CHAPTER 9

THE THERMODYNAMIC PROPERTIES OF STEAM

The most widely used tabulation of the properties of steam is that by Keenan and Keyes [1], based on experimental data up to 460°C and 360 atmospheres. Koch [2, 3, 4] has published a table in metric units, ranging from 0° to 550°C and from 0.01 to 300 atmospheres. Goff and Gratch [3] published an accurate table of low-pressure values of properties of water from -160° to 212°F. The recorrelation in 1949 by Keyes [4] of the existing data for steam and the recent experimental data of Kennedy [5] and Kirillin and Rumjanzev [6] prompted a reexamination of the situation. The tables given below are a result of this investigation.

Calculation of the Tables

The tables of the compressibility factor and density for steam given here comprise newly calculated values obtained from the thorough correlation by Keyes [4] of all of the then existing data of state. During the course of the calculations, the data of Kennedy [5] were processed with a view of extending the temperature and pressure range of the tables. These data were found too inconsistent at the higher pressures and unreliable at the lower pressures to warrant their use (see figure 9a). In view of this and of the purely empirical nature of the correlation equation used, the tables could not be extended beyond the tabulated range. The data of Kirillin and Rumjanzev are in good agreement with the values of the compressibility factor obtained from the Keyes correlation as is shown in figure 9b.

The data of state have been represented by Keyes [4] by the equations found on page 923 of reference 4. The implicit nature of this equation of state required an iterative procedure which was employed until each of the calculated values became constant to a part in 10,000. The values of the gas imperfection corrections to the heat capacity were calculated from an earlier correlation of Keyes, et al., [7], which is consistent with the PVT representation [4] and which was more amenable to computation. The corrections for enthalpy and entropy were obtained by integration of the above corrections. A fuller discussion of the details of the computation is to be found in the above cited works and in the report of Fano, Hubbell, and Beckett [8].

As a check of the consistency of the independent calculations of compressibility and gas imperfection corrections to the derived properties, the corrections to the free energy function were computed both from the tabulated compressibilities by numerical integration from the equation

$$\frac{F - F^o}{RT} = \int_o^P \frac{Z - 1}{P} dP$$

and from the tabulated entropy and enthalpy. The agreement between the results was very satisfactory, the discrepancies being in the worst case about 2 percent of the correction.

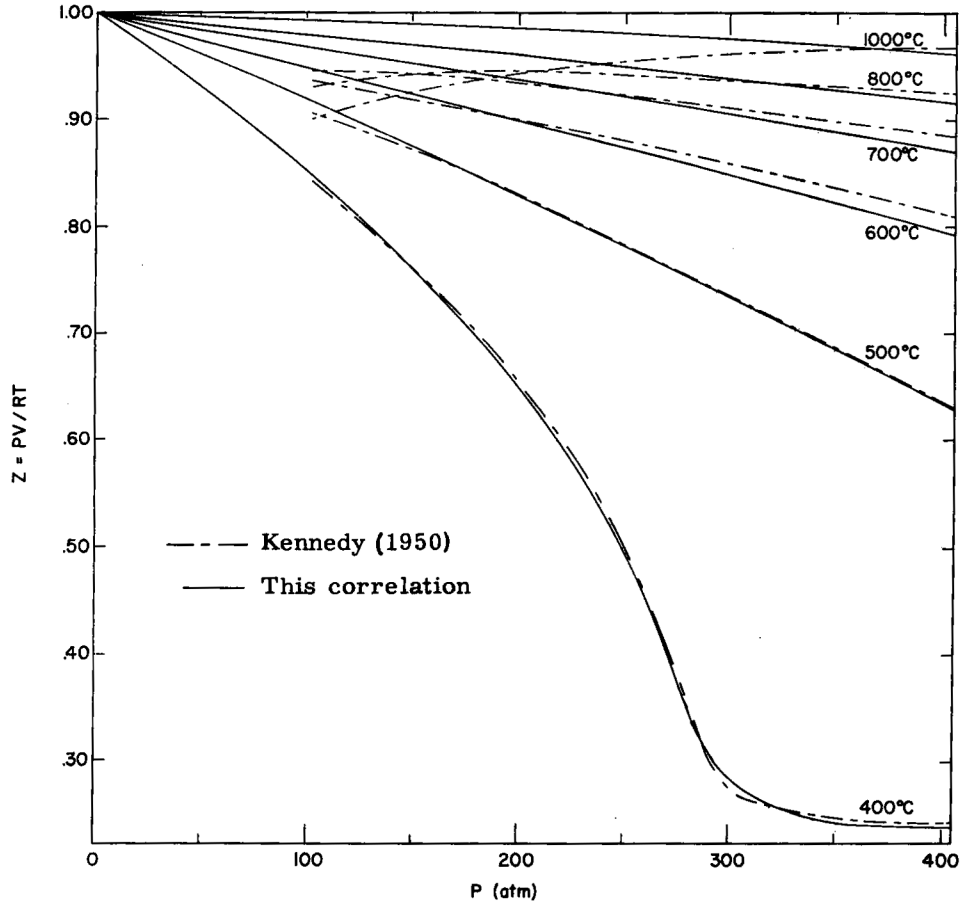

Figure 9a. A comparison of the experimental data of Kennedy [5] with this correlation

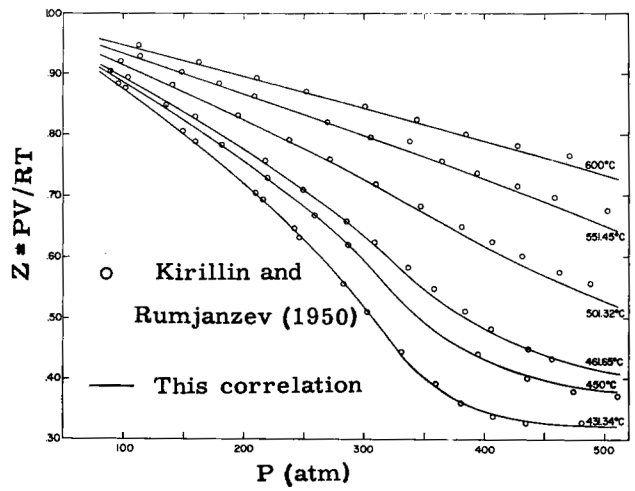

Figure 9b. A comparison of the experimental data of Kirillin and Rumjanzev [6] with this correlation

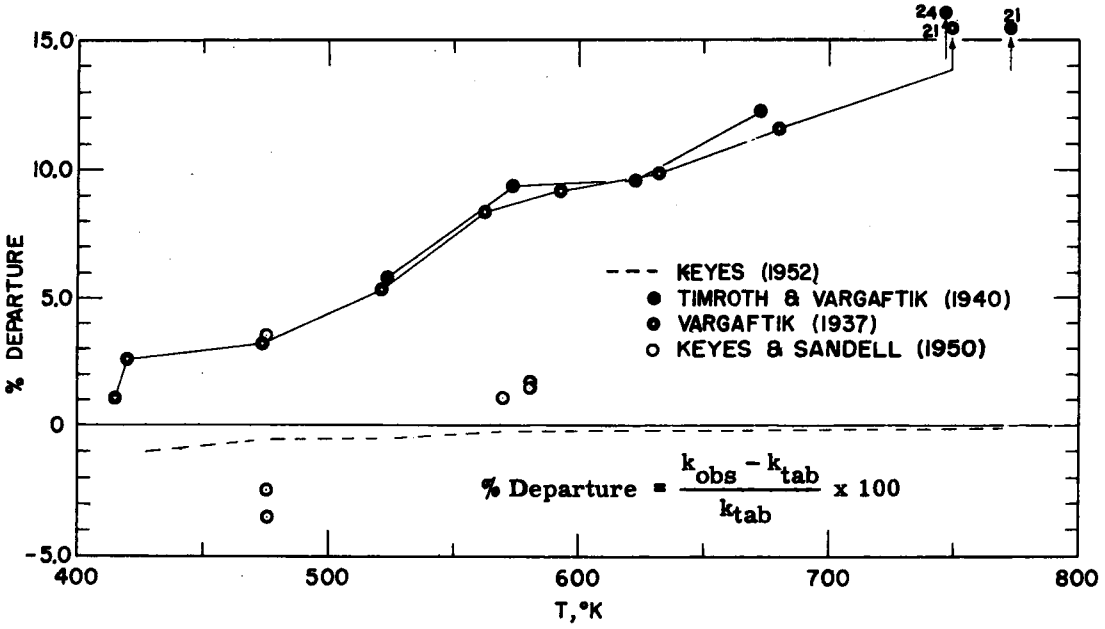

Figure 9c. Departures of low-pressure experimental thermal conductivities from the tabulated values for steam (table 9-7)

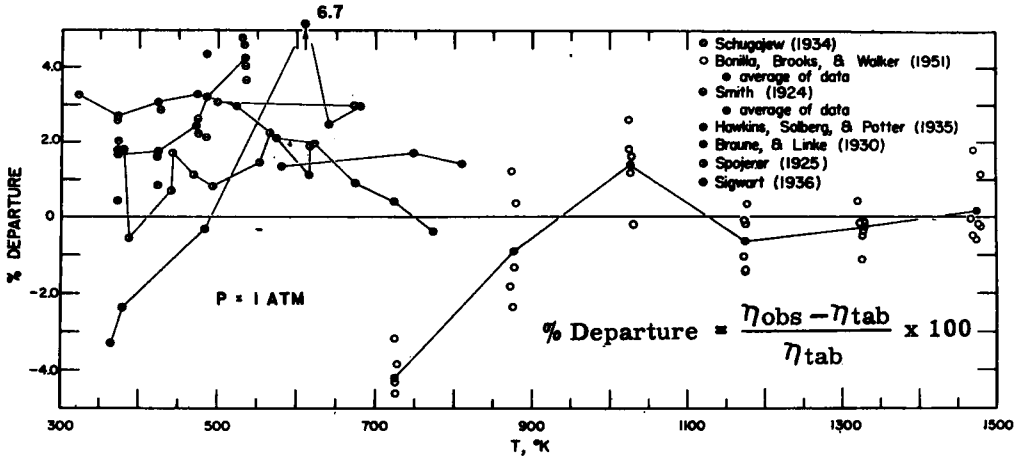

Figure 9d. Departure of low-pressure experimental viscosities from the tabulated values for steam (table 9-6)

The tabulated values of the thermodynamic functions for the ideal gas are those of Friedman and Haar [9]. These authors have calculated the properties of H_2O to temperatures of 5000°K employing a partition function expanded in closed form. The calculations include first order correction terms for anharmonicity, rotation-vibration interaction, and centrifugal stretching. The calculations are based on the best available molecular constants obtained from extensive spectroscopic measurements by Benedict, Gailor, and Plyler [10, 11] and Benedict, Claassen, and Shaw [12]. The same spectroscopic data were employed by Glatt, Adams, and Johnston [13] in a term-by-term summation over the energy levels of the unexpanded partition function with appropriate rotational cut-off. The agreement of this tabulation with earlier tables [14, 15, 16] is discussed fully by Friedman and Haar [9].

The viscosity and thermal conductivity were computed from the equations given in summary tables 1-B and 1-C. A discussion of the correlation is given by Hilsenrath and Touloukian [17].

The vapor pressures tabulated for the liquid were taken from the tabulation of Osborne, Stimson, and Ginnings [18]. The vapor pressure for ice was taken from the tabulation given by Dorsey [19], who lists values for the critical constants, $t_c = 374.15°C$, $p_c = 218.39$ atmospheres, and for the triple point pressure, $p = 0.00603$ atmospheres.

The Consistency and Reliability of the Tables

The accuracy of the tables of thermodynamic functions depends largely on the precision of the correlation of experimental data of state by Keyes [4]. It is estimated that the uncertainty in the values of the compressibility factor (table 9-1) does not exceed a few percent of $Z - 1$. The values of the density (table 9-2) are equally reliable, since they were computed directly from the compressibility factors. For the derived thermodynamic properties, namely, specific heat (table 9-3), enthalpy (table 9-4), entropy (table 9-5), and free energy function (table 9-8), the uncertainties should be approximately 10 percent of the gas imperfection correction.

The estimated uncertainties in the tabulated ideal-gas values are given in the summary table 1-D.

The tables of compressibility and density are in agreement with values obtained by appropriate interpolation methods from the table of specific volumes given in Keenan and Keyes [1]. The derived quantities, however, disagree by amounts corresponding to the differences between the values of the ideal-gas properties used here and those employed in the steam tables. A comparison of this tabulation with the Collins-Keyes [16] formulation for the ideal-gas specific heat shows table 9-10 to be higher by 0.015 in C_p^o/R in the temperature region 300° - 500°K.

Comparisons of tables of entropy and enthalpy must take into account the arbitrary values at the reference points for these functions. The reference point used here for both the enthalpy function and entropy is 0°K at which point the values of these properties are taken to be zero.

The tabulated values of thermal conductivity (table 9-7) have an average deviation of 2.1 percent from the observed values reported by Keyes and Sandell [20], whose experimental data extend to 625°K and 150 atmospheres. The tabulated values depart appreciably from data of Vargaftik [21]

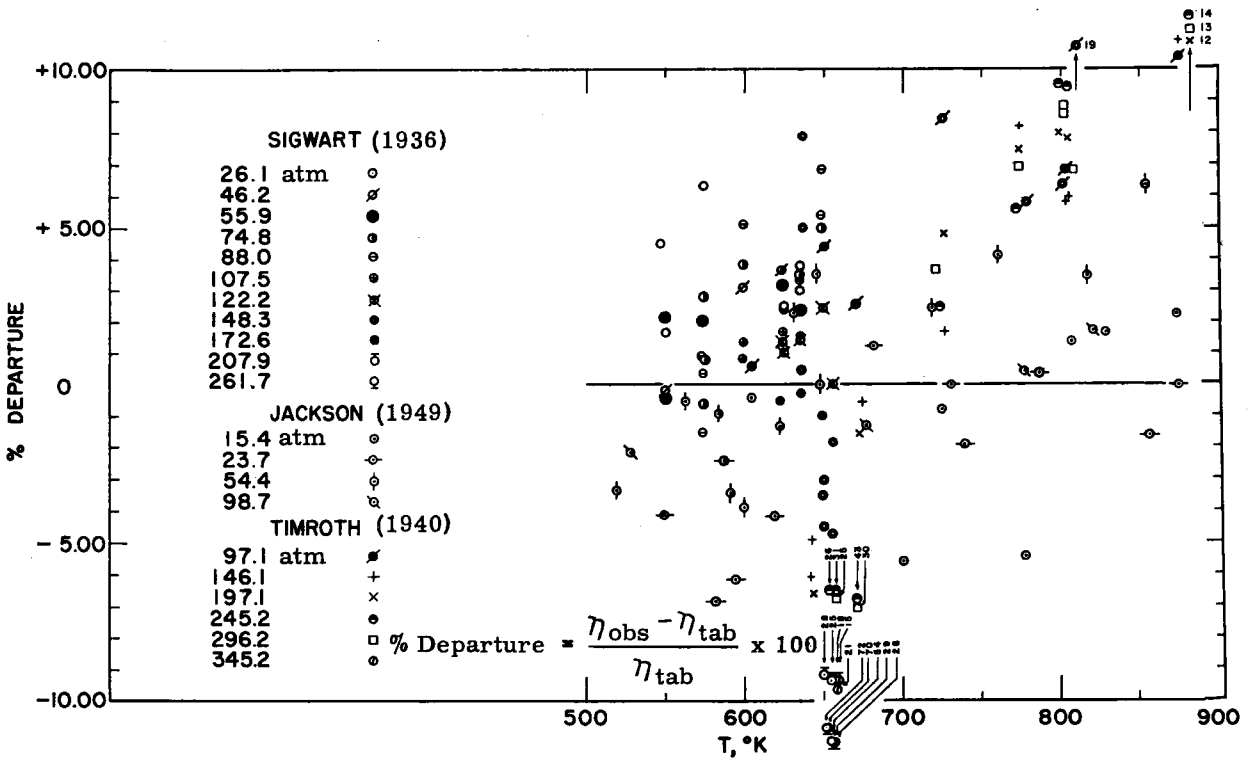

Figure 9e. Departures of high-pressure experimental viscosities from the tabulated values for steam (table 9-6/a)

and Timroth [22]. Figure 9c shows these departures in the low-pressure region (1 atmosphere). The broken line in that figure represents points calculated from the most recent correlation by F. G. Keyes [23].

The departures from the tabulated values of the low-pressure viscosity data for steam are shown in figure 9d to be less than 4 percent. The scatter of the reliable measurements at elevated pressures is higher (approximately 10 percent) as is indicated in figure 9e.

The tables of vapor pressure are thought to be reliable to better than 0.1 percent.

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Table 9-a. VALUES OF THE GAS CONSTANT, R, FOR STEAM

Values of R for Steam for Temperatures in Degrees Kelvin

Pressure / Density	atm	kg/cm^2	mm Hg	lb/in^2
g/cm^3	4.55466	4.70660	3461.54	66.9353
$mole/cm^3$	82.0567	84.7832	62363.1	1205.91
mole/liter	0.0820544	0.0847809	62.3613	1.20587
lb/ft^3	0.0729579	0.0753821	55.4480	1.07219
lb $mole/ft^3$	1.31441	1.35808	998.952	19.3166

Values of R for Steam for Temperatures in Degrees Rankine

Pressure / Density	atm	kg/cm^2	mm Hg	lb/in^2
g/cm^3	2.53037	2.61444	1923.08	37.1863
$mole/cm^3$	45.5871	47.1018	34646.2	669.950
mole/liter	0.0455858	0.0471005	34.6452	0.669928
lb/ft^3	0.0405322	0.0418789	30.8044	0.595661
lb $mole/ft^3$	0.730228	0.754489	554.973	10.7314

Table 9-b. CONVERSION FACTORS FOR THE STEAM TABLES

Conversion Factors for Table 9-2

To Convert Tabulated Value of	To	Having the Dimensions Indicated Below	Multiply by
ρ in g cm^{-3}	ρ	mole cm^{-3}	.055506
		g $liter^{-1}$	1.00003×10^{3}
		lb in^{-3}	3.61275×10^{-2}
		lb ft^{-3}	62.4283

Conversion Factors for Table 9-4 and 9-10

To Convert Tabulated Value of	To	Having the Dimensions Indicated Below	Multiply by
$(H^{o} - E_{0}^{o})/RT_{0}$,	$(H^{o} - E_{0}^{o})$,	cal $mole^{-1}$	542.821
$(H - E_{0}^{o})/RT_{0}$	$(H - E_{0}^{o})$	cal g^{-1}	30.1299
		joules g^{-1}	126.064
		Btu $(lb\ mole)^{-1}$	976.437
		Btu lb^{-1}	54.1983

Conversion Factors for Tables 9-3, 9-5, 9-8, and 9-10

To Convert Tabulated Value of	To	Having the Dimensions Indicated Below	Multiply by
C_{p}^{o}/R, S^{o}/R,	C_{p}^{o}, S^{o},	cal $mole^{-1}\ {}^{o}K^{-1}$ (or $^{o}C^{-1}$)	1.98719
C_{p}/R, S/R,	C_{p}, S,	cal $g^{-1}\ {}^{o}K^{-1}$ (or $^{o}C^{-1}$)	0.110301
$-(F^{o} - E_{0}^{o})/RT$,	$-(F^{o} - E_{0}^{o})/T$,	joules $g^{-1}\ {}^{o}K^{-1}$ (or $^{o}C^{-1}$)	0.461500
		Btu $(lb\ mole)^{-1}\ {}^{o}R^{-1}$ (or $^{o}F^{-1}$)	1.98588
$-(F - E_{0}^{o})/RT$	$-(F - E_{0}^{o})/T$	Btu $lb^{-1}\ {}^{o}R^{-1}$ (or $^{o}F^{-1}$)	0.110229

Molecular weight of steam is 18.016 g $mole^{-1}$. Unless otherwise specified, the mole is the gram-mole; the calorie is the thermochemical calorie; and the joule is the absolute joule.

Conversion Factors for Table 9-6

To Convert Tabulated Value of	To	Having the Dimensions Indicated Below	Multiply by
η in poise or($g\,sec^{-1}\,cm^{-1}$)	η	$kg\,hr^{-1}\,m^{-1}$	3.6000×10^{2}
		$slug\,hr^{-1}\,ft^{-1}$	7.5188
		$lb\,sec^{-1}\,ft^{-1}$	6.7197×10^{-2}
		$lb\,hr^{-1}\,ft^{-1}$	2.4191×10^{2}

Conversion Factors for Table 9-7

To Convert Tabulated Value of	To	Having the Dimensions Indicated Below	Multiply by
k/k_0^o	k	$cal\,cm^{-1}\,sec^{-1}\,{}^oK^{-1}$	3.789×10^{-5}
		$Btu\,ft^{-1}\,hr^{-1}\,{}^oR^{-1}$	9.160×10^{-3}
		$watts\,cm^{-1}\,{}^oK^{-1}$	1.585×10^{-4}

Table 9-1. COMPRESSIBILITY FACTOR FOR STEAM $Z = PV/RT$

°K	1 atm		10 atm		20 atm		40 atm		°R
380	.98591	176							684
390	.98767	145							702
400	.98912	120							720
410	.99032	101							738
420	.99133	86							756
430	.99219	75							774
440	.99294	65							792
450	.99359	56							810
460	.99415	50	.93377	671					828
470	.99465	44	.94048	569					846
480	.99509	39	.94617	488					864
490	.99548	35	.95105	423	.89209	1065			882
500	.99583	31	.95528	369	.90274	902			900
510	.99614	28	.95897	326	.91176	777			918
520	.99642	25	.96223	288	.91953	673			936
530	.99667	23	.96511	257	.92626	589	.83225	1613	954
540	.99690	21	.96768	231	.93215	521	.84838	1367	972
550	.99711	19	.96999	208	.93736	462	.86205	1174	990
560	.99730	17	.97207	188	.94198	413	.87379	1021	1008
570	.99747	16	.97395	170	.94611	372	.88400	895	1026
580	.99763	14	.97565	155	.94983	335	.89295	792	1044
590	.99777	13	.97720	142	.95318	304	.90087	705	1062
600	.99790	12	.97862	130	.95622	277	.90792	633	1080
610	.99802	12	.97992	119	.95899	253	.91425	570	1098
620	.99814	10	.98111	110	.96152	232	.91995	516	1116
630	.99824	10	.98221	102	.96384	212	.92511	469	1134
640	.99834	9	.98323	94	.96596	195	.92980	422	1152
650	.99843	9	.98417	86	.96791	178	.93402	385	1170
660	.99852	8	.98503	81	.96969	168	.93787	356	1188
670	.99860	7	.98584	75	.97137	155	.94143	329	1206
680	.99867	7	.98659	70	.97292	144	.94472	305	1224
690	.99874	6	.98729	66	.97436	134	.94777	283	1242
700	.99880	6	.98795	61	.97570	125	.95060	263	1260
710	.99886	6	.98856	57	.97695	118	.95323	245	1278
720	.99892	5	.98913	54	.97813	110	.95568	229	1296
730	.99897	5	.98967	51	.97923	103	.95797	214	1314
740	.99902	5	.99018	47	.98026	97	.96011	200	1332
750	.99907	4	.99065	45	.98123	90	.96211	188	1350
760	.99911	4	.99110	42	.98213	86	.96399	177	1368
770	.99915	4	.99152	40	.98299	80	.96576	166	1386
780	.99919	4	.99192	37	.98379	76	.96742	156	1404
790	.99923	4	.99229	36	.98455	72	.96898	147	1422
800	.99927	3	.99265	33	.98527	68	.97045	139	1440
810	.99930	3	.99298	32	.98595	64	.97184	131	1458
820	.99933	3	.99330	30	.98659	61	.97315	124	1476
830	.99936	3	.99360	29	.98720	58	.97439	117	1494
840	.99939	3	.99389	27	.98778	54	.97556	111	1512
850	.99942		.99416		.98832		.97667		1530

Table 9-1. COMPRESSIBILITY FACTOR FOR STEAM - Cont. $Z = PV/RT$

°K	60 atm		80 atm		100 atm		120 atm		°R
550	.76634	2397							990
560	.79031	1983							1008
570	.81014	1678	.71657	3026					1026
580	.82692	1441	.74683	2458					1044
590	.84133	1253	.77141	2053	.6840	340			1062
600	.85386	1101	.79194	1750	.7180	274	.6214	461	1080
610	.86487	975	.80944	1514	.7454	228	.6675	350	1098
620	.87462	871	.82458	1326	.7682	194	.7025	283	1116
630	.88333	782	.83784	1171	.7876	167	.7308	234	1134
640	.89115	692	.84955	1017	.8043	142	.7542	194	1152
650	.89807	625	.85972	905	.81848	1242	.7736	166	1170
660	.90432	572	.86877	823	.83090	1117	.7902	147	1188
670	.91004	526	.87700	751	.84207	1011	.80493	1316	1206
680	.91530	485	.88451	688	.85218	920	.81809	1185	1224
690	.92015	448	.89139	633	.86138	839	.82994	1074	1242
700	.92463	415	.89772	582	.86977	769	.84068	977	1260
710	.92878	385	.90354	539	.87746	707	.85045	894	1278
720	.93263	358	.90893	498	.88453	652	.85939	819	1296
730	.93621	334	.91391	463	.89105	603	.86758	755	1314
740	.93955	312	.91854	432	.89708	559	.87513	697	1332
750	.94267	291	.92286	402	.90267	520	.88210	645	1350
760	.94558	273	.92688	375	.90787	484	.88855	599	1368
770	.94831	255	.93063	350	.91271	451	.89454	557	1386
780	.95086	241	.93413	329	.91722	421	.90011	519	1404
790	.95327	226	.93742	309	.92143	395	.90530	485	1422
800	.95553	213	.94051	290	.92538	370	.91015	453	1440
810	.95766	200	.94341	273	.92908	348	.91468	425	1458
820	.95966	190	.94614	257	.93256	327	.91893	399	1476
830	.96156	179	.94871	242	.93583	308	.92292	375	1494
840	.96335	169	.95113	229	.93891	290	.92667	354	1512
850	.96504		.95342		.94181		.93021		1530

°K	120 atm		140 atm		160 atm		180 atm		°R
600	.6214	461							1080
610	.6675	350							1098
620	.7025	283	.6209	433					1116
630	.7308	234	.6642	337	.5797	518			1134
640	.7542	194	.6979	264	.6315	371	.5464	569	1152
650	.7736	166	.7243	218	.6686	289	.6033	395	1170
660	.7902	147	.7461	190	.6975	246	.6428	321	1188
670	.80493	1316	.7651	168	.7221	212	.6749	269	1206
680	.81809	1185	.78194	1495	.7433	187	.7018	231	1224
690	.82994	1074	.79689	1342	.76198	1652	.72492	2016	1242
700	.84068	977	.81031	1212	.77850	1478	.74508	1783	1260
710	.85045	894	.82243	1100	.79328	1332	.76291	1591	1278
720	.85939	819	.83343	1004	.80660	1206	.77882	1430	1296
730	.86758	755	.84347	919	.81866	1099	.79312	1294	1314
740	.87513	697	.85266	845	.82965	1005	.80606	1177	1332
750	.88210	645	.86111	780	.83970	922	.81783	1076	1350
760	.88855	599	.86891	720	.84892	851	.82859	988	1368
770	.89454	557	.87611	669	.85743	785	.83847	909	1386
780	.90011	519	.88280	621	.86528	728	.84756	840	1404
790	.90530	485	.88901	579	.87256	677	.85596	779	1422
800	.91015	453	.89480	540	.87933	630	.86375	723	1440
810	.91468	425	.90020	505	.88563	588	.87098	673	1458
820	.91893	399	.90525	473	.89151	549	.87771	627	1476
830	.92292	375	.90998	444	.89700	514	.88398	587	1494
840	.92667	354	.91442	418	.90214	485	.88985	551	1512
850	.93021		.91860		.90699		.89536		1530

Table 9-1. COMPRESSIBILITY FACTOR FOR STEAM - Cont. $Z = PV/RT$

°K	180 atm		200 atm		220 atm		240 atm		°R
640	.5464	569							1152
650	.6033	395	.5206	584	.3763	1224			1170
660	.6428	321	.5790	432	.4987	625	.3751	1120	1188
670	.6749	269	.6222	344	.5612	453	.4871	628	1206
680	.7018	231	.6566	287	.6065	360	.5499	459	1224
690	.72492	2016	.6853	245	.6425	298	.5958	366	1242
700	.74508	1783	.70978	2137	.6723	255	.6324	305	1260
710	.76291	1591	.73115	1884	.69785	2220	.6629	260	1278
720	.77882	1430	.74999	1679	.72005	1956	.6889	227	1296
730	.79312	1294	.76678	1508	.73961	1743	.7116	200	1314
740	.80606	1177	.78186	1364	.75704	1565	.7316	178	1332
750	.81783	1076	.79550	1240	.77269	1415	.7494	160	1350
760	.82859	988	.80790	1133	.78684	1287	.7654	145	1368
770	.83847	909	.81923	1039	.79971	1176	.7799	132	1386
780	.84756	840	.82962	957	.81147	1079	.7931	121	1404
790	.85596	779	.83919	885	.82226	994	.8052	110	1422
800	.86375	723	.84804	819	.83220	918	.8162	102	1440
810	.87098	673	.85623	761	.84138	851	.8264	95	1458
820	.87771	627	.86384	708	.84989	790	.8359	87	1476
830	.88398	587	.87092	660	.85779	736	.8446	81	1494
840	.88985	551	.87752	619	.86515	688	.8527	76	1512
850	.89536		.88371		.87203		.8603		1530

°K	240 atm		260 atm		280 atm		300 atm		°R
660	.3751	1120							1188
670	.4871	628	.3888	952					1206
680	.5499	459	.4840	604	.4066	805	.3323	931	1224
690	.5958	366	.5444	451	.4871	564	.4254	690	1242
700	.6324	305	.5895	365	.5435	436	.4944	519	1260
710	.6629	260	.6260	305	.5871	356	.5463	413	1278
720	.6889	227	.6565	261	.6227	300	.5876	344	1296
730	.7116	200	.6826	228	.6527	259	.6220	292	1314
740	.7316	178	.7054	202	.6786	227	.6512	254	1332
750	.7494	160	.7256	180	.7013	202	.6766	224	1350
760	.7654	145	.7436	162	.7215	180	.6990	199	1368
770	.7799	132	.7598	147	.7395	162	.7189	179	1386
780	.7931	121	.7745	134	.7557	148	.7368	161	1404
790	.8052	110	.7879	122	.7705	134	.7529	147	1422
800	.8162	102	.8001	113	.7839	124	.7676	134	1440
810	.8264	95	.8114	104	.7963	113	.7810	123	1458
820	.8359	87	.8218	96	.8076	105	.7933	114	1476
830	.8446	81	.8314	89	.8181	97	.8047	105	1494
840	.8527	76	.8403	83	.8278	89	.8152	97	1512
850	.8603		.8486		.8367		.8249		1530

Table 9-2. DENSITY OF STEAM ρ

°K	1 atm		10 atm		20 atm		40 atm		°R
	g/cm^3		g/cm^3		g/cm^3		g/cm^3		
380	.00058604	−1605							684
390	.00056999	−1506							702
400	.00055493	−1419							720
410	.00054074	−1342							738
420	.00052732	−1270							756
430	.00051462	−1208							774
440	.00050254	−1149							792
450	.00049105	−1095							810
460	.00048010	−1045	.0051115	− 1445					828
470	.00046965	− 999	.0049670	− 1327					846
480	.00045966	− 955	.0048343	− 1229					864
490	.00045011	− 916	.0047114	− 1147	.010045	− 317			882
500	.00044095	− 878	.0045967	− 1075	.0097284	− 2851			900
510	.00043217	− 843	.0044892	− 1012	.0094433	− 2598			918
520	.00042374	− 810	.0043880	− 957	.0091835	− 2388			936
530	.00041564	− 779	.0042923	− 907	.0089447	− 2211	.019910	− 740	954
540	.00040785	− 750	.0042016	− 862	.0087236	− 2062	.019170	− 647	972
550	.00040035	− 722	.0041154	− 821	.0085174	− 1932	.018523	− 576	990
560	.00039313	− 697	.0040333	− 784	.0083242	− 1817	.017947	− 518	1008
570	.00038616	− 672	.0039549	− 750	.0081425	− 1717	.017429	− 472	1026
580	.00037944	− 648	.0038799	− 718	.0079708	− 1627	.016957	− 434	1044
590	.00037296	− 626	.0038081	− 689	.0078081	− 1545	.016523	− 402	1062
600	.00036670	− 606	.0037392	− 662	.0076536	− 1472	.016121	− 374	1080
610	.00036064	− 586	.0036730	− 636	.0075064	− 1405	.015747	− 350	1098
620	.00035478	− 567	.0036094	− 613	.0073659	− 1344	.015397	− 329	1116
630	.00034911	− 548	.0035481	− 590	.0072315	− 1286	.015068	− 310	1134
640	.00034363	− 532	.0034891	− 570	.0071029	− 1234	.014758	− 292	1152
650	.00033831	− 516	.0034321	− 550	.0069795	− 1184	.014466	− 278	1170
660	.00033315	− 500	.0033771	− 531	.0068611	− 1140	.014188	− 265	1188
670	.00032815	− 484	.0033240	− 514	.0067471	− 1099	.013923	− 252	1206
680	.00032331	− 471	.0032726	− 497	.0066372	− 1058	.013671	− 242	1224
690	.00031860	− 457	.0032229	− 481	.0065314	− 1022	.013429	− 231	1242
700	.00031403	− 444	.0031748	− 467	.0064292	− 986	.013198	− 222	1260
710	.00030959	− 432	.0031281	− 452	.0063306	− 955	.012976	− 213	1278
720	.00030527	− 420	.0030829	− 439	.0062351	− 923	.012763	− 205	1296
730	.00030107	− 408	.0030390	− 426	.0061428	− 894	.012558	− 197	1314
740	.00029699	− 398	.0029964	− 414	.0060534	− 866	.012361	− 190	1332
750	.00029301	− 386	.0029550	− 402	.0059668	− 839	.012171	− 184	1350
760	.00028915	− 377	.0029148	− 390	.0058829	− 815	.011987	− 177	1368
770	.00028538	− 367	.0028758	− 381	.0058014	− 790	.011810	− 172	1386
780	.00028171	− 358	.0028377	− 369	.0057224	− 768	.011638	− 165	1404
790	.00027813	− 349	.0028008	− 360	.0056456	− 747	.011473	− 161	1422
800	.00027464	− 339	.0027648	− 351	.0055709	− 725	.011312	− 156	1440
810	.00027125	− 332	.0027297	− 341	.0054984	− 706	.011156	− 150	1458
820	.00026793	− 324	.0026956	− 333	.0054278	− 687	.011006	− 147	1476
830	.00026469	− 315	.0026623	− 325	.0053591	− 669	.010859	− 142	1494
840	.00026154	− 309	.0026298	− 316	.0052922	− 651	.010717	− 138	1512
850	.00025845		.0025982		.0052271		.010579		1530

Table 9-2. DENSITY OF STEAM - Cont.

°K	60 atm		80 atm		100 atm		120 atm		°R
	g/cm^3		g/cm^3		g/cm^3		g/om^3		
550	.031254	− 1489							990
560	.029765	− 1238							1008
570	.028527	− 1060	.043003	− 2454					1026
580	.027467	− 928	.040549	− 1957					1044
590	.026539	− 826	.038592	− 1627	.05441	−345			1062
600	.025713	− 743	.036965	− 1392	.05096	−268	.07066	− 595	1080
610	.024970	− 677	.035573	− 1217	.04828	−218	.06471	− 422	1098
620	.024293	− 621	.034356	− 1080	.04610	−185	.06049	− 327	1116
630	.023672	− 574	.033276	− 971	.04425	−160	.05722	− 264	1134
640	.023098	− 531	.032305	− 874	.04265	−138	.05458	− 218	1152
650	.022567	− 496	.031431	− 798	.041269	−1233	.05240	− 188	1170
660	.022071	− 466	.030633	− 741	.040036	−1121	.05052	− 167	1188
670	.021605	− 440	.029292	− 689	.038915	−1027	.048853	− 1493	1206
680	.021165	− 416	.029203	− 646	.037888	− 948	.047360	− 1352	1224
690	.020749	− 396	.028557	− 606	.036940	− 879	.046008	− 1237	1242
700	.020353	− 376	.027951	− 571	.036061	− 819	.044771	− 1138	1260
710	.019977	− 359	.027380	− 541	.035242	− 767	.043633	−1053	1278
720	.019618	− 343	.026839	− 512	.034475	− 721	.042580	− 980	1296
730	.019275	− 328	.026327	− 486	.033754	− 680	.041600	− 916	1314
740	.018947	− 314	.025841	− 464	.033074	− 644	.040684	− 860	1332
750	.018633	− 302	.025377	− 443	.032430	− 610	.039824	− 809	1350
760	.018331	− 290	.024934	− 423	.031820	− 579	.039015	− 765	1368
770	.018041	− 279	.024511	− 405	.031241	− 552	.038250	− 724	1386
780	.017762	− 269	.024106	− 388	.030689	− 527	.037526	− 687	1404
790	.017493	− 260	.023718	− 374	.030162	− 504	.036839	− 655	1422
800	.017233	− 251	.023344	− 359	.029658	− 483	.036184	− 623	1440
810	.016982	− 242	.022985	− 346	.029175	− 464	.035561	− 596	1458
820	.016740	− 234	.022639	− 333	.028711	− 445	.034965	− 571	1476
830	.016506	− 227	.022306	−322	.028266	− 428	.034394	− 547	1494
840	.016279	− 220	.021984	−310	.027838	− 412	.033847	− 525	1512
850	.016059		.021674		.027426		.033322		1530

Table 9-2. DENSITY OF STEAM - Cont.

ρ

°K	120 atm		140 atm		160 atm		180 atm		°R
	g/cm³		g/cm³		g/cm³		g/cm³		
600	.07066	− 595							1080
610	.06471	− 422							1098
620	.06049	− 327	.07985	− 637					1116
630	.05722	− 264	.07348	− 466	.09619	− 927			1134
640	.05458	− 218	.06882	− 353	.08692	− 609	.1130	− 122	1152
650	.05240	− 188	.06529	− 287	.08083	− 452	.1008	− 76	1170
660	.05052	− 167	.06242	− 246	.07631	− 370	.09315	− 575	1188
670	.048853	− 1493	.05996	− 215	.07261	− 312	.08740	− 459	1206
680	.047360	− 1352	.057808	− 1906	.06949	− 268	.08281	− 380	1224
690	.046008	− 1237	.055902	− 1712	.066814	− 2351	.079009	− 3236	1242
700	.044771	− 1138	.054190	− 1550	.064463	− 2093	.075773	− 2813	1260
710	.043633	− 1053	.052640	− 1416	.062370	− 1881	.072960	− 2483	1278
720	.042580	− 980	.051224	− 1303	.060489	− 1708	.070477	− 2219	1296
730	.041600	− 916	.049921	− 1206	.058781	− 1562	.068258	− 2003	1314
740	.040684	− 860	.048715	− 1121	.057219	− 1439	.066255	− 1825	1332
750	.039824	− 809	.047594	− 1048	.055780	− 1332	.064430	− 1673	1350
760	.039015	− 765	.046546	− 982	.054448	− 1240	.062757	− 1545	1368
770	.038250	− 724	.045564	− 925	.053208	− 1159	.061212	− 1433	1386
780	.037526	− 687	.044639	− 873	.052049	− 1088	.059779	− 1336	1404
790	.036839	− 655	.043766	− 827	.050961	− 1024	.058443	− 1251	1422
800	.036184	− 623	.042939	− 784	.049937	− 967	.057192	− 1174	1440
810	.035561	− 596	.042155	− 747	.048970	− 917	.056018	− 1108	1458
820	.034965	− 571	.041408	− 711	.048053	− 869	.054910	− 1046	1476
830	.034394	− 547	.040697	− 680	.047184	− 827	.053864	− 993	1494
840	.033847	− 525	.040017	− 650	.046357	− 791	.052871	− 943	1512
850	.033322		.039367		.045566		.051928		1530

°K	180 atm		200 atm		220 atm		240 atm		°R
	g/cm³		g/cm³		g/cm³		g/cm³		
640	.1130	− 122							1152
650	.1008	− 76	.1298	− 149	.1975	− 507			1170
660	.09315	− 575	.1149	− 96	.1468	− 183	.2128	− 513	1188
670	.08740	− 459	.1053	− 70	.1285	− 114	.1615	− 206	1206
680	.08281	− 380	.09835	− 547	.1171	− 81	.1409	− 127	1224
690	.079009	− 3236	.09288	− 450	.1090	− 64	.1282	− 92	1242
700	.075773	− 2813	.088380	− 3792	.1026	− 51	.1190	− 70	1260
710	.072960	− 2483	.084588	− 3270	.09749	− 432	.1120	− 58	1278
720	.070477	− 2219	.081318	− 2870	.093169	− 3706	.1062	− 48	1296
730	.068258	− 2003	.078448	− 2553	.089463	− 3242	.1014	− 41	1314
740	.066255	− 1825	.075895	− 2296	.086221	− 2872	.09733	− 358	1332
750	.064430	− 1673	.073599	− 2083	.083349	− 2576	.09375	− 317	1350
760	.062757	− 1545	.071516	− 1905	.080773	− 2332	.09058	− 284	1368
770	.061212	− 433	.069611	− 1753	.078441	− 2128	.08774	− 256	1386
780	.059779	− 1336	.067858	− 1623	.076313	− 1955	.08518	− 234	1404
790	.058443	− 1251	.066235	− 1511	.074358	− 1806	.08284	− 214	1422
800	.057192	− 1174	.064724	− 1410	.072552	− 1678	.08070	− 198	1440
810	.056018	− 1108	.063314	− 1323	.070874	− 1565	.07872	− 184	1458
820	.054910	− 1046	.061991	− 1245	.069309	− 1466	.07688	− 171	1476
830	.053864	− 993	.060746	− 1174	.067843	− 1378	.07517	− 160	1494
840	.052871	− 943	.059572	− 1114	.066465	− 1300	.07357	− 151	1512
850	.051928		.058458		.065165		.07206		1530

Table 9-2. DENSITY OF STEAM - Cont.

°K	240 atm		260 atm		280 atm		300 atm		°R
	g/cm^3		g/cm^3		g/cm^3		g/cm^3		
660	.2128	− 513							1188
670	.1615	− 206	.2191	− 457					1206
680	.1409	− 127	.1734	− 214	.2223	− 394	.2915	− 671	1224
690	.1282	− 92	.1520	− 137	.1829	− 213	.2244	− 341	1242
700	.1190	− 70	.1383	− 99	.1616	− 141	.1903	− 205	1260
710	.1120	− 58	.1284	− 76	.1475	− 104	.1698	− 141	1278
720	.1062	− 48	.1208	− 62	.1371	− 81	.1557	− 106	1296
730	.1014	− 41	.1146	− 52	.1290	− 66	.1451	− 84	1314
740	.09733	− 358	.1094	− 45	.1224	− 55	.1367	− 69	1332
750	.09375	− 317	.1049	− 39	.1169	− 48	.1298	− 58	1350
760	.09058	− 284	.1010	− 34	.1121	− 41	.1240	− 50	1368
770	.08774	− 256	.09757	− 308	.1080	− 37	.1190	− 44	1386
780	.08518	− 234	.09449	− 278	.1043	− 33	.1146	− 39	1404
790	.08284	− 214	.09171	− 253	.1010	− 30	.1107	− 34	1422
800	.08070	− 198	.08918	− 233	.09803	− 272	.1073	− 32	1440
810	.07872	− 184	.08685	− 214	.09531	− 248	.1041	− 28	1458
820	.07688	− 171	.08471	− 199	.09283	− 229	.1013	− 27	1476
830	.07517	− 160	.08272	− 185	.09054	− 213	.09862	− 243	1494
840	.07357	− 151	.08037	− 173	.08841	− 197	.09619	− 225	1512
850	.07206		.07914		.08644		.09394		1530

Table 9-3. SPECIFIC HEAT OF STEAM C_p/R

°K	1 atm		10 atm		20 atm		40 atm		°R
380	4.462	-64							684
390	4.398	-43							702
400	4.355	-27							720
410	4.328	-16							738
420	4.312	-12							756
430	4.300	- 9							774
440	4.291	- 7							792
450	4.284	- 2							810
460	4.282		5.614	-216					828
470	4.282	3	5.398	-167					846
480	4.285	3	5.231	-132					864
490	4.288	6	5.099	-105	6.574	-363			882
500	4.294	7	4.994	- 84	6.211	-284			900
510	4.301	7	4.910	- 68	5.927	-224			918
520	4.308	9	4.842	- 54	5.703	-180			936
530	4.317	9	4.788	- 44	5.523	-145	8.041	-609	954
540	4.326	9	4.744	- 36	5.378	-118	7.432	-465	972
550	4.335	11	4.708	- 27	5.260	- 96	6.967	-365	990
560	4.346	11	4.681	- 22	5.164	- 79	6.602	-291	1008
570	4.357	10	4.659	- 18	5.085	- 66	6.311	-237	1026
580	4.367	12	4.641	- 13	5.019	- 54	6.074	-193	1044
590	4.379	12	4.628	- 10	4.965	- 44	5.881	-158	1062
600	4.391	13	4.618	- 7	4.921	- 37	5.723	-131	1080
610	4.404	12	4.611	- 5	4.884	- 30	5.591	-110	1098
620	4.416	13	4.606	- 2	4.854	- 25	5.481	- 92	1116
630	4.429	13	4.604	- 1	4.829	- 21	5.389	- 78	1134
640	4.442	12	4.603	1	4.808	- 16	5.311	- 65	1152
650	4.454	13	4.604	2	4.792	- 13	5.246	- 56	1170
660	4.467	14	4.606	4	4.779	- 9	5.190	- 46	1188
670	4.481	14	4.610	5	4.770	- 8	5.144	- 40	1206
680	4.495	13	4.615	5	4.762	- 5	5.104	- 34	1224
690	4.508	14	4.620	7	4.757	- 3	5.070	- 27	1242
700	4.522	13	4.627	7	4.754	- 2	5.043	- 25	1260
710	4.535	15	4.634	8	4.752		5.018	- 19	1278
720	4.550	14	4.642	9	4.752	2	4.999	- 16	1296
730	4.564	14	4.651	8	4.754	2	4.983	- 13	1314
740	4.578	14	4.659	10	4.756	4	4.970	- 11	1332
750	4.592	15	4.669	11	4.760	5	4.959	- 8	1350
760	4.607	14	4.680	10	4.765	5	4.951	- 8	1368
770	4.621	15	4.690	11	4.770	6	4.943	- 4	1386
780	4.636	14	4.701	11	4.776	8	4.939	- 2	1404
790	4.650	15	4.712	12	4.784	8	4.937		1422
800	4.665	15	4.724	12	4.792	8	4.937	1	1440
810	4.680	14	4.736	12	4.800	9	4.938	1	1458
820	4.694	15	4.748	12	4.809	9	4.939	2	1476
830	4.709	15	4.760	12	4.818	10	4.941	3	1494
840	4.724	15	4.772	13	4.828	10	4.944	5	1512
850	4.739	15	4.785	13	4.838	10	4.949	5	1530

Table 9-3. SPECIFIC HEAT OF STEAM - Cont.

C_p/R

°K	40 atm		60 atm		80 atm		100 atm		°R
530	8.041	-609							954
540	7.432	-465							972
550	6.967	-365	10.328	-1197					990
560	6.602	-291	9.131	- 805					1008
570	6.311	-237	8.326	- 601	12.503	-1929			1026
580	6.074	-193	7.725	- 468	10.574	-1150			1044
590	5.881	-158	7.257	- 371	9.424	- 805	13.879	-2366	1062
600	5.723	-132	6.886	- 301	8.619	- 611	11.513	-1364	1080
610	5.591	-110	6.585	- 247	8.008	- 481	10.149	- 934	1098
620	5.481	- 92	6.338	- 203	7.527	- 386	9.215	- 698	1116
630	5.389	- 78	6.135	- 169	7.141	- 315	8.517	- 547	1134
640	5.311	- 65	5.966	- 141	6.826	- 258	7.970	- 439	1152
650	5.246	- 56	5.825	- 121	6.568	- 217	7.531	- 359	1170
660	5.190	- 46	5.704	- 100	6.351	- 179	7.172	- 294	1188
670	5.144	- 40	5.604	- 86	6.172	- 152	6.878	- 244	1206
680	5.104	- 34	5.518	- 73	6.020	- 127	6.634	- 204	1224
690	5.070	- 27	5.445	- 62	5.893	- 108	6.430	- 171	1242
700	5.043	- 25	5.383	- 54	5.785	- 95	6.259	- 148	1260
710	5.018	- 19	5.329	- 45	5.690	- 80	6.111	- 124	1278
720	4.999	- 16	5.284	- 39	5.610	- 68	5.987	- 106	1296
730	4.983	- 13	5.245	- 34	5.542	- 60	5.881	- 92	1314
740	4.970	- 11	5.211	- 29	5.482	- 50	5.789	- 79	1332
750	4.959	- 8	5.182	- 24	5.432	- 45	5.710	- 69	1350
760	4.951	- 8	5.158	- 23	5.387	- 41	5.641	- 63	1368
770	4.943	- 4	5.135	- 17	5.346	- 32	5.578	- 50	1386
780	4.939	- 2	5.118	- 13	5.314	- 27	5.528	- 43	1404
790	4.937		5.105	- 11	5.287	- 23	5.485	- 37	1422
800	4.937	1	5.094	- 8	5.264	- 19	5.448	- 31	1440
810	4.938	1	5.086	- 8	5.245	- 18	5.417	- 30	1458
820	4.939	2	5.078	- 5	5.227	- 14	5.387	- 24	1476
830	4.941	3	5.073	- 4	5.213	- 12	5.363	- 21	1494
840	4.944	5	5.069	- 2	5.201	- 9	5.342	- 18	1512
850	4.949	5	5.067		5.192	- 6	5.324	- 15	1530

Table 9-4. ENTHALPY OF STEAM* $(H-E_0^0)/RT_0$

°K	1 atm		10 atm		20 atm		40 atm		°R
380	5.482	162							684
390	5.644	160							702
400	5.804	159							720
410	5.963	158							738
420	6.121	158							756
430	6.279	157							774
440	6.436	157							792
450	6.593	157							810
460	6.750	157	6.306	201					828
470	6.907	156	6.507	195					846
480	7.063	157	6.702	189					864
490	7.220	157	6.891	184	6.432	233			882
500	7.377	158	7.075	182	6.665	222			900
510	7.535	157	7.257	178	6.887	213			918
520	7.692	158	7.435	176	7.100	206			936
530	7.850	158	7.611	175	7.306	199	6.528	283	954
540	8.008	159	7.786	173	7.505	195	6.811	263	972
550	8.167	159	7.959	172	7.700	190	7.074	248	990
560	8.326	159	8.131	171	7.890	188	7.322	236	1008
570	8.485	160	8.302	170	8.078	185	7.558	227	1026
580	8.645	160	8.472	169	8.263	183	7.785	219	1044
590	8.805	160	8.641	170	8.446	181	8.004	212	1062
600	8.965	161	8.811	168	8.627	179	8.216	207	1080
610	9.126	162	8.979	169	8.806	178	8.423	202	1098
620	9.288	162	9.148	169	8.984	177	8.625	199	1116
630	9.450	162	9.317	168	9.161	177	8.824	196	1134
640	9.612	163	9.485	169	9.338	175	9.020	193	1152
650	9.775	163	9.654	168	9.513	176	9.213	191	1170
660	9.938	164	9.822	169	9.689	174	9.404	189	1188
670	10.102	164	9.991	169	9.863	175	9.593	188	1206
680	10.266	165	10.160	169	10.038	174	9.781	186	1224
690	10.431	165	10.329	169	10.212	174	9.967	185	1242
700	10.596	166	10.498	170	10.386	174	10.152	184	1260
710	10.762	166	10.668	170	10.560	174	10.336	184	1278
720	10.928	167	10.838	170	10.734	174	10.520	183	1296
730	11.095	167	11.008	170	10.908	174	10.703	182	1314
740	11.262	168	11.178	171	11.082	174	10.885	181	1332
750	11.430	169	11.349	171	11.256	175	11.066	182	1350
760	11.599	169	11.520	171	11.431	174	11.248	181	1368
770	11.768	169	11.691	172	11.605	175	11.429	181	1386
780	11.937	170	11.863	173	11.780	175	11.610	181	1404
790	12.107	171	12.036	172	11.955	175	11.791	180	1422
800	12.278	171	12.208	173	12.130	176	11.971	181	1440
810	12.449	171	12.381	174	12.306	176	12.152	181	1458
820	12.620	172	12.555	174	12.482	176	12.333	181	1476
830	12.792	173	12.729	174	12.658	176	12.514	181	1494
840	12.965	173	12.903	175	12.834	177	12.695	181	1512
850	13.138		13.078		13.011		12.876		1530

*The enthalpy function is divided here by a constant RT_0 where $T_0 = 273.16°K$ (491.688°R).

Table 9-4. ENTHALPY OF STEAM - Cont.* $(H-E_0^o)/RT_0$

°K	40 atm		60 atm		80 atm		100 atm		°R
530	6.528	283							954
540	6.811	263							972
550	7.074	248	6.237	355					990
560	7.322	236	6.592	319					1008
570	7.558	227	6.911	293	6.051	420			1026
580	7.785	219	7.204	274	6.471	365			1044
590	8.004	212	7.478	258	6.836	329	6.000	462	1062
600	8.216	207	7.736	247	7.165	304	6.462	395	1080
610	8.432	202	7.983	236	7.469	284	6.857	353	1098
620	8.625	199	8.219	228	7.753	269	7.210	324	1116
630	8.824	196	8.447	222	8.022	255	7.534	302	1134
640	9.020	193	8.669	216	8.277	245	7.836	283	1152
650	9.213	191	8.885	210	8.522	236	8.119	269	1170
660	9.404	189	9.095	207	8.758	230	8.388	257	1188
670	9.593	188	9.302	204	8.988	223	8.645	247	1206
680	9.781	186	9.506	201	9.211	218	8.892	239	1224
690	9.967	185	9.707	198	9.429	213	9.131	233	1242
700	10.152	184	9.905	196	9.642	210	9.364	226	1260
710	10.336	184	10.101	194	9.852	207	9.590	221	1278
720	10.520	183	10.295	193	10.059	204	9.811	217	1296
730	10.703	182	10.488	191	10.263	202	10.028	214	1314
740	10.885	181	10.679	190	10.465	200	10.242	211	1332
750	11.066	182	10.869	190	10.665	198	10.453	207	1350
760	11.248	181	11.059	188	10.863	196	10.660	206	1368
770	11.429	181	11.247	188	11.059	195	10.866	203	1386
780	11.610	181	11.435	187	11.254	194	11.069	201	1404
790	11.791	180	11.622	186	11.448	193	11.270	200	1422
800	11.971	181	11.808	187	11.641	193	11.470	199	1440
810	12.152	181	11.995	186	11.834	191	11.669	198	1458
820	12.333	181	12.181	186	12.025	191	11.867	197	1476
830	12.514	181	12.367	185	12.216	191	12.064	196	1494
840	12.695	181	12.552	186	12.407	190	12.260	195	1512
850	12.876		12.738		12.597		12.455		1530

* The enthalpy function is divided here by a constant RT_0 where T_0 = 273.16°K (491.688°R).

Table 9-5. ENTROPY OF STEAM S/R

°K	1 atm		10 atm		20 atm		40 atm		°R
380	23.628	115							684
390	23.743	111							702
400	23.854	107							720
410	23.961	104							738
420	24.065	101							756
430	24.166	99							774
440	24.265	97							792
450	24.362	94							810
460	24.456	92	21.945	118					828
470	24.548	90	22.063	112					846
480	24.638	88	22.175	106					864
490	24.726	87	22.281	102	21.384	129			882
500	24.813	85	22.383	98	21.513	120			900
510	24.898	84	22.481	95	21.633	113			918
520	24.982	82	22.576	92	21.746	107			936
530	25.064	81	22.668	89	21.853	101	20.837	144	954
540	25.145	79	22.757	87	21.954	98	20.981	132	972
550	25.224	78	22.844	84	22.052	94	21.113	122	990
560	25.302	77	22.928	83	22.146	90	21.235	114	1008
570	25.379	76	23.011	81	22.236	88	21.349	108	1026
580	25.455	75	23.092	79	22.324	86	21.457	102	1044
590	25.530	74	23.171	78	22.410	83	21.559	98	1062
600	25.604	72	23.249	76	22.493	81	21.657	93	1080
610	25.676	72	23.325	75	22.574	79	21.750	90	1098
620	25.748	71	23.400	73	22.653	77	21.840	87	1116
630	25.819	70	23.473	73	22.730	76	21.927	84	1134
640	25.889	69	23.546	71	22.806	75	22.011	82	1152
650	25.958	68	23.617	71	22.881	73	22.093	80	1170
660	26.026	67	23.688	69	22.954	72	22.173	77	1188
670	26.093	66	23.757	68	23.026	70	22.250	76	1206
680	26.159	66	23.825	68	23.096	70	22.326	74	1224
690	26.225	65	23.893	66	23.166	68	22.400	73	1242
700	26.290	64	23.959	66	23.234	67	22.473	72	1260
710	26.354	64	24.025	65	23.301	67	22.545	70	1278
720	26.418	63	24.090	64	23.368	66	22.615	68	1296
730	26.481	62	24.154	63	23.434	64	22.683	68	1314
740	26.543	61	24.217	63	23.498	64	22.751	67	1332
750	26.604	61	24.280	62	23.562	63	22.818	65	1350
760	26.665	61	24.342	61	23.625	62	22.883	65	1368
770	26.726	60	24.403	60	23.687	62	22.948	64	1386
780	26.786	59	24.463	60	23.749	61	23.012	63	1404
790	26.845	58	24.523	60	23.810	60	23.075	62	1422
800	26.903	58	24.583	59	23.870	60	23.137	61	1440
810	26.961	58	24.642	58	23.930	59	23.198	61	1458
820	27.019	57	24.700	57	23.989	58	23.259	60	1476
830	27.076	56	24.757	57	24.047	58	23.319	59	1494
840	27.132	56	24.814	57	24.105	57	23.378	58	1512
850	27.188	55	24.871	56	24.162	56	23.436	58	1530

Table 9-5 ENTROPY OF STEAM - Cont. S/R

°K	40 atm		60 atm		80 atm		100 atm		°R
530	20.837	144							954
540	20.981	132							972
550	21.113	122	20.364	175					990
560	21.235	114	20.539	155					1008
570	21.349	108	20.694	139	20.060	200			1026
580	21.457	102	20.833	128	20.260	170			1044
590	21.559	98	20.961	119	20.430	152	19.880	212	1062
600	21.657	93	21.080	111	20.582	137	20.092	178	1080
610	21.750	90	21.191	105	20.719	126	20.270	157	1098
620	21.840	87	21.296	100	20.845	117	20.427	142	1116
630	21.927	84	21.396	95	20.962	110	20.569	130	1134
640	22.011	82	21.491	91	21.072	104	20.699	120	1152
650	22.093	80	21.582	88	21.176	98	20.819	112	1170
660	22.173	77	21.670	85	21.274	95	20.931	106	1188
670	22.250	76	21.755	83	21.369	90	21.037	100	1206
680	22.326	74	21.838	80	21.459	87	21.137	95	1224
690	22.400	73	21.918	78	21.546	84	21.232	91	1242
700	22.473	72	21.996	76	21.630	81	21.323	88	1260
710	22.545	70	22.072	74	21.711	79	21.411	84	1278
720	22.615	68	22.146	72	21.790	77	21.495	82	1296
730	22.683	68	22.218	72	21.867	75	21.577	80	1314
740	22.751	67	22.290	69	21.942	73	21.657	77	1332
750	22.818	65	22.359	69	22.015	72	21.734	75	1350
760	22.883	65	22.428	67	22.087	70	21.809	73	1368
770	22.948	64	22.495	66	22.157	69	21.882	72	1386
780	23.012	63	22.561	65	22.226	68	21.954	70	1404
790	23.075	62	22.626	64	22.294	66	22.024	69	1422
800	23.137	61	22.690	64	22.360	65	22.093	67	1440
810	23.198	61	22.754	62	22.425	64	22.160	67	1458
820	23.259	60	22.816	62	22.489	64	22.227	65	1476
830	23.319	59	22.878	60	22.553	62	22.292	64	1494
840	23.378	58	22.938	60	22.615	61	22.356	63	1512
850	23.436	58	22.998	59	22.676	61	22.419	62	1530

Table 9-6. VISCOSITY OF STEAM AT ATMOSPHERIC PRESSURE

°K	η		°R
	poise x 10^{-5}		
280*	9.09	*72	504
300	9.81	72	540
320	10.53	72	576
340	11.25	73	612
360	11.98	72	648
380	12.70	72	684
400	13.42	72	720
420	14.14	72	756
440	14.86	73	792
460	15.59	72	828
480	16.31	72	864
500	17.03	72	900
520	17.75	72	936
540	18.47	73	972
560	19.20	72	1008
580	19.92	72	1044
600	20.64	72	1080
620	21.36	72	1116
640	22.08	73	1152
660	22.81	72	1188
680	23.53	72	1224
700	24.25	72	1260
720	24.97	72	1296
740	25.69	73	1332
760	26.42	72	1368
780	27.14	72	1404
800	27.86	73	1440
820	28.59	73	1476
840	29.32	75	1512
860	30.07	78	1548
880	30.85	85	1584
900	31.70		1620

°K	η		°R
	poise x 10^{-5}		
900	31.70	85	1620
920	32.55	84	1656
940	33.39	83	1692
960	34.22	82	1728
980	35.04	81	1764
1000	35.85	80	1800
1020	36.65	78	1836
1040	37.43	78	1872
1060	38.21	76	1908
1080	38.97	75	1944
1100	39.72	74	1980
1120	40.46	72	2016
1140	41.18	71	2052
1160	41.89	70	2088
1180	42.59	68	2124
1200	43.27	66	2160
1220	43.93	66	2196
1240	44.59	63	2232
1260	45.22	63	2268
1280	45.85	61	2304
1300	46.46	60	2340
1320	47.06	57	2376
1340	47.63	57	2412
1360	48.20	55	2448
1380	48.75	53	2484
1400	49.28	52	2520
1420	49.80	51	2556
1440	50.31	49	2592
1460	50.80	48	2628
1480	51.28	46	2664
1500	51.74		2700

*Entries below 373.16°K refer to the viscosity of the vapor near the saturation pressure.

Table 9-6/a. VISCOSITY OF STEAM AT ELEVATED PRESSURE

°K	20 atm		40 atm		60 atm		80 atm		°R
	poises x 10^{-5}		poises x 10^{-5}		poises x 10^{-5}		poises x 10^{-5}		
500	17.17	178							900
550	18.95	180	19.14	176	19.45	167			990
600	20.75	179	20.90	177	21.12	170	21.42	164	1080
650	22.54	180	22.67	179	22.82	178	23.06	172	1170
700	24.34	181	24.46	179	24.60	178	24.78	175	1260
750	26.15	179	26.25	179	26.38	177	26.53	175	1350
800	27.94	184	28.04	183	28.15	182	28.28	181	1440
850	29.78	199	29.87	199	29.97	198	30.09	196	1530
900	31.77	210	31.86	209	31.95	208	32.05	204	1620
950	33.87	205	33.95	204	34.03	204	34.09	207	1710
1000	35.92	196	35.99	196	36.07	196	36.16	195	1800
1050	37.88	190	37.95	190	38.03	189	38.11	188	1890
1100	39.78		39.85		39.92		39.99		1980

°K	100 atm		200 atm		250 atm		300 atm		°R
	poises x 10^{-5}		poises x 10^{-5}		poises x 10^{-5}		poises x 10^{-5}		
600	21.87	147							1080
650	23.34	165	27.90	- 90					1170
700	24.99	171	27.00	127	29.29	2	34.01	-293	1260
750	26.70	173	28.27	136	29.31	108	31.08	42	1350
800	28.43	179	29.63	150	30.39	140	31.50	111	1440
850	30.22	195	31.13	182	31.79	171	32.61	153	1530
900	32.17	206	32.95	197	33.50	188	34.14	177	1620
950	34.23	202	34.92	194	35.38	188	35.91	180	1710
1000	36.25	195	36.86	189	37.26	184	37.71	178	1800
1050	38.20	188	38.75	182	39.10	179	39.49	176	1890
1100	40.08		40.57		40.89		41.25		1980

Table 9-7. THERMAL CONDUCTIVITY OF STEAM

k/k_0

°K	0 atm limit		1 atm		4 atm		7 atm		°R
300	1.126	47							540
310	1.173	48							558
320	1.221	48							576
330	1.269	49							594
340	1.318	49							612
350	1.367	49							630
360	1.416	49							648
370	1.465	50							666
380	1.515	50	1.547	46					684
390	1.565	50	1.593	48					702
400	1.615	50	1.641	48					720
410	1.665	51	1.689	48					738
420	1.716	51	1.737	49	1.809	41			756
430	1.767	51	1.786	49	1.850	43			774
440	1.818	52	1.835	50	1.893	45	1.962	37	792
450	1.870	51	1.885	50	1.938	47	1.999	42	810
460	1.921	52	1.935	51	1.985	47	2.041	42	828
470	1.973	52	1.986	51	2.032	46	2.083	41	846
480	2.025	52	2.037	51	2.078	47	2.124	42	864
490	2.077	52	2.088	51	2.125	47	2.166	42	882
500	2.129	52	2.139	51	2.172	49	2.208	47	900
510	2.181	52	2.190	52	2.221	50	2.255	47	918
520	2.233	53	2.242	52	2.271	49	2.302	46	936
530	2.286	52	2.294	52	2.320	49	2.348	47	954
540	2.338	53	2.346	52	2.369	50	2.395	47	972
550	2.391	53	2.398	52	2.419	51	2.442	50	990
560	2.444	52	2.450	52	2.470	51	2.492	50	1008
570	2.496	53	2.502	53	2.521	52	2.542	49	1026
580	2.549	53	2.555	53	2.573	51	2.591	50	1044
590	2.602	53	2.608	52	2.624	51	2.641	50	1062
600	2.655	54	2.660	53	2.675	52	2.691	51	1080
610	2.709	53	2.713	53	2.727	52	2.742	51	1098
620	2.762	53	2.766	53	2.779	53	2.793	52	1116
630	2.815	53	2.819	53	2.832	52	2.845	51	1134
640	2.868	54	2.872	53	2.884	52	2.896	51	1152
650	2.922	53	2.925	54	2.936	53	2.947	52	1170
660	2.975	54	2.979	53	2.989	53	2.999	52	1188
670	3.029	53	3.032	53	3.042	52	3.051	53	1206
680	3.082	54	3.085	54	3.094	53	3.104	52	1224
690	3.136	54	3.139	53	3.147	53	3.156	52	1242
700	3.190	53	3.192	53	3.200	53	3.208	53	1260
710	3.243	54	3.245	54	3.253	53	3.261	53	1278
720	3.297	54	3.299	54	3.306	54	3.314	52	1296
730	3.351	53	3.353	53	3.360	53	3.366	53	1314
740	3.404	54	3.406	54	3.413	53	3.419	53	1332
750	3.458	54	3.460	54	3.466	53	3.472	53	1350
760	3.512	54	3.514	53	3.519	54	3.525	54	1368
770	3.566	53	3.567	54	3.573	53	3.579	53	1386
780	3.619	54	3.621	54	3.626	54	3.632	53	1404
790	3.673	53	3.675	53	3.680	53	3.685	52	1422
800	3.726		3.728		3.733		3.737		1440

Table 9-7. THERMAL CONDUCTIVITY OF STEAM - Cont. k/k_0°

°K	10 atm		40 atm		70 atm		100 atm		°R
450	2.069	31							810
460	2.100	33							828
470	2.133	36							846
480	2.169	38							864
490	2.207	41							882
500	2.248	43							900
510	2.291	44							918
520	2.335	44							936
530	2.379	44							954
540	2.423	44							972
550	2.467	48	2.842	6	3.602	-110			990
560	2.515	49	2.848	13	3.492	- 80			1008
570	2.564	48	2.861	18	3.412	- 57			1026
580	2.612	48	2.879	23	3.355	- 39			1044
590	2.660	48	2.902	26	3.316	- 25	4.020	-132	1062
600	2.708	50	2.928	29	3.291	- 11	3.888	-100	1080
610	2.758	50	2.957	34	3.280	- 6	3.788	- 75	1098
620	2.808	50	2.991	34	3.274	4	3.713	- 53	1116
630	2.858	51	3.025	37	3.278	11	3.660	- 38	1134
640	2.909	50	3.062	39	3.289	16	3.622	- 24	1152
650	2.959	52	3.101	43	3.305	21	3.598	- 13	1170
660	3.011	51	3.144	42	3.326	24	3.585	- 4	1188
670	3.062	52	3.186	43	3.350	28	3.581	3	1206
680	3.114	51	3.229	42	3.378	31	3.584	10	1224
690	3.165	51	3.271	43	3.409	33	3.594	15	1242
700	3.216	53	3.314	47	3.442	35	3.609	20	1260
710	3.269	52	3.361	47	3.477	37	3.629	23	1278
720	3.321	53	3.408	46	3.514	39	3.652	26	1296
730	3.374	52	3.454	47	3.553	40	3.678	30	1314
740	3.426	52	3.501	47	3.593	41	3.708	32	1332
750	3.478	53	3.548	49	3.634	42	3.740	34	1350
760	3.531	53	3.597	49	3.676	43	3.774	36	1368
770	3.584	52	3.646	50	3.719	44	3.810	37	1386
780	3.636	53	3.696	49	3.763	45	3.847	39	1404
790	3.689	52	3.745	49	3.808	47	3.886	40	1422
800	3.741		3.794		3.855		3.926		1440

°K	150 atm		200 atm		250 atm		300 atm		°R
620	5.042	-272							1116
630	4.770	-211							1134
640	4.559	-162	6.338	-482					1152
650	4.397	-126	5.856	-376	8.522	-911	13.388	-2020	1170
660	4.271	- 97	5.480	-294	7.611	-700	11.368	-1516	1188
670	4.174	- 72	5.186	-229	6.911	-539	9.852	-1141	1206
680	4.102	- 54	4.957	-179	6.372	-422	8.711	- 877	1224
690	4.048	- 38	4.778	-141	5.950	-332	7.834	- 680	1242
700	4.010	- 26	4.637	-110	5.618	-262	7.154	- 532	1260
710	3.984	- 15	4.527	- 85	5.356	-208	6.622	- 421	1278
720	3.969	- 6	4.442	- 64	5.148	-164	6.201	- 331	1296
730	3.963	1	4.378	- 48	4.984	-130	5.870	- 266	1314
740	3.964	7	4.330	- 34	4.854	-102	5.604	- 212	1332
750	3.971	13	4.296	- 22	4.752	- 79	5.392	- 166	1350
760	3.984	17	4.274	- 14	4.673	- 61	5.226	- 135	1368
770	4.001	21	4.260	- 5	4.612	- 45	5.091	- 107	1386
780	4.022	24	4.255	2	4.567	- 16	4.984	- 83	1404
790	4.046	27	4.257	7	4.551	- 38	4.901	- 65	1422
800	4.073		4.264		4.513		4.836		1440

Table 9-8. FREE ENERGY FUNCTION OF STEAM $-(F - E_0^\circ)/RT$

°K	1 atm		10 atm		20 atm		40 atm		°R
380	19.687	103							684
390	19.790	100							702
400	19.890	98							720
410	19.988	96							738
420	20.084	94							756
430	20.178	92							774
440	20.270	89							792
450	20.359	88							810
460	20.447	87	18.200	81					828
470	20.534	84	18.281	80					846
480	20.618	83	18.361	79					864
490	20.701	82	18.440	78	17.798	74			882
500	20.783	79	18.518	77	17.872	72			900
510	20.862	79	18.595	75	17.944	71			918
520	20.941	77	18.670	75	18.015	73			936
530	21.018	76	18.745	73	18.088	70	17.472	64	954
540	21.094	74	18.818	73	18.158	70	17.536	63	972
550	21.168	73	18.891	71	18.228	69	17.599	64	990
560	21.241	72	18.962	70	18.297	69	17.663	64	1008
570	21.313	71	19.032	70	18.366	66	17.727	63	1026
580	21.384	69	19.102	68	18.432	67	17.790	63	1044
590	21.453	69	19.170	67	18.499	66	17.853	63	1062
600	21.522	67	19.237	67	18.565	65	17.916	63	1080
610	21.589	67	19.304	65	18.630	65	17.979	61	1098
620	21.656	66	19.369	65	18.695	63	18.040	61	1116
630	21.722	64	19.434	63	18.758	63	18.101	60	1134
640	21.786	64	19.497	63	18.821	61	18.161	60	1152
650	21.850	62	19.560	62	18.882	62	18.221	59	1170
660	21.912	62	19.622	61	18.944	60	18.280	59	1188
670	21.974	62	19.683	61	19.004	60	18.339	58	1206
680	22.036	60	19.744	60	19.064	59	18.397	58	1224
690	22.096	59	19.804	59	19.123	58	18.455	57	1242
700	22.155	59	19.863	58	19.181	58	18.512	56	1260
710	22.214	58	19.921	57	19.239	57	18.568	56	1278
720	22.272	57	19.978	57	19.296	56	18.624	55	1296
730	22.329	57	20.035	56	19.352	56	18.679	55	1314
740	22.386	55	20.091	55	19.408	55	18.734	54	1332
750	22.441	55	20.146	55	19.463	54	18.788	53	1350
760	22.496	55	20.201	54	19.517	53	18.841	52	1368
770	22.551	54	20.255	54	19.570	53	18.893	53	1386
780	22.605	53	20.309	53	19.623	53	18.946	52	1404
790	22.658	53	20.362	52	19.676	52	18.998	51	1422
800	22.711	52	20.414	52	19.728	51	19.049	51	1440
810	22.763	52	20.466	51	19.779	52	19.100	51	1458
820	22.815	51	20.517	51	19.831	50	19.151	49	1476
830	22.866	50	20.568	50	19.881	50	19.200	49	1494
840	22.916	50	20.618	50	19.931	49	19.249	49	1512
850	22.966		20.668		19.980		19.298		1530

Table 9-8. FREE ENERGY FUNCTION OF STEAM - Cont. $-(F - E_0^\circ)/RT$

°K	40 atm		60 atm		80 atm		100 atm		°R
530	17.472	64							954
540	17.536	63							972
550	17.599	64	17.267	56					990
560	17.663	64	17.323	58					1008
570	17.727	63	17.381	59	17.161	51			1026
580	17.790	63	17.440	59	17.212	53			1044
590	17.853	63	17.499	59	17.265	54	17.102	48	1062
600	17.916	63	17.558	59	17.319	55	17.150	50	1080
610	17.979	61	17.617	58	17.374	55	17.200	51	1098
620	18.040	61	17.675	58	17.429	55	17.251	51	1116
630	18.101	60	17.733	58	17.484	55	17.302	52	1134
640	18.161	60	17.791	58	17.539	55	17.354	53	1152
650	18.221	59	17.849	57	17.594	56	17.407	52	1170
660	18.280	59	17.906	57	17.650	54	17.459	53	1188
670	18.339	58	17.963	56	17.704	55	17.512	52	1206
680	18.397	58	18.019	56	17.759	55	17.564	52	1224
690	18.455	57	18.075	56	17.814	53	17.616	53	1242
700	18.512	56	18.131	55	17.867	54	17.669	53	1260
710	18.568	56	18.186	54	17.921	53	17.722	52	1278
720	18.624	55	18.240	54	17.974	53	17.774	51	1296
730	18.679	55	18.294	54	18.027	53	17.825	51	1314
740	18.734	54	18.348	53	18.080	52	17.876	51	1332
750	18.788	53	18.401	52	18.132	51	17.927	51	1350
760	18.841	52	18.453	52	18.183	51	17.978	50	1368
770	18.893	53	18.505	52	18.234	50	18.028	49	1386
780	18.946	52	18.557	51	18.284	50	18.077	50	1404
790	18.998	51	18.608	50	18.334	50	18.127	49	1422
800	19.049	51	18.658	50	18.384	50	18.176	49	1440
810	19.100	51	18.708	50	18.434	49	18.225	49	1458
820	19.151	49	18.758	49	18.483	49	18.274	48	1476
830	19.200	49	18.807	49	18.532	48	18.322	47	1494
840	19.249	49	18.856	48	18.580	48	18.369	47	1512
850	19.298		18.904		18.628		18.416		1530

Table 9-9. VAPOR PRESSURE OF ICE

T	P		T
°K	atm		°R
154	.0000000001	2	277.2
155	.0000000003		279.0
156	.0000000003		280.8
157	.0000000003	1	282.6
158	.0000000004	1	284.4
159	.0000000005	3	286.2
160	.0000000008	1	288.0
161	.0000000009		289.8
162	.000000001		291.6
163	.000000001		293.4
164	.000000001	2	295.2
165	.000000003		297.0
166	.000000003	1	298.8
167	.000000004		300.6
168	.000000004	1	302.4
169	.000000005	2	304.2
170	.000000007	1	306.0
171	.000000008		307.8
172	.00000001		309.6
173	.00000001		311.4
174	.00000001		313.2
175	.00000001	2	315.0
176	.00000003		316.8
177	.00000003	1	318.6
178	.00000004		320.4
179	.00000004	1	322.2
180	.00000005	2	324.0
181	.00000007	1	325.8
182	.00000008	1	327.6
183	.00000009		329.4
184	.0000001	3	331.2
185	.00000013	3	333.0
186	.00000016	2	334.8
187	.00000018	4	336.6
188	.00000022	4	338.4
189	.00000026	6	340.2
190	.00000032	5	342.0
191	.00000037	6	343.8
192	.00000043	8	345.6
193	.00000051	10	347.4
194	.00000061	11	349.2
195	.00000072	12	351.0
196	.00000084	15	352.8
197	.00000099	2	354.6
198	.0000012	1	356.4
199	.00000134	24	358.2
200	.00000158	26	360.0
201	.00000184	30	361.8
202	.00000214	35	363.6
203	.00000249	40	365.4
204	.00000289	47	367.2

T	P		T
°K	atm		°R
205	.00000336	52	369.0
206	.00000388	61	370.8
207	.00000449	69	372.6
208	.00000518	79	374.4
209	.00000597	90	376.2
210	.00000687	104	378.0
211	.00000791	114	379.8
212	.00000905	13	381.6
213	.0000104	15	383.4
214	.0000119	18	385.2
215	.0000137	18	387.0
216	.0000155	23	388.8
217	.0000178	25	390.6
218	.0000203	26	392.4
219	.0000229	33	394.2
220	.0000262	34	396.0
221	.0000296	41	397.8
222	.0000337	45	399.6
223	.0000382	50	401.4
224	.0000432	56	403.2
225	.0000488	62	405.0
226	.0000550	71	406.8
227	.0000621	78	408.6
228	.0000699	88	410.4
229	.0000787	96	412.2
230	.0000883	109	414.0
231	.0000992	12	415.8
232	.000111	14	417.6
233	.000125	15	419.4
234	.0001397	166	421.2
235	.0001563	183	423.0
236	.0001746	202	424.8
237	.0001948	226	426.6
238	.0002174	248	428.4
239	.0002422	274	430.2
240	.0002696	303	432.0
241	.0002999	333	433.8
242	.0003332	368	435.6
243	.0003700	41	437.4
244	.000411	43	439.2
245	.000454	50	441.0
246	.000504	53	442.8
247	.000557	59	444.6
248	.000616	66	446.4
249	.000682	69	448.2
250	.000751	78	450.0
251	.000829	84	451.8
252	.000913	10	453.6
253	.00101	10	455.4
254	.00111	10	457.2

Table 9-9. VAPOR PRESSURE OF ICE - Cont.

T	P		T
°K	atm		°R
254.0	.00111	5	457.2
254.5	.00116	6	458.1
255.0	.00122	6	459.0
255.5	.00128	6	459.9
256.0	.001337	63	460.8
256.5	.001400	67	461.7
257.0	.001467	70	462.6
257.5	.001537	72	463.5
258.0	.001609	77	464.4
258.5	.001686	78	465.3
259.0	.001764	83	466.2
259.5	.001847	86	467.1
260.0	.001933	91	468.0
260.5	.002024	92	468.9
261.0	.002116	97	469.8
261.5	.002213	101	470.7
262.0	.002314	106	471.6
262.5	.002420	110	472.5
263.0	.002530	115	473.4
263.5	.002645	119	474.3
264.0	.002764	124	475.2
264.5	.002888	129	476.1
265.0	.003017	134	477.0
265.5	.003151	141	477.9
266.0	.003292	145	478.8
266.5	.003437	152	479.7
267.0	.003589	158	480.6
267.5	.003747	164	481.5
268.0	.003911	169	482.4
268.5	.004080	178	483.3
269.0	.004258	184	484.2
269.5	.004442	191	485.1
270.0	.004633	199	486.0
270.5	.004832	206	486.9
271.0	.005038	215	487.8
271.5	.005253	222	488.7
272.0	.005475	232	489.6
272.5	.005707	239	490.5
273.0	.005946		491.4

Table 9-9/a. VAPOR PRESSURE OF WATER

T	P		T
°K	atm		°R
274	.006406	477	493.2
275	.006883	508	495.0
276	.007391	542	496.8
277	.007933	576	498.6
278	.008509	614	500.4
279	.009123	651	502.2
280	.009774	692	504.0
281	.010466	735	505.8
282	.011201	781	507.6
283	.011982	827	509.4
284	.012809	878	511.2
285	.013687	930	513.0
286	.014617	986	514.8
287	.015603	1043	516.6
289	.016646	1104	518.4
289	.017750	1167	520.2
290	.018917	1235	522.0
291	.020152	1305	523.8
292	.021457	1378	525.6
293	.022835	1455	527.4
294	.024290	1535	529.2
295	.025825	1620	531.0
296	.027445	1707	532.8
297	.029152	1800	534.6
298	.030952	1896	536.4
299	.032848	1996	538.2
300	.034844	2101	540.0
301	.036945	2210	541.8
302	.039155	2325	543.6
303	.041480	2444	545.4
304	.043924	2568	547.2
305	.046492	2697	549.0
306	.049189	2832	550.8
307	.052021	2972	552.6
308	.054993	3119	554.4
309	.058112	3270	556.2
310	.061382	3428	558.0
311	.064810	3593	559.8
312	.068403	3764	561.6
313	.072167	3941	563.4
314	.076108	4126	565.2
315	.080234	4317	567.0
316	.084551	4516	568.8
317	.089067	4723	570.6
318	.093790	4939	572.4
319	.098729	515	574.2
320	.10388	539	576.0
321	.10927	563	577.8
322	.11490	587	579.6
323	.12077	613	581.4
324	.12690	639	583.2

T	P		T
°K	atm		°R
325	.13329	667	585.0
326	.13996	695	586.8
327	.14691	724	588.6
328	.15415	755	590.4
329	.16170	786	592.2
330	.16956	819	594.0
331	.17775	852	595.8
332	.18627	887	597.6
333	.19514	922	599.4
334	.20436	959	601.2
335	.21395	997	603.0
336	.22392	1036	604.8
337	.23428	1077	606.6
338	.24505	1118	608.4
339	.25623	1162	610.2
340	.26785	1206	612.0
341	.27991	1251	613.8
342	.29242	1299	615.6
343	.30541	1346	617.4
344	.31887	1398	619.2
345	.33285	1448	621.0
346	.34733	1501	622.8
347	.36234	1555	624.6
348	.37789	1611	626.4
349	.39400	1669	628.2
350	.41069	1728	630.0
351	.42797	1789	631.8
352	.44586	1851	633.6
353	.46437	1915	635.4
354	.48352	1981	637.2
355	.50333	2049	639.0
356	.52382	2119	640.8
357	.54501	2189	642.6
358	.56690	2263	644.4
359	.58953	2337	646.2
360	.61290	2415	648.0
361	.63705	2493	649.8
362	.66198	2574	651.6
363	.68772	2658	653.4
364	.71430	2742	655.2
365	.74172	2829	657.0
366	.77001	2919	658.8
367	.79920	3010	660.6
368	.82930	3104	662.4
369	.86034	3199	664.2
370	.89233	3298	666.0
371	.92531	3398	667.8
372	.95929	3501	669.6
373	.99430	361	671.4
374	1.0304	371	673.2

Table 9-9/a. VAPOR PRESSURE OF WATER - Cont.

T	P		T
°K	atm		°R
375	1.0675	382	675.0
376	1.1057	394	676.8
377	1.1451	405	678.6
378	1.1856	417	680.4
379	1.2273	429	682.2
380	1.2702	441	684.0
381	1.3143	454	685.8
382	1.3597	466	687.6
383	1.4063	480	689.4
384	1.4543	493	691.2
385	1.5036	506	693.0
386	1.5542	521	694.8
387	1.6063	535	696.6
388	1.6598	549	698.4
389	1.7147	564	700.2
390	1.7711	579	702.0
391	1.8290	595	703.8
392	1.8885	610	705.6
393	1.9495	626	707.4
394	2.0121	643	709.2
395	2.0764	659	711.0
396	2.1423	676	712.8
397	2.2099	693	714.6
398	2.2792	711	716.4
399	2.3503	729	718.2
400	2.4232	748	720.0
401	2.4980	766	721.8
402	2.5746	785	723.6
403	2.6531	804	725.4
404	2.7335	824	727.2
405	2.8159	844	729.0
406	2.9003	865	730.8
407	2.9868	885	732.6
408	3.0753	906	734.4
409	3.1659	927	736.2
410	3.2586	950	738.0
411	3.3536	971	739.8
412	3.4507	994	741.6
413	3.5501	1018	743.4
414	3.6519	1042	745.2
415	3.7561	1063	747.0
416	3.8624	1088	748.8
417	3.9712	1114	750.6
418	4.0826	1138	752.4
419	4.1964	1163	754.2
420	4.3127	1189	756.0
421	4.4316	1215	757.8
422	4.5531	1242	759.6
423	4.6773	1269	761.4
424	4.8042	1296	763.2

T	P		T
°K	atm		°R
425	4.9338	1325	765.0
426	5.0663	1352	766.8
427	5.2015	1382	768.6
428	5.3397	1410	770.4
429	5.4807	1440	772.2
430	5.6247	1470	774.0
431	5.7717	1500	775.8
432	5.9217	1531	777.6
433	6.0748	1563	779.4
434	6.2311	1595	781.2
435	6.3906	1626	783.0
436	6.5532	1660	784.8
437	6.7192	1693	786.6
438	6.8885	1727	788.4
439	7.0612	1760	790.2
440	7.2372	1796	792.0
441	7.4168	1830	793.8
442	7.5998	1867	795.6
443	7.7865	1902	797.4
444	7.9767	1939	799.2
445	8.1706	1976	801.0
446	8.3682	2014	802.8
447	8.5696	2051	804.6
448	8.7747	2091	806.4
449	8.9838	2130	808.2
450	9.1968	2170	810.0
451	9.4138	2210	811.8
452	9.6348	2250	813.6
453	9.8598	229	815.4
454	10.089	234	817.2
455	10.323	237	819.0
456	10.560	242	820.8
457	10.802	246	822.6
458	11.048	250	824.4
459	11.298	256	826.2
460	11.554	259	828.0
461	11.813	264	829.8
462	12.077	268	831.6
463	12.345	273	833.4
464	12.618	279	835.2
465	12.897	282	837.0
466	13.179	288	838.8
467	13.467	292	840.6
468	13.759	298	842.4
469	14.057	302	844.2
470	14.359	307	846.0
471	14.666	313	847.8
472	14.979	317	849.6
473	15.296	323	851.4
474	15.619	328	853.2

Table 9-9/a. VAPOR PRESSURE OF WATER - Cont.

T	P		T
°K	atm		°R
475	15.947	334	855.0
476	16.281	339	856.8
477	16.620	344	858.6
478	16.964	350	860.4
479	17.314	356	862.2
480	17.670	361	864.0
481	18.031	367	865.8
482	18.398	372	867.6
483	18.770	379	869.4
484	19.149	384	871.2
485	19.533	391	873.0
486	19.924	396	874.8
487	20.320	402	876.6
488	20.722	409	878.4
489	21.131	415	880.2
490	21.546	421	882.0
491	21.967	428	883.8
492	22.395	433	885.6
493	22.828	441	887.4
494	23.269	447	889.2
495	23.716	453	891.0
496	24.169	460	892.8
497	24.629	466	894.6
498	25.095	474	896.4
499	25.569	481	898.2
500	26.050	487	900.0
501	26.537	495	901.8
502	27.032	501	903.6
503	27.533	508	905.4
504	28.041	516	907.2
505	28.557	523	909.0
506	29.080	530	910.8
507	29.610	538	912.6
508	30.148	545	914.4
509	30.693	553	916.2
510	31.246	560	918.0
511	31.806	568	919.8
512	32.374	575	921.6
513	32.949	584	923.4
514	33.533	592	925.2
515	34.125	599	927.0
516	34.724	608	928.8
517	35.332	615	930.6
518	35.947	624	932.4
519	36.571	632	934.2
520	37.203	641	936.0
521	37.844	649	937.8
522	38.493	657	939.6
523	39.150	666	941.4
524	39.816	674	943.2

T	P		T
°K	atm		°R
525	40.490	684	945.0
526	41.174	692	946.8
527	41.866	700	948.6
528	42.566	710	950.4
529	43.276	719	952.2
530	43.995	728	954.0
531	44.723	737	955.8
532	45.460	746	957.6
533	46.206	756	959.4
534	46.962	766	961.2
535	47.728	774	963.0
536	48.502	784	964.8
537	49.286	793	966.6
538	50.079	804	968.4
539	50.883	813	970.2
540	51.696	824	972.0
541	52.520	833	973.8
542	53.353	843	975.6
543	54.196	853	977.4
544	55.049	864	979.2
545	55.913	874	981.0
546	56.787	884	982.8
547	57.671	894	984.6
548	58.565	906	986.4
549	59.471	916	988.2
550	60.387	927	990.0
551	61.314	937	991.8
552	62.251	948	993.6
553	63.199	960	995.4
554	64.159	971	997.2
555	65.130	982	999.0
556	66.112	993	1000.8
557	67.105	1004	1002.6
558	68.109	1016	1004.4
559	69.125	1028	1006.2
560	70.153	1039	1008.0
561	71.192	1050	1009.8
562	72.242	1063	1011.6
563	73.305	1074	1013.4
564	74.379	1087	1015.2
565	75.466	1099	1017.0
566	76.565	1110	1018.8
567	77.675	1123	1020.6
568	78.798	1136	1022.4
569	79.934	1148	1024.2
570	81.082	1161	1026.0
571	82.243	1174	1027.8
572	83.417	1186	1029.6
573	84.603	1199	1031.4
574	85.802	1212	1033.2

Table 9-9/a. VAPOR PRESSURE OF WATER - Cont.

T	P		T
°K	atm		°R
575	87.014	1226	1035.0
576	88.240	1238	1036.8
577	89.478	1251	1038.6
578	90.729	1266	1040.4
579	91.995	1279	1042.2
580	93.274	1292	1044.0
581	94.566	1306	1045.8
582	95.872	1319	1047.6
583	97.191	1334	1049.4
584	98.525	1349	1051.2
585	99.874	137	1053.0
586	101.24	137	1054.8
587	102.61	139	1056.6
588	104.00	141	1058.4
589	105.41	142	1060.2
590	106.83	144	1062.0
591	108.27	145	1063.8
592	109.72	146	1065.6
593	111.18	148	1067.4
594	112.66	150	1069.2
595	114.16	151	1071.0
596	115.67	153	1072.8
597	117.20	155	1074.6
598	118.75	156	1076.4
599	120.31	157	1078.2
600	121.88	159	1080.0
601	123.47	161	1081.8
602	125.08	162	1083.6
603	126.70	164	1085.4
604	128.34	166	1087.2
605	130.00	168	1089.0
606	131.68	169	1090.8
607	133.37	171	1092.6
608	135.08	172	1094.4
609	136.80	175	1096.2

T	P		T
°K	atm		°R
610	138.55	176	1098.0
611	140.31	178	1099.8
612	142.09	179	1101.6
613	143.88	182	1103.4
614	145.70	183	1105.2
615	147.53	185	1107.0
616	149.38	187	1108.8
617	151.25	189	1110.6
618	153.14	191	1112.4
619	155.05	193	1114.2
620	156.98	195	1116.0
621	158.93	197	1117.8
622	160.90	199	1119.6
623	162.89	201	1121.4
624	164.90	203	1123.2
625	166.93	205	1125.0
626	168.98	207	1126.8
627	171.05	209	1128.6
628	173.14	212	1130.4
629	175.26	213	1132.2
630	177.39	216	1134.0
631	179.55	219	1135.8
632	181.74	220	1137.6
633	183.94	223	1139.4
634	186.17	226	1141.2
635	188.43	228	1143.0
636	190.71	230	1144.8
637	193.01	232	1146.6
638	195.33	235	1148.4
639	197.68	238	1150.2
640	200.06	241	1152.0
641	202.47	244	1153.8
642	204.91	247	1155.6
643	207.38	249	1157.4
644	209.87	253	1159.2
645	212.40	256	1161.0
646	214.96	260	1162.8
647	217.56		1164.6

Table 9-10 IDEAL-GAS THERMODYNAMIC FUNCTIONS FOR STEAM

°K	$\frac{C_p^\circ}{R}$		$\frac{(H^\circ - E_o^\circ)^*}{RT_o}$		$\frac{-(F^\circ - E_o^\circ)}{RT}$		$\frac{S^\circ}{R}$		°R
50	4.0072	- 9	.7149	1467	11.6321	7137	15.5379	7305	90
60	4.0063	- 4	.8616	1467	12.3458	6056	16.2684	6176	108
70	4.0059	- 2	1.0083	1466	12.9514	5260	16.8860	5349	126
80	4.0057		1.1549	1467	13.4774	4649	17.4209	4718	144
90	4.0057	1	1.3016	1466	13.9423	4165	17.8927	4220	162
100	4.0058	2	1.4482	1467	14.3588	3773	18.3147	3819	180
110	4.0060	2	1.5949	1466	14.7361	3448	18.6966	3485	198
120	4.0062	3	1.7415	1467	15.0809	3174	19.0451	3207	216
130	4.0065	3	1.8882	1467	15.3983	2941	19.3658	2969	234
140	4.0068	4	2.0349	1466	15.6924	2740	19.6627	2765	252
150	4.0072	4	2.1815	1468	15.9664	2565	19.9392	2586	270
160	4.0076	4	2.3283	1467	16.2229	2410	20.1978	2430	288
170	4.0080	6	2.4750	1467	16.4639	2274	20.4408	2291	306
180	4.0086	7	2.6217	1468	16.6913	2152	20.6699	2167	324
190	4.0093	9	2.7685	1468	16.9065	2042	20.8866	2057	342
200	4.0102	11	2.9153	1468	17.1107	1943	21.0923	1957	360
210	4.0113	14	3.0621	1469	17.3050	1853	21.2880	1866	378
220	4.0127	18	3.2090	1469	17.4903	1771	21.4746	1784	396
230	4.0145	21	3.3559	1470	17.6674	1697	21.6530	1709	414
240	4.0166	25	3.5029	1471	17.8371	1627	21.8239	1641	432
250	4.0191	30	3.6500	1472	17.9998	1565	21.9880	1577	450
260	4.0221	36	3.7972	1473	18.1563	1506	22.1457	1518	468
270	4.0257	40	3.9445	1474	18.3069	1451	22.2975	1465	486
280	4.0297	46	4.0919	1476	18.4520	1401	22.4440	1415	504
290	4.0343	51	4.2395	1478	18.5921	1354	22.5855	1368	522
300	4.0394	57	4.3873	1480	18.7275	1311	22.7223	1326	540
310	4.0451	63	4.5353	1482	18.8586	1269	22.8549	1285	558
320	4.0514	68	4.6835	1484	18.9855	1230	22.9834	1248	576
330	4.0582	73	4.8319	1487	19.1085	1194	23.1082	1212	594
340	4.0655	78	4.9806	1490	19.2279	1161	23.2294	1180	612
350	4.0733	83	5.1296	1493	19.3440	1128	23.3474	1148	630
360	4.0816	88	5.2789	1495	19.4568	1097	23.4622	1120	648
370	4.0904	92	5.4284	1500	19.5665	1069	23.5742	1092	666
380	4.0996	96	5.5784	1502	19.6734	1042	23.6834	1066	684
390	4.1092	100	5.7286	1506	19.7776	1017	23.7900	1042	702
400	4.1192	547	5.8792	7589	19.8793	4737	23.8942	4882	720
450	4.1739	606	6.6381	7695	20.3530	4254	24.3824	4429	810
500	4.2345	644	7.4076	7809	20.7784	3866	24.8253	4066	900
550	4.2989	670	8.1885	7930	21.1650	3548	25.2319	3769	990
600	4.3659	691	8.9815	8055	21.5198	3282	25.6088	3522	1080
650	4.4350	709	9.7870	8182	21.8480	3058	25.9610	3312	1170
700	4.5059	726	10.6052	8314	22.1538	2864	26.2922	3134	1260
750	4.5785	740	11.4366	8448	22.4402	2697	26.6056	2978	1350
800	4.6525	753	12.2814	8585	22.7099	2551	26.9034	2843	1440
850	4.7278	760	13.1399	8723	22.9650	2422	27.1877	2724	1530
900	4.8038	766	14.0122	8863	23.2072	2308	27.4601	2618	1620
950	4.8804	765	14.8985	9004	23.4380	2205	27.7219	2523	1710
1000	4.9569	761	15.7989	9143	23.6585	2114	27.9742	2436	1800
1050	5.0330	754	16.7132	9281	23.8699	2030	28.2178	2359	1890
1100	5.1084	742	17.6413	9419	24.0729	1955	28.4537	2287	1980
1150	5.1826	729	18.5832	9553	24.2684	1885	28.6824	2222	2070

* The enthalpy function is divided here by a constant RT_0 where T_0 = 273.16°K (491.688°R).

Table 9-10 IDEAL-GAS THERMODYNAMIC FUNCTIONS FOR STEAM - Cont.

°K	$\frac{C_p^\circ}{R}$		$\frac{(H^\circ - E_0^\circ)^*}{RT_o}$		$\frac{-(F^\circ - E_0^\circ)}{RT}$		$\frac{S^\circ}{R}$		°R
1200	5.2555	1405	19.5385	19499	24.4569	3587	28.9046	4262	2160
1300	5.3960	1326	21.4884	19999	24.8156	3371	29.3308	4048	2340
1400	5.5286	1240	23.4883	20470	25.1527	3185	29.7356	3857	2520
1500	5.6526	1152	25.5353	20907	25.4712	3022	30.1213	3686	2700
1600	5.7678	1065	27.6260	21312	25.7734	2879	30.4899	3529	2880
1700	5.8743	982	29.7572	21688	26.0613	2751	30.8428	3386	3060
1800	5.9725	903	31.9260	22031	26.3364	2636	31.1814	3253	3240
1900	6.0628	832	34.1291	22350	26.6000	2532	31.5067	3132	3420
2000	6.1460	764	36.3641	22641	26.8532	2438	31.8199	3017	3600
2100	6.2224	704	38.6282	22910	27.0970	2350	32.1216	2911	3780
2200	6.2928	648	40.9192	23158	27.3320	2271	32.4127	2812	3960
2300	6.3576	598	43.2350	23385	27.5591	2196	32.6939	2718	4140
2400	6.4174	553	45.5735	23596	27.7787	2128	32.9657	2631	4320
2500	6.4727	511	47.9331	23789	27.9915	2063	33.2288	2549	4500
2600	6.5238	474	50.3120	23971	28.1978	2004	33.4837	2471	4680
2700	6.5712	441	52.7091	24139	28.3982	1948	33.7308	2398	4860
2800	6.6153	410	55.1230	24293	28.5930	1894	33.9706	2329	5040
2900	6.6563	382	57.5523	24439	28.7824	1845	34.2035	2263	5220
3000	6.6945	691	59.9962	49273	28.9669	3552	34.4298	4343	5400
3200	6.7636	608	64.9235	49748	29.3221	3382	34.8641	4119	5760
3400	6.8244	538	69.8983	50168	29.6603	3229	35.2760	3916	6120
3600	6.8782	481	74.9151	50539	29.9832	3091	35.6676	3732	6480
3800	6.9263	431	79.9690	50872	30.2923	2964	36.0408	3564	6840
4000	6.9694	389	85.0562	51173	30.5887	2848	36.3972	3410	7200
4200	7.0083	353	90.1735	51444	30.8735	2740	36.7382	3269	7560
4400	7.0436	322	95.3179	51691	31.1475	2642	37.0651	3138	7920
4600	7.0758	295	100.4870	51917	31.4117	2550	37.3789	3018	8280
4800	7.1053	272	105.6787	52124	31.6667	2464	37.6807	2906	8640
5000	7.1325		110.8911		31.9131		37.9713		9000

* The enthalpy function is divided here by a constant RT_0 where T_0 = 273.16°K (491.688°R).