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The Heat Content of Iron

Joseph William Richards

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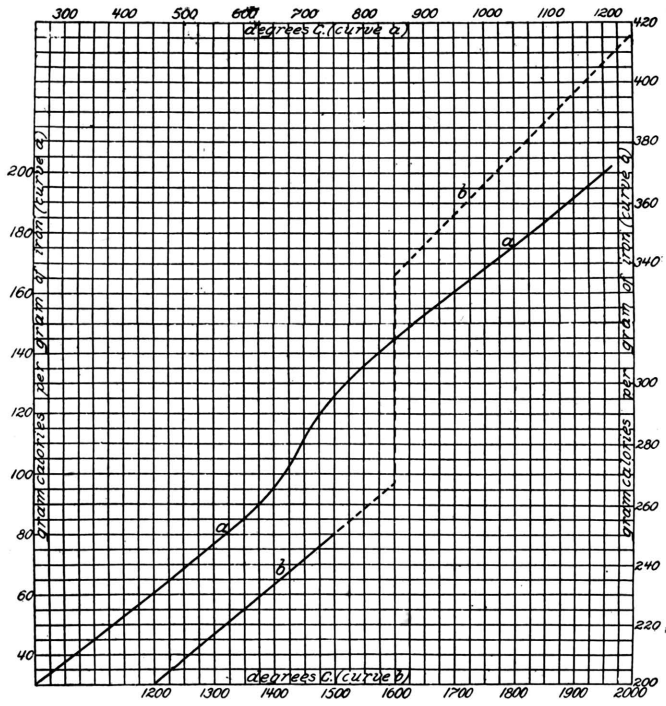
Dr-Engineer P. Oberhoffer contributes to *Metallurgie* of June 22, July 8 and 22, the full story of his researches on the specific heat of iron. It is a pity that some of Prof. Burgess' pure electrolytic iron was not used; instead, some soft steel from Krupp's was used, containing 0.06 carbon, 0.005 silicon,



ENERGY CONTENT OF IRON.

(Curve *b* is the continuation of curve *a*. The scales for curve *a* are at the left and the top; the scales for curve *b* are at the right and the bottom.)

0.005 phosphorus, 0.019 sulphur, and 0.05 per cent manganese. Cooling curves showed arrests in the speed of cooling culminating at 860°, 750° and 680° C.

The specimens were heated in a vacuum, and the heat unit is referred to water at room temperature. The results showed the specific heat of alpha iron to increase regularly, while that of gamma iron is practically constant, thus supporting the earlier determinations of Pionchon.

The actual results obtained by Oberhoffer are given in the following table, and are plotted in the annexed diagram, showing the gram calories contained per gram of iron:

	Cal.		*Cal.*
250°	30.5	1200°	200.0
300°	37.7	1250°	208.3
350°	45.0	1300°	261.1
400°	52.2	1350°	224.2
450°	60.3	1400°	233.1
500°	68.3	1450°	241.4
550°	76.7	1500°	250.0
600°	85.0	1550°	258.3
650°	95.1	1600°	266.7
700°	111.8	1600°	336.
750°	125.6	1650°	346.
800°	135.8	1700°	356.
850°	144.4	1750°	366.
900°	152.8	1800°	376.
950°	160.4	1850°	386.
1000°	167.8	1900°	396.
1050°	175.4	1950°	406.
1100°	183.0	2000°	416.
1150°	191.7		

The inferences to be drawn from these figures are interesting and important.

First, we notice that the specific heat of iron rises from about 0.11 at zero to 0.144 at 250°, and to 0.166 at 600°; that between 650 and 700 there is an absorption of latent heat of about 10 Calories; again, about 750°, there is absorption of 7 Calories. About 850° there may be an absorption of 2 Calories, but the observation is somewhat doubtful. Above 900 the specific heat is nearly constant at 0.167. It is a curious fact that from 1.000° up to 1,500° the amount of heat in the iron, reckoned from 0°, is almost exactly 0.167t; *i. e.*, Sm to 0° is 0.167.

The figures above 1,500° (represented in the diagram by a dotted line) are estimated values which we have added to Oberhoffer's observations. Up to 1,600°, the assumed melting point, we have extended the last observation of the last paragraph, making Q = 0.167t. At the melting point we have taken the latent heat of fusion as lying between 69 and 70 Calories. The calculation of this quantity on thermochemical principles is too long to insert here, but may be found fully explained by J. W. Richards in the *Journal* of the Franklin Institute, May, 1897. This makes the heat in just melted iron 336 Calories.

From this temperature on the iron is liquid, and since the solid iron just before melting has a constant specific heat of 0.167, the specific heat of the liquid iron will in all probability (from analogy with other metals) be also constant and probably only slightly higher than in the solid state. We have completed the curve to 2,000°, using a specinc heat of 0.20 for the liquid iron.

We think, from a close study of Oberhoffer's work, that he has probably given us the most accurate figures yet obtained for the heat in pure iron, and rounding out his observations by the probable values given and explained; we think these figures altogether are the most accurate which are at present available for use in the metallurgy of iron. Jos. W. Richards.