Physics. — *On the rectilinear diameter of ethylene.* By E. MATHIAS, C. A. CROMMELIN and H. GARFIT WATTS. (Communication N°. 189*a* from the Physical Laboratory at Leiden.) (Communicated by Prof. W. H. KEESOM.)

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§ 1. The density curve and the rectilinear diameter of ethylene we thought would be an interesting subject for investigation, firstly because the results that have so far been obtained are only of a temporary character [1]) and secondly because this substance is one of those used in refrigeration. The present research forms part of a series of observations upon the diameter of oxygen [2]), argon [3]), nitrogen [4]), hydrogen [5]), neon [6]) and helium [7]). All these investigations were carried out in the Physical Laboratory of the University of Leiden.

§ 2. Our apparatus was almost exactly the same as that used in the above mentioned investigations, for particulars we may therefore refer to the papers already published on these. The only difference is that as liquid in the cryostat we used ethyl-chloride for temperatures above —24° C., methyl chloride for temperatures between —24° C. and —103° C. and ethylene for those below —103° C. Temperatures above the freezing-point of mercury were measured with a mercury thermometer standardized in the Physikalisch-Technische Reichsanstalt at Charlottenburg ; those that were lower, by means of a platinum resistance thermometer compared directly with the helium thermometer.

The ethylene was first technically prepared (ethyl-alcohol and sulphuric acid) and afterwards purified as thoroughly as possible by means of repeated distillation at a low temperature.

For the weight of 1 liter under normal conditions we took the figure 1.2609_8 [8]).

In the following table we have arranged the values found for the

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[1]) L. CAILLETET and E. MATHIAS, Journ. de Phys. (2) **5** (1886) p. 549.

[2]) C. R. January 1911. Leiden Comm. N°. 117.

[3]) C. R. 13 January 1913. Leiden Comm. N°. 131*a*.

[4]) C. R. **160** (1915) p. 237. Leiden Comm. N°. 145*c*.

[5]) C. R. **172** (1921) p. 261. Leiden Comm. N°. 154*b*.

[6]) C. R. 20 November 1922. Leiden Comm. N°. 162*b*.

[7]) C. R. **180** (1925) p. 1005. Leiden Comm. N°. 172*b*.

[8]) Determined by STAHRFOSS in the laboratory of PH. A. GUYE at Geneva. See Arch. d. Sc. physiques et naturelles, Genève 28 (1909), p. 384.

densities δ and δ' for the liquid and the saturated vapour at the same temperature θ and for the ordinates of the diameter.

θ	δ (observed)	δ' (observed)	y (observed)	y (obs.) — y (calc.)	y (obs.) — y (calc.) in $^0/_0$
+ 7°.98C.	0.28726	0.15268	0.21997	+0.00307	+ 1.40
+ 6.50	30342	13716	22029	+ 00249	+ 1.30
+ 5.84	30840	13266	22053	+ 00232	+ 1.05
— 7.70	37721	076050	22663	+ 00013	+ 0.06
— 10.93	38818	067215	22770	— 00078	— 0.34
— 14.18	39855	059942	22925	— 00123	— 0.54
— 19.20[5]	41313	051138	23214	— 00141	— 0.61
— 24.33	42655	041854	23420	— 00250	— 1.07
— 37.13	45610	029465	24279	— 00175	— 0.72
— 48.15	47822	020407	24932	— 00197	— 0.79
— 63.41	50588	012584	25923	— 00141	— 0.54
—103.01	56740	0021928 [1]	28480	— 00011	— 0.04
—114.69	58380	0011127 [1]	29246	+ 00040	+ 0.14
—129.90	60449	00037586 [1]	30244	+ 00106	+ 0.35
—145.07	62465	0003 9363 [1]	31237	+ 00169	+ 0.56

The values calculated for the ordinates of the diameter, deduced from the observations according to the method of the least squares are represented by the formula

$$y = 0.22179 - 0.00061277\,\theta.$$

The direction constant of the diameter is therefore

$$\alpha = -0.00061277.$$

(differs very little from that of methane).

The formula for the diameter gives +9°.5 C. [2]), at the critical temperature, for the critical density

$$\triangle = 0.21597$$

The critical coefficient is

$$\frac{R\,T_k}{p_k\,v_k} = 3.524$$

[1]) Calculated by means of the general reduced equation of state. Comm. Leiden Suppl. N°. 19.

[2]) E. CARDOSO and E. ARNI, Journ. de chimie physique **10** (1912) p. 504.

(T_k = critical temperature, p_k = critical pressure, v_k = critical volume and R = gas constant).

§ 4. The deviations of the diameter are not so small as in hydrogen and neon, they are sometimes even greater than 1/100; nevertheless ethylene may be said to conform approximately to the laws of the rectilinear diameter. The deviations are of the same systematic character that we have met with in other substances, such as argon and carbonic acid, i.e. in the neighbourhood of the critical point the diameter is slightly concave towards the temperature axis, while at low temperatures it is convex[1]).

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[1]) See Comm. Leiden Suppl. N°. 23, Enc. Math. Wiss. V. 10, § 85 *a* and *c*; further § 50 note 576.