113	607.7	300
310	0.64404	169.5	0.3023	0.2570	1.1071	614.8		0.59207	169.3	0.3006	0.2577	1.1092	612.8	310
320	0.65389	172.1	0.3057	0.2584	1.1052	619.8		0.60129	171.9	0.3039	0.2592	1.1072	617.9	320
330	0.66375	174.7	0.3090	0.2599	1.1035	624.6		0.61039	174.5	0.3072	0.2606	1.1054	622.8	330
340	0.67354	177.3	0.3122	0.2614	1.1019	629.4		0.61962	177.1	0.3105	0.2621	1.1036	627.7	340
350	0.68329	179.9	0.3155	0.2629	1.1003	634.1		0.62865	179.7	0.3138	0.2635	1.1020	632.5	350
360	0.69300	182.6	0.3187	0.2645	1.0988	638.8		0.63771	182.4	0.3170	0.2650	1.1004	637.2	360
370	0.70264	185.2	0.3220	0.2660	1.0974	643.4		0.64666	185.0	0.3202	0.2665	1.0989	641.9	370
380	0.71225	187.9	0.3252	0.2675	1.0961	648.0		0.65569	187.7	0.3234	0.2680	1.0975	646.5	380
390	0.72192	190.6	0.3283	0.2690	1.0948	652.5		0.66458	190.4	0.3266	0.2695	1.0962	651.1	390
400	0.73142	193.3	0.3315	0.2706	1.0936	656.9		0.67345	193.1	0.3298	0.2710	1.0949	655.6	400