Physics. — *Isotherms of di-atomic substances and their binary mixtures.*
XXXIV. Isotherms of hydrogen at temperatures of 0° C. and
+100° C. By G. P. NIJHOFF and W. H. KEESOM. (Comm. N⁰. 188*d*
from the Physical Laboratory at Leiden.)

The isotherms of +100° C. and 0° C. have been measured with a piezo-
meter with a capacity of 1500 cm³, the same with which VAN URK and
KAMERLINGH ONNES [1]) have measured part of their nitrogen isotherms.
To this we connected a reservoir with a capacity of 33.6 cm³. The pressures
were measured with the aid of the closed manometer M 60. The temperature
of 0° C. was obtained with the aid of finely planed ice made from water
of the main, whereas for that of + 100° C. the steam apparatus described
by KAMERLINGH ONNES in Comm. N⁰. 27 [2]) was used, still in the old
shape [3]). The temperature of the vapour in this apparatus was measured
with a BECKMANN-thermometer of which the steam point had been
determined separately.

. Beforehand, for the sake of control, we have first measured three points
at +20° C., which agreed well with SCHALKWIJK's isotherm. In the last
column of table I we give the differences between the observed pv_A's and
the values of pv_A calculated with the aid of values of B_A and C_A, which
we communicate in table II and which, in order to make them correspond
as well as possible, we chose somewhat differing from the values of
SCHALKWIJK [4]) and from the later ones of KAMERLINGH ONNES, CROMMELIN
and Miss SMID [5]).

Concerning the isotherms of +100° C. and 0° C., the region of pressures
in which we have measured does not seem to be too favourable for the
determination of the values of B; for the C plays a not to be neglected
part here.

For 100° C. we determined B_A and C_A as follows. HOLBORN and
OTTO [6]), who have measured to about 100 atmospheres, give for +100° C.
in their development according to ascending powers of the pressure, only
a second term, whereas they don't want a quadratic term. If we compare

[1]) A. TH. VAN URK and H. KAMERLINGH ONNES, Comm. Leiden N⁰. 169*d*. For the
calibration see also A. TH. VAN URK, Thesis Leiden.

[2]) H. KAMERLINGH ONNES, Verslagen Kon. Ak. v. Wet. Amsterdam **5**, 79, 1896,
Comm. Leiden N⁰. 27.

[3]) Compare W. H. KEESOM and Miss H. V. D. HORST, These Proc. **30**, 970, 1927;
Comm. Leiden N⁰. 188*a*.

[4]) J. C. SCHALKWIJK, These Proc. **4**, 107, 1902; Comm. Leiden N⁰. 70.

[5]) H. KAMERLINGH ONNES, C. A. CROMMELIN and Miss E. I. SMID, These Proc.
18, 465, 1915, Comm. Leiden N⁰. 146*b*.

[6]) L. HOLBORN and J. OTTO, Zs. f. Physik. **33**, 1, 1925.

their development according to p with a development in series according to d_A, then from the coefficients of the first development in series, we can calculate the corresponding coefficients of the last mentioned series. In this way we calculated the value of B_A and C_A communicated in table II. In the last column of table I we give the differences between the observed values of pv_A and the values, which we calculated with the values just mentioned of B_A and C_A. We conclude from these that the values of B_A and C_A derived from HOLBORN and OTTO give sufficient correspondence also for our measurements.

As the value $C_A = 0.606 \times 10^{-6}$ calculated from the measurements of AMAGAT for the same temperature, is only little different, we can also put some trust into the value used by us $C_A = 0.635 \times 10^{-6}$.

For the isotherm of 0° C. we find the best correspondence with $B_A = 0.605 \times 10^{-6}$ and $C_A = 0.565 \times 10^{-6}$, whereas from the measurements of HOLBORN and OTTO follows $B_A = 0.620 \times 10^{-3}$ and $C_A = 0.760 \times 10^{-6}$, and from AMAGAT has been calculated for $C_A = 0.670 \times 10^{-6}$.

The measured quantities are following here :

TABLE I.

θ °C.	p int. atm.	pv_A	d_A	$O-C\,(pv_A)$	
+ 20	32.006⁵	1.0947	31.063⁵	−0.0003	
	40.098	1.0990	36.485		0
	45.771⁵	1.1021	42.527	−	6
+ 100	39.964	1.3929	28.691	−	2
	43.852	1.3951	31.431⁵	+	3
	48.746	1.3987	34.850	−	0⁵
	54.603	1.4028	38.924		0
	59.391	1.4061	42.237	+	1
0	32.312⁵	1.0188	31.715	−0.0003⁵	
	32.323	1.0190	31.721	−	1⁵
	33.524	1.0194	32.885	−	5
	34.875	1.0206	34.171	−	1
	36.306⁵	1.0217	35.536	+	1
	37.883	1.0226	37.047		0
	39.544⁵	1.0231	38.652	−	5
	42.905⁵	1.0260	41.817	+	3
	44.085	1.0264⁵	42.949	+	0⁵
	44.119	1.0266	43.284		0

In the following table we collect the values of B_A and C_A found by the different observers.

TABLE II.

	$B_A \cdot 10^3$	$C_A \cdot 10^6$
0° C.		
AMAGAT	0.669	0.670
KAMERLINGH ONNES and BRAAK	0.580	0.670
WITKOWSKI	0.619	
CHAPPUIS	0.605	
HOLBORN and OTTO	0.620	0.760
VERSCHOYLE	0.626	0.560
NIJHOFF and KEESOM	0.605	0.565
20° C.		
SCHALKWIJK	0.667	0.993
KAMERLINGH ONNES, CROMMELIN and Miss SMID	0.657	1.119
VERSCHOYLE	0.698	0.533
NIJHOFF and KEESOM	0.677	0.797
100° C.		
AMAGAT	1.057	0.606
WITKOWSKI	0.920	
HOLBORN and OTTO	0.937	0.635
KAMERLINGH ONNES and BRAAK	0.863	0.606
NIJHOFF and KEESOM	0.937	0.635

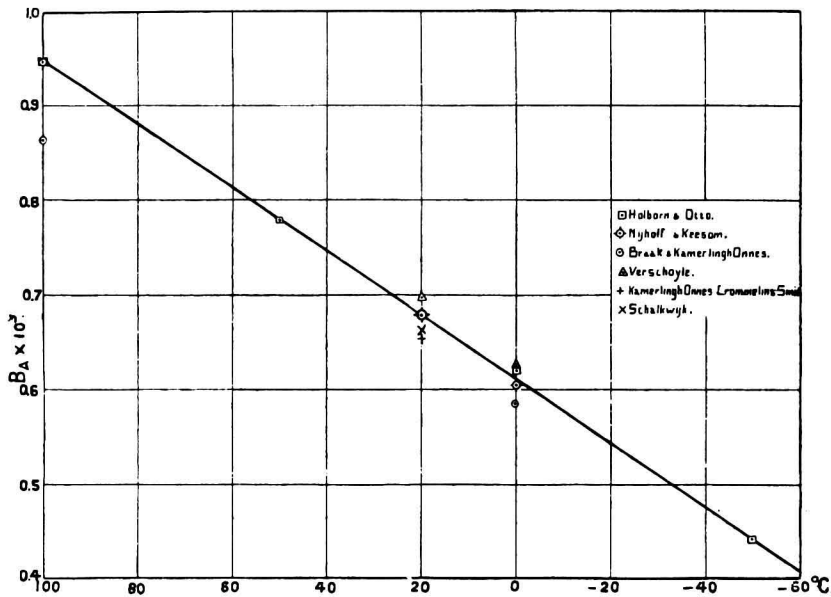In fig. 1 the most important values of B_A for this temperature region have been indicated.

Fig. 1.