Heat Content and Heat Capacity of an Extruded Graphite from 341° to 1723° K.

R. A. McDONALD
Thermal Research Laboratory, The Dow Chemical Co. Midland, Mich.

The heat content of grade SPK graphite has been measured between 341° and 1723° K. Smoothed values of enthalpy and heat capacity from 298° to 1800° K. are given.

THE use of a high purity graphite as a calibrating heat capacity standard in an arc imaging furnace (*5*) requires that the heat capacity of the graphite be known with greater certainty than that indicated by the wide range of published experimental values (*2, 4, 6, 7, 9*). The data appeared to be dependent on the source of the graphite (*2, 6, 7*), and therefore it was most desirable to investigate the graphite selected for use in the arc imaging furnace.

EXPERIMENTAL

A 5.686-gram portion of graphite was cut from a Special Spectroscopic Electrode, Grade SPK, purchased from the National Carbon Company Division of Union Carbide Corp. Grade SPK graphite is described as an extruded product of high purity with a maximum ash of less than 10 p.p.m. and a density of 1.90. Each lot of material is spectroscopically analyzed by the manufacturer; only iron, magnesium, and sodium were detectable in the lot from which the sample was taken.

The sample was sealed in a platinum–10% rhodium capsule (14.727 grams) by arc welding under a helium pressure of 8 cm. of mercury.

The heat content, $H_T - H_{298.15° K.}$, was measured by the drop method with a copper-block calorimeter previously described (*3*). The platinum *vs.* platinum–10% rhodium thermocouple used to measure the sample temperature in the furnace had been calibrated recently by comparison with a similar couple standardized at the National Bureau of Standards. Correction for the heat content of the capsule was determined from previous empty capsule measurements.

Table I. Observed Enthalpy of Grade SPK Graphite[a]

T, ° K.	$H_T - H_{298.15}$, Cal./G. Atom	T, ° K.	$H_T - H_{298.15}$, Cal./G. Atom
341.0	92.92	1231.9	4051.2
414.4	289.57	1289.1	4365.9
546.4	733.84	1309.7	4474.4
685.9	1303.1	1315.1	4544.0
754.9	1622.2	1370.1	4819.6
822.2	1931.5	1394.1	4959.3
882.7	2231.3	1429.8	5178.3
963.1	2626.0	1482.8	5453.8
992.1	2777.4	1541.4	5798.7
1036.7	2976.6	1620.0	6260.2
1101.0	3337.9	1676.4	6575.0
1142.2	3568.2	1723.3	6882.5
1204.2	3905.9	...	...

[a] Gram atomic weight carbon = 12.011.

Table II. Smoothed Enthalpy and Heat Capacity of Grade SPK Graphite

T, ° K.	$H_T - H_{298.15}$, Cal./ G. Atom	C_p, Cal./ (G. Atom Deg.)	T, ° K.	$H_T - H_{298.15}$, Cal./ G. Atom	C_p, Cal./ (G. Atom Deg.)
300	3.78	2.05	1100	3339.8	5.30
400	248.10	2.82	1200	3876.0	5.43
500	564.56	3.49	1300	4425.2	5.56
600	941.96	4.03	1400	4988.5	5.67
700	1365.7	4.44	1500	5560.7	5.77
800	1825.4	4.74	1600	6143.4	5.86
900	2310.8	4.97	1700	6730.7	5.93
1000	2817.5	5.15	1800	7327.5	6.00

RESULTS

The observed enthalpies are given in Table I. These were treated in the manner of Shomate (*8*), using both the $C_{p\,298.15} = 2.038$ cal. per gram atom deg. and the low temperature heat capacities listed in the JANAF Thermochemical Tables (*1*) as an aid in smoothing the data.

Smoothed heat contents and heat capacities are listed in Table II. The observed enthalpies fall within ±0.4% of the smoothed curve with the exception of the values at 1036.7° and 1315.1° K. which are within ±1%.

LITERATURE CITED

(1) Dow Chemical Co. Midland, Mich., JANAF Thermochemical Tables, March 1961.
(2) Lucks, C.F., Deem, H.W., Wood, W.D., *Am. Ceram. Soc. Bull.* **39**, 313 (1960).
(3) McDonald, R.A., Stull, D.R., J. CHEM. ENG. DATA **6**, 609 (1961).
(4) Magnus, A., *Ann. Physik* (4) **70**, 303 (1923).
(5) Prophet, H., Stull, D.R., J. CHEM. ENG. DATA **8**, 78 (1963).
(6) Rasor, N.S., McClelland, J.D., *Phys. Chem. Solids* **15**, 17 (1960).
(7) Schlapfer, P., Debrunner, P., *Helv. Chim. Acta* **7**, 31 (1924).
(8) Shomate, C.H., *J. Phys. Chem.* **58**, 368 (1954).
(9) Worthing, A.G., *Phys. Rev.* **12**, 199 (1918).

RECEIVED for review January 18, 1965. Accepted May 28, 1965. This work was supported by the Advanced Research Project Agency under Air Force Contract No. AF33(616)-6149.