TABLE 2-221 Enthalpies and Gibbs Energies of Formation, Entropies, and Net Enthalpies of Combustion of Inorganic and Organic Compounds at 298.15 K

Cmpd. no.	Name	Formula	CAS no.	Mol wt	Ideal gas enthalpy of formation, J/kmol × 1E-07	Ideal gas Gibbs energy of formation, J/kmol × 1E-07	Ideal gas entropy, J/(kmol·K) × 1E-05	Standard net enthalpy of combustion, J/kmol × 1E-09
1	Methane	CH_4	74828	16.043	−7.4520	−5.0490	1.8627	−0.8026
2	Ethane	C_2H_6	74840	30.070	−8.3820	−3.1920	2.2912	−1.4286
3	Propane	C_3H_8	74986	44.097	−10.4680	−2.4390	2.7020	−2.0431
4	*n*-Butane	C_4H_{10}	106978	58.123	−12.5790	−1.6700	3.0991	−2.6573
5	*n*-Pentane	C_5H_{12}	109660	72.150	−14.6760	−0.8813	3.4945	−3.2449
6	*n*-Hexane	C_6H_{14}	110543	86.177	−16.6940	−0.0066	3.8874	−3.8551
7	*n*-Heptane	C_7H_{16}	142825	100.204	−18.7650	0.8165	4.2798	−4.4647
8	*n*-Octane	C_8H_{18}	111659	114.231	−20.8750	1.6000	4.6723	−5.0742
9	*n*-Nonane	C_9H_{20}	111842	128.258	−22.8740	2.4980	5.0640	−5.6846
10	*n*-Decane	$C_{10}H_{22}$	124185	142.285	−24.9460	3.3180	5.4570	−6.2942
11	*n*-Undecane	$C_{11}H_{24}$	1120214	156.312	−27.0430	4.1160	5.8493	−6.9036
12	*n*-Dodecane	$C_{12}H_{26}$	112403	170.338	−29.0720	4.9810	6.2415	−7.5137
13	*n*-Tridecane	$C_{13}H_{28}$	629505	184.365	−31.1770	5.7710	6.6337	−8.1229
14	*n*-Tetradecane	$C_{14}H_{30}$	629594	198.392	−33.2440	6.5990	7.0259	−8.7328
15	*n*-Pentadecane	$C_{15}H_{32}$	629629	212.419	−35.3110	7.4260	7.4181	−9.3424
16	*n*-Hexadecane	$C_{16}H_{34}$	544763	226.446	−37.4170	8.2160	7.8102	−9.9515
17	*n*-Heptadecane	$C_{17}H_{36}$	629787	240.473	−39.4450	9.0830	8.2023	−10.5618
18	*n*-Octadecane	$C_{18}H_{38}$	593453	254.500	−41.5120	9.9100	8.5945	−11.1715
19	*n*-Nonadecane	$C_{19}H_{40}$	629925	268.527	−43.5790	10.7400	8.9866	−11.7812
20	*n*-Eicosane	$C_{20}H_{42}$	112958	282.553	−45.6460	11.5700	9.3787	−12.3908
21	2-Methylpropane	C_4H_{10}	75285	58.123	−13.4180	−2.0760	2.9539	−2.6490
22	2-Methylbutane	C_5H_{12}	78784	72.150	−15.3700	−1.4050	3.4374	−3.2395
23	2,3-Dimethylbutane	C_6H_{14}	79298	86.177	−17.6800	−0.3125	3.6592	−3.8476
24	2-Methylpentane	C_6H_{14}	107835	86.177	−17.4550	−0.5338	3.8089	−3.8492
25	2,3-Dimethylpentane	C_7H_{16}	565593	100.204	−19.4100	0.5717	4.1455	−4.4608
26	2,3,3-Trimethylpentane	C_8H_{18}	560214	114.231	−21.8450	1.8280	4.2702	−5.0688
27	2,2,4-Trimethylpentane	C_8H_{18}	540841	114.231	−22.4010	1.3940	4.2296	−5.0653
28	Ethylene	C_2H_4	74851	28.054	5.2510	6.8440	2.1920	−1.3230
29	Propylene	C_3H_6	115071	42.081	1.9710	6.2150	2.6660	−1.9257

TABLE 2-221 Enthalpies and Gibbs Energies of Formation, Entropies, and Net Enthalpies of Combustion of Inorganic and Organic Compounds (*Continued*)

Cmpd. no.	Name	Formula	CAS no.	Mol wt	Ideal gas enthalpy of formation, J/kmol × 1E-07	Ideal gas Gibbs energy of formation, J/kmol × 1E-07	Ideal gas entropy, J/(kmol·K) × 1E-05	Standard net enthalpy of combustion, J/kmol × 1E-09
30	1-Butene	C_4H_8	106989	56.108	−0.0540	7.0270	3.0775	−2.5408
31	*cis*-2-Butene	C_4H_8	590181	56.108	−0.7400	6.5360	3.0120	−2.5339
32	*trans*-2-Butene	C_4H_8	624646	56.108	−1.1000	6.3160	2.9650	−2.5303
33	1-Pentene	C_5H_{10}	109671	70.134	−2.1300	7.8450	3.4699	−3.1296
34	1-Hexene	C_6H_{12}	592416	84.161	−4.2000	8.7390	3.8389	−3.7394
35	1-Heptene	C_7H_{14}	592767	98.188	−6.2800	9.4830	4.2549	−4.3489
36	1-Octene	C_8H_{16}	111660	112.215	−8.3600	10.3000	4.6469	−4.9606
37	1-Nonene	C_9H_{18}	124118	126.242	−10.4000	11.1500	5.0399	−5.5684
38	1-Decene	$C_{10}H_{20}$	872059	140.269	−12.4700	11.9800	5.4319	−6.1781
39	2-Methylpropene	C_4H_8	115117	56.108	−1.7100	5.8080	2.9309	−2.5242
40	2-Methyl-1-butene	C_5H_{10}	563462	70.134	−3.5300	6.6680	3.3950	−3.1159
41	2-Methyl-2-butene	C_5H_{10}	513359	70.134	−4.1800	6.0450	3.3860	−3.1088
42	1,2-Butadiene	C_4H_6	590192	54.092	16.2300	19.8600	2.9300	−2.4617
43	1,3-Butadiene	C_4H_6	106990	54.092	10.9240	14.9720	2.7889	−2.4090
44	2-Methyl-1,3-butadiene	C_5H_8	78795	68.119	7.5730	14.5896	3.1564	−2.9842
45	Acetylene	C_2H_2	74862	26.038	22.8200	21.0680	2.0081	−1.2570
46	Methylacetylene	C_3H_4	74997	40.065	18.4900	19.3840	2.4836	−1.8487
47	Dimethylacetylene	C_4H_6	503173	54.092	14.5700	18.4900	2.8330	−2.4189
48	3-Methyl-1-butyne	C_5H_8	598232	68.119	13.8000	20.7200	3.1890	−3.0460
49	1-Pentyne	C_5H_8	627190	68.119	14.4400	21.0300	3.2980	−3.0510
50	2-Pentyne	C_5H_8	627214	68.119	12.5100	19.0700	3.3084	−3.0291
51	1-Hexyne	C_6H_{10}	693027	82.145	12.3700	21.8500	3.6940	−3.6610
52	2-Hexyne	C_6H_{10}	764352	82.145	10.5000	19.9000	3.7200	−3.6400
53	3-Hexyne	C_6H_{10}	928494	82.145	10.6000	19.9000	3.7600	−3.6400
54	1-Heptyne	C_7H_{12}	628717	96.172	10.3000	22.7000	4.0850	−4.2717
55	1-Octyne	C_8H_{14}	629050	110.199	8.2300	23.5000	4.4780	−4.8815
56	Vinylacetylene	C_4H_4	689974	52.076	30.4600	30.6000	2.7940	−2.3620
57	Cyclopentane	C_5H_{10}	287923	70.134	−7.7030	3.8850	2.9290	−3.0709
58	Methylcyclopentane	C_6H_{12}	96377	84.161	−10.6200	3.6300	3.3990	−3.6741
59	Ethylcyclopentane	C_7H_{14}	1640897	98.188	−12.6900	4.4800	3.7830	−4.2839
60	Cyclohexane	C_6H_{12}	110827	84.161	−12.3300	3.1910	2.9728	−3.6560
61	Methylcyclohexane	C_7H_{14}	108872	98.188	−15.4800	2.7330	3.4330	−4.2571
62	1,1-Dimethylcyclohexane	C_8H_{16}	590669	112.215	−18.1000	3.5229	3.6501	−4.8639
63	Ethylcyclohexane	C_8H_{16}	1678917	112.215	−17.1500	3.9550	3.8260	−4.8705
64	Cyclopentene	C_5H_8	142290	68.119	3.3100	11.0500	2.9127	−2.9393
65	1-Methylcyclopentene	C_6H_{10}	693890	82.145	−0.3800	10.3800	3.2640	−3.5340
66	Cyclohexene	C_6H_{10}	110838	82.145	−0.4600	10.7700	3.1052	−3.5320
67	Benzene	C_6H_6	71432	78.114	8.2880	12.9600	2.6930	−3.1360
68	Toluene	C_7H_8	108883	92.141	5.0170	12.2200	3.2099	−3.7340
69	*o*-Xylene	C_8H_{10}	95476	106.167	1.9080	12.2000	3.5383	−4.3330
70	*m*-Xylene	C_8H_{10}	108383	106.167	1.7320	11.8760	3.5854	−4.3318
71	*p*-Xylene	C_8H_{10}	106423	106.167	1.8030	12.1400	3.5223	−4.3330
72	Ethylbenzene	C_8H_{10}	100414	106.167	2.9920	13.0730	3.6063	−4.3450
73	Propylbenzene	C_9H_{12}	103651	120.194	0.7910	13.8090	3.9843	−4.9542
74	1,2,4-Trimethylbenzene	C_9H_{12}	95636	120.194	−1.3800	11.7100	3.9610	−4.9307
75	Isopropylbenzene	C_9H_{12}	98828	120.194	0.4000	13.7900	3.8600	−4.9510
76	1,3,5-Trimethylbenzene	C_9H_{12}	108678	120.194	−1.5900	11.8100	3.8560	−4.9291
77	*p*-Isopropyltoluene	$C_{10}H_{14}$	99876	134.221	−2.9000	13.3520	4.2630	−5.5498
78	Naphthalene	$C_{10}H_8$	91203	128.174	15.0580	22.4080	3.3315	−4.9809
79	Biphenyl	$C_{12}H_{10}$	92524	154.211	18.2420	28.0230	3.9367	−6.0317
80	Styrene	C_8H_8	100425	104.152	14.7400	21.3900	3.4510	−4.2190
81	*m*-Terphenyl	$C_{18}H_{14}$	92068	230.309	27.6600	42.3000	5.2630	−9.0530
82	Methanol	CH_4O	67561	32.042	−20.0940	−16.2320	2.3988	−0.6382
83	Ethanol	C_2H_6O	64175	46.069	−23.4950	−16.7850	2.8064	−1.2350
84	1-Propanol	C_3H_8O	71238	60.096	−25.5200	−15.9900	3.2247	−1.8438
85	1-Butanol	$C_4H_{10}O$	71363	74.123	−27.4600	−15.0300	3.6148	−2.4560
86	2-Butanol	$C_4H_{10}O$	78922	74.123	−29.2900	−16.9600	3.6469	−2.4408
87	2-Propanol	C_3H_8O	67630	60.096	−27.2700	−17.3470	3.0920	−1.8300
88	2-Methyl-2-propanol	$C_4H_{10}O$	75650	74.123	−31.2400	−17.7600	3.2630	−2.4239
89	1-Pentanol	$C_5H_{12}O$	71410	88.150	−29.8737	−14.6022	4.0250	−3.0605
90	2-Methyl-1-butanol	$C_5H_{12}O$	137326	88.150	−30.2085	−14.6709	3.9351	−3.0620
91	3-Methyl-1-butanol	$C_5H_{12}O$	123513	88.150	−30.2100	−14.5000	3.8770	−3.0623
92	1-Hexanol	$C_6H_{14}O$	111273	102.177	−31.6500	−13.4400	4.4010	−3.6766
93	1-Heptanol	$C_7H_{16}O$	111706	116.203	−33.6400	−12.5300	4.7919	−4.2860
94	Cyclohexanol	$C_6H_{12}O$	108930	100.161	−28.6200	−10.9500	3.2770	−3.4639
95	Ethylene glycol	$C_2H_6O_2$	107211	62.068	−38.7500	−30.2600	3.2350	−1.0590
96	1,2-Propylene glycol	$C_3H_8O_2$	57556	76.095	−42.1500	−30.4000	3.5200	−1.6476

TABLE 2-221 Enthalpies and Gibbs Energies of Formation, Entropies, and Net Enthalpies of Combustion of Inorganic and Organic Compounds (*Continued*)

Cmpd. no.	Name	Formula	CAS no.	Mol wt	Ideal gas enthalpy of formation, J/kmol × 1E-07	Ideal gas Gibbs energy of formation, J/kmol × 1E-07	Ideal gas entropy, J/(kmol·K) × 1E-05	Standard net enthalpy of combustion, J/kmol × 1E-09
97	Phenol	C_6H_6O	108952	94.113	−9.6399	−3.2637	3.1481	−2.9210
98	*o*-Cresol	C_7H_8O	95487	108.140	−12.8570	−3.5430	3.5259	−3.5280
99	*m*-Cresol	C_7H_8O	108394	108.140	−13.2300	−4.0190	3.5604	−3.5278
100	*p*-Cresol	C_7H_8O	106445	108.140	−12.5350	−3.1660	3.5075	−3.5226
101	Dimethyl ether	C_2H_6O	115106	46.069	−18.4100	−11.2800	2.6670	−1.3284
102	Methyl ethyl ether	C_3H_8O	540670	60.096	−21.6400	−11.7100	3.0881	−1.9314
103	Methyl *n*-propyl ether	$C_4H_{10}O$	557175	74.123	−23.8200	−11.1000	3.5200	−2.5174
104	Methyl isopropyl ether	$C_4H_{10}O$	598538	74.123	−25.2000	−12.1800	3.4160	−2.5311
105	Methyl *n*-butyl ether	$C_5H_{12}O$	628284	88.150	−25.8100	−10.1700	3.9010	−3.1282
106	Methyl isobutyl ether	$C_5H_{12}O$	625445	88.150	−26.6000	−10.7000	3.8100	−3.1220
107	Methyl tert-butyl ether	$C_5H_{12}O$	1634044	88.150	−28.3500	−11.7500	3.5780	−3.1049
108	Diethyl ether	$C_4H_{10}O$	60297	74.123	−25.2100	−12.2100	3.4230	−2.5035
109	Ethyl propyl ether	$C_5H_{12}O$	628320	88.150	−27.2200	−11.5200	3.8810	−3.1200
110	Ethyl isopropyl ether	$C_5H_{12}O$	625547	88.150	−28.5800	−12.6400	3.8000	−3.1030
111	Methyl phenyl ether	C_7H_8O	100663	108.140	−6.7900	2.2700	3.6100	−3.6072
112	Diphenyl ether	$C_{12}H_{10}O$	101848	170.211	5.2000	17.5000	4.1300	−5.8939
113	Formaldehyde	CH_2O	50000	30.026	−10.8600	−10.2600	2.1866	−0.5268
114	Acetaldehyde	C_2H_4O	75070	44.053	−16.6200	−13.3100	2.6420	−1.1045
115	1-Propanal	C_3H_6O	123386	58.080	−18.6300	−12.4600	3.0440	−1.6857
116	1-Butanal	C_4H_8O	123728	72.107	−20.7000	−11.6300	3.4365	−2.3035
117	1-Pentanal	$C_5H_{10}O$	110623	86.134	−22.7800	−10.7100	3.8289	−2.9100
118	1-Hexanal	$C_6H_{12}O$	66251	100.161	−24.8600	−10.0050	4.2214	−3.5200
119	1-Heptanal	$C_7H_{14}O$	111717	114.188	−26.9400	−9.1910	4.6138	−4.1360
120	1-Octanal	$C_8H_{16}O$	124130	128.214	−29.0200	−8.3770	5.0063	−4.7400
121	1-Nonanal	$C_9H_{18}O$	124196	142.241	−31.0900	−7.5530	5.3988	−5.3500
122	1-Decanal	$C_{10}H_{20}O$	112312	156.268	−33.1700	−6.7390	5.7912	−5.9590
123	Acetone	C_3H_6O	67641	58.080	−21.5700	−15.1300	2.9540	−1.6590
124	Methyl ethyl ketone	C_4H_8O	78933	72.107	−23.9000	−14.7000	3.3940	−2.2680
125	2-Pentanone	$C_5H_{10}O$	107879	86.134	−25.9200	−13.8300	3.7860	−2.8796
126	Methyl isopropyl ketone	$C_5H_{10}O$	563804	86.134	−26.2400	−13.9000	3.6990	−2.8770
127	2-Hexanone	$C_6H_{12}O$	591786	100.161	−27.9826	−13.0081	4.1786	−3.4900
128	Methyl isobutyl ketone	$C_6H_{12}O$	108101	100.161	−28.8000	−13.5000	4.0700	−3.4900
129	3-Methyl-2-pentanone	$C_6H_{12}O$	565617	100.161	−28.1000	−12.9000	4.1200	−3.4900
130	3-Pentanone	$C_5H_{10}O$	96220	86.134	−25.7900	−13.4400	3.7000	−2.8804
131	Ethyl isopropyl ketone	$C_6H_{12}O$	565695	100.161	−28.6100	−13.3000	4.0690	−3.4860
132	Diisopropyl ketone	$C_7H_{14}O$	565800	114.188	−31.1400	−13.2000	4.5700	−4.0950
133	Cyclohexanone	$C_6H_{10}O$	108941	98.145	−22.6100	−8.6620	3.2200	−3.2990
134	Methyl phenyl ketone	C_8H_8O	98862	120.151	−8.6700	−0.1364	3.8450	−3.9730
135	Formic acid	CH_2O_2	64186	46.026	−37.8600	−35.1000	2.4870	−0.2115
136	Acetic acid	$C_2H_4O_2$	64197	60.053	−43.2800	−37.4600	2.8250	−0.8146
137	Propionic acid	$C_3H_6O_2$	79094	74.079	−45.3500	−36.6700	3.2300	−1.3950
138	*n*-Butyric acid	$C_4H_8O_2$	107926	88.106	−47.5800	−36.0000	3.6200	−2.0077
139	Isobutyric acid	$C_4H_8O_2$	79312	88.106	−48.4100	−36.2100	3.4120	−2.0004
140	Benzoic acid	$C_7H_6O_2$	65850	122.123	−29.4100	−21.4200	3.6900	−3.0951
141	Acetic anhydride	$C_4H_6O_3$	108247	102.090	−57.2500	−47.3400	3.8990	−1.6750
142	Methyl formate	$C_2H_4O_2$	107313	60.053	−35.2400	−29.5000	2.8520	−0.8924
143	Methyl acetate	$C_3H_6O_2$	79209	74.079	−41.1900	−32.4200	3.1980	−1.4610
144	Methyl propionate	$C_4H_8O_2$	554121	88.106	−42.7500	−31.1000	3.5960	−2.0780
145	Methyl *n*-butyrate	$C_5H_{10}O_2$	623427	102.133	−45.0700	−30.5300	3.9880	−2.6860
146	Ethyl formate	$C_3H_6O_2$	109944	74.079	−38.8300	−30.3100	3.2820	−1.5070
147	Ethyl acetate	$C_4H_8O_2$	141786	88.106	−44.4500	−32.8000	3.5970	−2.0610
148	Ethyl propionate	$C_5H_{10}O_2$	105373	102.133	−46.3600	−31.9300	4.0250	−2.6740
149	Ethyl *n*-butyrate	$C_6H_{12}O_2$	105544	116.160	−48.5500	−31.2200	4.4170	−3.2840
150	*n*-Propyl formate	$C_4H_8O_2$	110747	88.106	−40.7600	−29.3600	3.6780	−2.0410
151	*n*-Propyl acetate	$C_5H_{10}O_2$	109604	102.133	−46.4800	−32.0400	4.0230	−2.6720
152	*n*-Butyl acetate	$C_6H_{12}O_2$	123864	116.160	−48.5600	−31.2600	4.4250	−3.2800
153	Methyl benzoate	$C_8H_8O_2$	93583	136.150	−28.7900	−18.1000	4.1400	−3.7720
154	Ethyl benzoate	$C_9H_{10}O_2$	93890	150.177	−32.6000	−19.0500	4.5500	−4.4100
155	Vinyl acetate	$C_4H_6O_2$	108054	86.090	−31.4900	−22.7900	3.2800	−1.9500
156	Methylamine	CH_5N	74895	31.057	−2.2970	3.2070	2.4330	−0.9751
157	Dimethylamine	C_2H_7N	124403	45.084	−1.8450	6.8390	2.7296	−1.6146
158	Trimethylamine	C_3H_9N	75503	59.111	−2.4310	9.8990	2.8700	−2.2449
159	Ethylamine	C_2H_7N	75047	45.084	−4.7150	3.6160	2.8480	−1.5874
160	Diethylamine	$C_4H_{11}N$	109897	73.138	−7.1420	7.3080	3.5220	−2.8003
161	Triethylamine	$C_6H_{15}N$	121448	101.192	−9.5800	11.4100	4.0540	−4.0405
162	*n*-Propylamine	C_3H_9N	107108	59.111	−7.0500	4.1700	3.2420	−2.1650

TABLE 2-221 Enthalpies and Gibbs Energies of Formation, Entropies, and Net Enthalpies of Combustion of Inorganic and Organic Compounds (*Continued*)

Cmpd. no.	Name	Formula	CAS no.	Mol wt	Ideal gas enthalpy of formation, J/kmol × 1E-07	Ideal gas Gibbs energy of formation, J/kmol × 1E-07	Ideal gas entropy, J/(kmol·K) × 1E-05	Standard net enthalpy of combustion, J/kmol × 1E-09
163	di-*n*-Propylamine	$C_6H_{15}N$	142847	101.192	−11.6000	8.6800	4.2900	−4.0189
164	Isopropylamine	C_3H_9N	75310	59.111	−8.3800	3.1920	3.1240	−2.1566
165	Diisopropylamine	$C_6H_{15}N$	108189	101.192	−15.0000	5.7900	4.1200	−3.9900
166	Aniline	C_6H_7N	62533	93.128	8.7100	16.6800	3.1980	−3.2390
167	*N*-Methylaniline	C_7H_9N	100618	107.155	8.8000	20.2000	3.4100	−3.9000
168	*N,N*-Dimethylaniline	$C_8H_{11}N$	121697	121.182	10.0500	24.7728	3.6600	−4.5250
169	Ethylene oxide	C_2H_4O	75218	44.053	−5.2630	−1.3230	2.4299	−1.2180
170	Furan	C_4H_4O	110009	68.075	−3.4800	0.0823	2.6714	−1.9959
171	Thiophene	C_4H_4S	110021	84.142	11.5440	12.6620	2.7865	−2.4352
172	Pyridine	C_5H_5N	110861	79.101	14.0370	19.0490	2.8278	−2.6721
173	Formamide	CH_3NO	75127	45.041	−19.2200	−14.7100	2.4857	−0.5021
174	*N,N*-Dimethylformamide	C_3H_7NO	68122	73.095	−19.1700	−8.8400	3.2600	−1.7887
175	Acetamide	C_2H_5NO	60355	59.068	−23.8300	−15.9600	2.7220	−1.0741
176	*N*-Methylacetamide	C_3H_7NO	79163	73.095	−24.0000	−13.5000	3.2000	−1.7100
177	Acetonitrile	C_2H_3N	75058	41.053	7.4040	9.1868	2.4329	−1.1904
178	Propionitrile	C_3H_5N	107120	55.079	5.1800	9.7495	2.8614	−1.8007
179	*n*-Butyronitrile	C_4H_7N	109740	69.106	3.4058	10.8658	3.2543	−2.4148
180	Benzonitrile	C_7H_5N	100470	103.123	21.8823	26.0872	3.2104	−3.5224
181	Methyl mercaptan	CH_4S	74931	48.109	−2.2900	−0.9800	2.5500	−1.1517
182	Ethyl mercaptan	C_2H_6S	75081	62.136	−4.6300	−0.4814	2.9610	−1.7366
183	*n*-Propyl mercaptan	C_3H_8S	107039	76.163	−6.7500	0.2583	3.3650	−2.3458
184	*n*-Butyl mercaptan	$C_4H_{10}S$	109795	90.189	−8.7800	1.1390	3.7520	−2.9554
185	Isobutyl mercaptan	$C_4H_{10}S$	513440	90.189	−9.6900	0.5982	3.6280	−2.9490
186	sec-Butyl mercaptan	$C_4H_{10}S$	513531	90.189	−9.6600	0.5120	3.6670	−2.9490
187	Dimethyl sulfide	C_2H_6S	75183	62.136	−3.7240	0.7302	2.8585	−1.7449
188	Methyl ethyl sulfide	C_3H_8S	624895	76.163	−5.9600	1.1470	3.3320	−2.3531
189	Diethyl sulfide	$C_4H_{10}S$	352932	90.189	−8.3470	1.7780	3.6800	−2.9607
190	Fluoromethane	CH_3F	593533	34.033	−23.4300	−21.0400	2.2273	−0.5219
191	Chloromethane	CH_3Cl	74873	50.488	−8.1960	−5.8440	2.3418	−0.6754
192	Trichloromethane	$CHCl_3$	67663	119.377	−10.2900	−7.0100	2.9560	−0.3800
193	Tetrachloromethane	CCl_4	56235	153.822	−9.5810	−5.3540	3.0991	−0.2653
194	Bromomethane	CH_3Br	74839	94.939	−3.7700	−2.8190	2.4580	−0.7054
195	Fluoroethane	C_2H_5F	353366	48.060	−26.4400	−21.2300	2.6440	−1.1270
196	Chloroethane	C_2H_5Cl	75003	64.514	−11.2260	−6.0499	2.7578	−1.2849
197	Bromoethane	C_2H_5Br	74964	108.966	−6.3600	−2.5820	2.8730	−1.2850
198	1-Chloropropane	C_3H_7Cl	540545	78.541	−13.3180	−5.2610	3.1547	−1.8670
199	2-Chloropropane	C_3H_7Cl	75296	78.541	−14.4770	−6.1360	3.0594	−1.8630
200	1,1-Dichloropropane	$C_3H_6Cl_2$	78999	112.986	−15.0800	−6.5200	3.4480	−1.7200
201	1,2-Dichloropropane	$C_3H_6Cl_2$	78875	112.986	−16.2800	−8.0180	3.5480	−1.7070
202	Vinyl chloride	C_2H_3Cl	75014	62.499	2.8450	4.1950	2.7354	−1.1780
203	Fluorobenzene	C_6H_5F	462066	96.104	−11.6566	−6.9036	3.0263	−2.8145
204	Chlorobenzene	C_6H_5Cl	108907	112.558	5.1090	9.8290	3.1403	−2.9760
205	Bromobenzene	C_6H_5Br	108861	157.010	10.5018	13.8532	3.2439	−3.0192
206	Air		132259100	28.951	0	0	1.9900	0
207	Hydrogen	H_2	1333740	2.016	0	0	1.3057	−0.2418
208	Helium-4	He	7440597	4.003	0	0	1.2604	0
209	Neon	Ne	7440019	20.180	0	0	1.4622	0
210	Argon	Ar	7440371	39.948	0	0	1.5474	0
211	Fluorine	F_2	7782414	37.997	0	0	2.0268	0
212	Chlorine	Cl_2	7782505	70.905	0	0	2.2297	0
213	Bromine	Br_2	7726956	159.808	3.0910	0.3140	2.4535	0
214	Oxygen	O_2	7782447	31.999	0	0	2.0504	0
215	Nitrogen	N_2	7727379	28.014	0	0	1.9150	0
216	Ammonia	NH_3	7664417	17.031	−4.5898	−1.6400	1.9266	−0.3168
217	Hydrazine	N_2H_4	302012	32.045	9.5353	15.9170	2.3861	−5.3420
218	Nitrous oxide	N_2O	10024972	44.013	8.2050	10.4160	2.1985	−0.0820
219	Nitric oxide	NO	10102439	30.006	9.0250	8.6570	2.1060	−0.0902
220	Cyanogen	C_2N_2	460195	52.036	30.9072	29.7553	2.4146	−1.0961
221	Carbon monoxide	CO	630080	28.010	−11.0530	−13.7150	1.9756	−0.2830
222	Carbon dioxide	CO_2	124389	44.010	−39.3510	−39.4370	2.1368	0
223	Carbon disulfide	CS_2	75150	76.143	11.6900	6.6800	2.3790	−1.0769
224	Hydrogen fluoride	HF	7664393	20.006	−27.3300	−27.5400	1.7367	0.1524
225	Hydrogen chloride	HCl	7647010	36.461	−9.2310	−9.5300	1.8679	−0.0286
226	Hydrogen bromide	HBr	10035106	80.912	−3.6290	−5.3340	1.9859	−0.0690
227	Hydrogen cyanide	HCN	74908	27.026	13.5143	12.4725	2.0172	−0.6233

TABLE 2-221 Enthalpies and Gibbs Energies of Formation, Entropies, and Net Enthalpies of Combustion of Inorganic and Organic Compounds (*Concluded*)

Cmpd. no.	Name	Formula	CAS no.	Mol wt	Ideal gas enthalpy of formation, J/kmol × 1E-07	Ideal gas Gibbs energy of formation, J/kmol × 1E-07	Ideal gas entropy, J/(kmol·K) × 1E-05	Standard net enthalpy of combustion, J/kmol × 1E-09
228	Hydrogen sulfide	H_2S	7783064	34.082	−2.0630	−3.3440	2.0560	−0.5180
229	Sulfur dioxide	SO_2	7446095	64.065	−29.6840	−30.0120	2.4810	0
230	Sulfur trioxide	SO_3	7446119	80.064	−39.5720	−37.0950	2.5651	0.0989
231	Water	H_2O	7732185	18.015	−24.1814	−22.8590	1.8872	0

All substances are listed in alphabetical order in Table 2-6*a*.

Compiled from Daubert, T. E., R. P. Danner, H. M. Sibul, and C. C. Stebbins, DIPPR Data Compilation of Pure Compound Properties, Project 801 Sponsor Release, July, 1993, Design Institute for Physical Property Data, AIChE, New York, NY; and from Thermodynamics Research Center, "Selected Values of Properties of Hydrocarbons and Related Compounds," Thermodynamics Research Center Hydrocarbon Project, Texas A&M University, College Station, Texas (extant 1994).

The compounds are considered to be formed from the elements in their standard states at 298.15 K and 101,325 P_a. These include C (graphite) and S (rhombic).

Enthalpy of combustion is the net value for the compound in its standard state at 298.15K and 101,325 Pa.

Products of combustion are taken to be CO_2 (gas), H_2O (gas), F_2 (gas), Cl_2 (gas), Br_2 (gas), I_2 (gas), SO_2 (gas), N_2 (gas), H_3PO_4 (solid), and SiO_2 (crystobalite).

J/kmol × 2.390E-04 = cal/gmol; J/kmol × 4.302106E-04 = Btu/lbmol.

J/(kmol·K) × 2.390E-04 = cal/(gmol·°C); J/(kmol·K) × 2.390059E-04 = Btu/(lbmol·°F).

TABLE 2-222 Ideal Gas Sensible Enthalpies, $h_T - h_{298}$ (kJ/kgmol), of Combustion Products

Temperature, K	CO	CO_2	H	OH	H_2	N	NO	NO_2	N_2	N_2O	O	O_2	SO_2	H_2O
200	−2858	−3414	−2040	−2976	−2774	−2040	−2951	−3495	−2857	−3553	−2186	−2868	−3736	−3282
240	−1692	−2079	−1209	−1756	−1656	−1209	−1743	−2104	−1692	−2164	−1285	−1703	−2258	−1948
260	−1110	−1383	−793	−1150	−1091	−793	−1142	−1392	−1110	−1438	−840	−1118	−1496	−1279
280	−529	−665	−377	−546	−522	−378	−543	−672	−528	−692	−398	−533	−718	−609
298.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
300	54	69	38	55	53	38	55	68	54	72	41	54	74	62
320	638	823	454	654	630	454	652	816	636	854	478	643	881	735
340	1221	1594	870	1251	1209	870	1248	1571	1219	1654	913	1234	1702	1410
360	1805	2382	1285	1847	1791	1286	1845	2347	1802	2470	1346	1828	2538	2088
380	2389	3184	1701	2442	2373	1701	2442	3130	2386	3302	1777	2425	3387	2769
400	2975	4003	2117	3035	2959	2117	3040	3927	2971	4149	2207	3025	4250	3452
420	3563	4835	2532	3627	3544	2533	3638	4735	3557	5010	2635	3629	5126	4139
440	4153	5683	2948	4219	4131	2949	4240	5557	4143	5884	3063	4236	6015	4829
460	4643	6544	3364	4810	4715	3364	4844	6392	4731	6771	3490	4847	6917	5523
480	5335	7416	3779	5401	5298	3780	5450	7239	5320	7670	3918	5463	7831	6222
500	5931	8305	4196	5992	5882	4196	6059	8099	5911	8580	4343	6084	8758	6925
550	7428	10572	5235	7385	6760	5235	7592	10340	7395	10897	5402	7653	11123	8699
600	8942	12907	6274	8943	8811	6274	9144	12555	8894	13295	6462	9244	13544	10501
650	10477	15303	7314	10423	10278	7314	10716	14882	10407	15744	7515	10859	16022	12321
700	12023	17754	8353	11902	11749	8353	12307	17250	11937	18243	8570	12499	18548	14192
750	13592	20260	9392	13391	13223	9329	13919	19671	13481	20791	9620	14158	21117	16082
800	15177	22806	10431	14880	14702	10431	15548	22136	15046	23383	10671	15835	23721	18002
850	16781	25398	11471	16384	16186	11471	17195	24641	16624	26014	11718	17531	26369	19954
900	18401	28030	12510	17888	17676	12510	18858	27179	18223	28681	12767	19241	29023	21938
950	20031	30689	13550	19412	19175	13550	20537	29749	19834	31381	13812	20965	31714	23954
1000	21690	33397	14589	20935	20680	14589	22229	32344	21463	34110	14860	22703	34428	26000
1100	25035	38884	16667	24024	23719	16667	25653	37605	24760	39647	16950	26212	39914	30191
1200	28430	44473	18746	27160	26797	18746	29120	42946	28109	45274	19039	29761	45464	34500
1300	31868	50148	20824	30342	29918	20824	32626	48351	31503	50976	21126	33344	51069	38943
1400	35343	55896	22903	33569	33082	22903	36164	53808	34936	56740	23212	36957	56718	43493
1500	38850	61705	24982	36839	36290	24982	39729	59309	38405	62557	25296	40599	62404	48151
1600	42385	67569	27060	40151	39541	27060	43319	64846	41904	68420	27381	44266	68123	52908
1700	45945	73480	29139	43502	42835	29139	46929	70414	45429	74320	29464	47958	73870	57758
1800	49526	79431	31217	46889	46169	31218	50557	76007	48978	80254	31547	51673	79642	62693
1900	53126	85419	33296	50310	49541	33296	54201	81624	52548	86216	33630	55413	85436	67700
2000	56744	91439	35375	53762	52951	35375	57859	87259	56137	92203	35713	59175	91250	72790
2100	60376	97488	37453	57243	56397	37454	61530	92911	59742	98212	37796	62961	97081	77941
2200	64021	103562	39532	60752	59876	39534	65212	98577	63361	104240	39878	66769	102929	83151
2300	67683	109660	41610	64285	63387	41614	68904	104257	66995	110284	41962	70600	108792	88421
2400	71324	115779	43689	67841	66928	43695	72606	109947	70640	116344	44045	74453	114669	93741
2500	74985	121917	45768	71419	70498	45777	76316	115648	74296	122417	46130	78328	120559	99101
2600	78673	128073	47846	75017	74096	47860	80034	121357	77963	128501	48216	82224	126462	104521
2700	82369	134246	49925	78633	77720	49945	83759	127075	81639	134596	50303	86141	132376	109971
2800	86074	140433	52004	82267	81369	52033	87491	132799	85323	140701	52391	90079	138302	115461
2900	89786	146636	54082	85918	85043	54124	91229	138530	89015	146814	54481	94036	144238	120990
3000	93504	152852	56161	89584	88740	56218	94973	144267	92715	152935	56574	98013	150184	126549
3500	112185	184109	66554	108119	107555	66769	113768	173020	111306	183636	67079	118165	180057	154766
4000	130989	215622	75947	126939	126874	77532	132671	201859	130027	214453	77675	188705	210145	183559
4500	149895	247354	87340	145991	146660	88614	151662	230756	148850	245348	88386	159572	240427	212766
5000	168890	279283	97733	165246	166876	100111	170730	259692	167763	276299	99222	180749	270893	242337

Converted and usually rounded off from JANAF Thermochemical Tables, NSRDS-NBS-37, 1971 (1141 pp.)

Tabella 30. – *Calori standard di combustione.*

Condizioni di riferimento: 25 °C (298,16 °K), 1 atm di pressione, sostanze gassose allo stato ideale.

ΔH°_c = calore standard di combustione, kcal/mole

Moltiplicare per 1.000 per ottenere cal/mole o kcal/kmole.

Abbreviazioni

s = solido *l* = liquido *g* = gassoso

Idrocarburi

Prodotti finali: $CO_2(g)$, $H_2O(l)$

Composto	Formula	Stato	$-\Delta H^\circ_c$
Carbonio (grafite)	C	*s*	94,0518
Ossido di carbonio	CO	*g*	67,6361
Idrogeno	H_2	*g*	68,3174
Metano	CH_4	*g*	212,798
Etino (acetilene)	C_2H_2	*g*	310,615
Etene (etilene)	C_2H_4	*g*	337,234
Etano	C_2H_6	*g*	372,820
Propino (allilene, metilacetilene)	C_3H_4	*g*	463,109
Propene (propilene)	C_3H_6	*g*	491,987
Propano	C_3H_8	*g*	530,605
1,2-butadiene	C_4H_6	*g*	620,71
2-metilpropene (isobutilene, isobutene)	C_4H_8	*g*	646,134
2-metilpropano (isobutano)	C_4H_{10}	*g*	686,342
n-butano	C_4H_{10}	*g*	687,982
1-pentene (anilene)	C_5H_{10}	*g*	806,85
Ciclopentano	C_5H_{10}	*l*	786,54
2,2-dimetilpropano (neopentano)	C_5H_{12}	*g*	840,49
2-metilbutano (isopentano)	C_5H_{12}	*g*	843,24
n-pentano	C_5H_{12}	*g*	845,16
Benzene	C_6H_6	*g*	789,08
Benzene	C_6H_6	*l*	780,98
1-esene (esilene)	C_6H_{12}	*g*	964,26
Cicloesano	C_6H_{12}	*l*	936,88
n-esano	C_6H_{14}	*l*	995,01
Metil benzene (toluene)	C_7H_8	*g*	943,58
Metil benzene (toluene)	C_7H_8	*l*	934,50
Cicloeptano	C_7H_{14}	*l*	1086,9
n-eptano	C_7H_{16}	*l*	1151,27
1,2-dimetilbenzene (*o*-xilene)	C_8H_{10}	*g*	1098,54
1,2-dimetilbenzene (*o*-xilene)	C_8H_{10}	*l*	1088,16
1,3-dimetilbenzene (*m*-xilene)	C_8H_{10}	*g*	1098,12
1,3-dimetilbenzene (*m*-xilene)	C_8H_{10}	*l*	1087,92
1,4-dimetilbenzene (*p*-xilene)	C_8H_{10}	*g*	1098,29
1,4-dimetilbenzene (*p*-xilene)	C_8H_{10}	*l*	1088,16
n-ottano	C_8H_{18}	*l*	1307,53
1,3,5-trimetilbenzene (mesitilene)	C_9H_{12}	*l*	1241,19
Naftalina	$C_{10}H_8$	*s*	1231,6
n-decano	$C_{10}H_{22}$	*l*	1620,06
Difenile	$C_{12}H_{10}$	*s*	1493,5
Antracene	$C_{14}H_{10}$	*s*	1695
Fenantrene	$C_{14}H_{10}$	*s*	1693
n-esadecano	$C_{16}H_{24}$	*l*	2557,64

Continua - Tabella 30.

Alcooli

Prodotto finale: $CO_2(g)$, $H_2O(l)$

Composto	Formula	Stato	$-\Delta H^\circ_c$
Alcool metilico	CH_4O	*g*	182,59
Alcool metilico	CH_4O	*l*	173,65
Alcool etilico	C_2H_6O	*g*	336,82
Alcool etilico	C_2H_6O	*l*	326,70
Glicol etilenico	$C_2H_6O_2$	*l*	284,48
Alcool allilico	C_3H_6O	*l*	442,3
Alcool *n*-propilico	C_3H_8O	*g*	494,26
Alcool *n*-propilico	C_3H_8O	*l*	483,56
Alcool isopropilico	C_3H_8O	*g*	493,02
Alcool isopropilico	C_3H_8O	*l*	481,11
Glicerina	$C_3H_8O_3$	*l*	396,27
Alcool *n*-butilico	$C_4H_{10}O$	*g*	649,98
Alcool *n*-butilico	$C_4H_{10}O$	*l*	638,18
Alcool amilico	$C_5H_{12}O$	*l*	786,7
Metil-dietil carbinolo	$C_6H_{14}O$	*l*	926,9

Acidi

Prodotto finale: $CO_2(g)$, $H_2O(l)$

Formico (monomolecolare)	CH_2O_2	*g*	75,70
Formico	CH_2O_2	*l*	64,57
Ossalico	$C_2H_2O_4$	*s*	58,82
Acetico	$C_2H_4O_2$	*g*	219,82
Acetico	$C_2H_4O_2$	*l*	208,34
Anidride acetica	$C_4H_6O_3$	*g*	432,34
Anidride acetica	$C_4H_6O_3$	*l*	426,00
Glicolico	$C_2H_4O_3$	*s*	166,54
Propionico	$C_3H_6O_2$	*g*	378,36
Propionico	$C_3H_6O_2$	*l*	365,41
Lattico	$C_3H_6O_3$	*s*	325,8
d-tartarico	$C_4H_6O_6$	*s*	274,9
n-butirrico	$C_4H_8O_2$	*l*	520
Citrico (anidro)	$C_6H_8O_7$	*s*	474,3
Benzoico	$C_7H_6O_2$	*s*	771,5
o-ftalico	$C_8H_6O_4$	*s*	770,8
Anidride ftalica	$C_8H_4O_3$	*s*	781,4
o-toluico	$C_8H_8O_2$	*s*	928,6
Palmitico	$C_{16}H_{32}O_2$	*s*	2379
Stearolico	$C_{18}H_{32}O_2$	*s*	2628
Elaidinico	$C_{18}H_{34}O_2$	*s*	2663
Oleico	$C_{18}H_{34}O_2$	*l*	2668
Stearico	$C_{18}H_{36}O_2$	*s*	2697

Carboidrati, cellulosa, amido, ecc.

Prodotti finali: $CO_2(g)$, $H_2O(l)$

d-glucosio (destrosio)	$C_6H_{12}O_6$	*s*	673
l-fruttosio	$C_6H_{12}O_6$	*s*	675
Lattosio (anidro)	$C_{12}H_{22}O_{11}$	*s*	1350,1
Saccarosio	$C_{12}H_{22}O_{11}$	*s*	1348,9
			cal/g
Amido			4177
Destrina			4108
Cellulosa			4179
Acetato di cellulosa			4495

Continua - Tabella 30.

Altri composti CHO

Prodotti finali: $CO_2(g)$, $H_2O(l)$

Composto	Formula	Stato	$-\Delta H^\circ_c$
Formaldeide	CH_2O	*g*	134,67
Acetaldeide	C_2H_4O	*g*	284,98
Acetone	C_3H_6O	*g*	435,32
Acetone	C_3H_6O	*l*	427,79
Metilacetato	$C_3H_6O_2$	*g*	397,5
Etilacetato	$C_4H_8O_2$	*g*	547,46
Etilacetato	$C_4H_8O_2$	*l*	538,76
Dietil etere	$C_4H_{10}O$	*l*	652,59
Dietil chetone	$C_5H_{10}O$	*l*	738,05
Fenolo	C_6H_6O	*g*	747,55
Fenolo	C_6H_6O	*l*	731,46
Pirogallolo	$C_6H_6O_3$	*s*	639
Amil acetato	$C_7H_{14}O_2$	*l*	1040
Canfora	$C_{10}H_{16}O$	*s*	1411

Composti dell'Azoto

Prodotti finali: $CO_2(g)$, $N_2(g)$, $H_2O(l)$

Urea	CH_4N_2O	*s*	151,05
Cianogeno	C_2N_2	*g*	261,70
Trimetilammina	C_3H_9N	*l*	578,4
Piridina	C_5H_5N	*l*	660
Trinitrobenzene (1,3,5)	$C_6H_3N_3O_6$	*s*	664,0
Trinitrofenolo (2,4,6)	$C_6H_3N_3O_7$	*s*	620,0
o-dinitrobenzene	$C_6H_4N_2O_4$	*s*	703,2
Nitrobenzene	$C_6H_5NO_2$	*l*	739
o-nitrofenolo	$C_6H_5NO_3$	*s*	689
o-nitroanilina	$C_6H_6N_2O_2$	*s*	766
Anilina	C_6H_7N	*l*	812
Trinitrotoluene (2,4,6)	$C_7H_5N_3O_6$	*s*	821
Nicotina	$C_{10}H_{14}N_2$	*l*	1428

Composti alogenati

Prodotti finali: $CO_2(g)$, $H_2O(l)$, sol. dil. di HCl

Tetracloruro di carbonio	CCl_4	*g*	92,01
Tetracloruro di carbonio	CCl_4	*l*	84,17
Cloroformio	$CHCl_3$	*g*	121,8
Cloroformio	$CHCl_3$	*l*	114,3
Cloruro di metile	CH_3Cl	*g*	182,81
Acido cloroacetico	$C_2H_3ClO_2$	*s*	172,24
Etilene dicloruro	$C_2H_4Cl_2$	*l*	296,77
Etil cloruro	C_2H_5Cl	*g*	339,66

Composti dello Zolfo

Prodotti finali: $CO_2(g)$, $SO_2(g)$, $H_2O(l)$

Solfuro di carbonile	COS	*g*	132,21
Solfuro di carbonio	CS_2	*g*	263,52
Solfuro di carbonio	CS_2	*l*	256,97
Metil mercaptano	CH_4S	*g*	298,68
Dimetil solfuro	C_2H_6S	*g*	457,12
Dimetil solfuro	C_2H_6S	*l*	450,42
Etil mercaptano	C_2H_6S	*l*	448,0

Riferimenti:

1. Selected Values of Physical and Thermodynamic Properties of Hydrocarbons and Related Compounds, *Am. Petroleum Inst. Research Proj.* **44**, pubblicato da F. D. Rossini, Carnegie Institute of Technology (1952).

2. *International Critical Tables*, vol. V (1929). I valori desunti da questa fonte sono stati trasformati per la temperatura di riferimento di 25 °C.

3. John H. Perry, *Chemical Engineers Handbook*, terza edizione, McGraw-Hill Book Co. (1950).