

of completely dissociated acetic acid, Λ_e , at the same ion concentration. Values of Λ_e are found by using Kohlrausch's law of independent ion migration, which is valid at the low ion concentrations involved. Applying the mass action law to the resulting degrees of dissociation we find a series of "constants," K' , which, to obtain the thermodynamic ionization K , must be multiplied by the product of the ionic activity coefficients, γ^2 .

It is noteworthy that to obtain a true constant the activity coefficients required are exactly those given by the Debye-Hückel theory in its limiting form

$$-\log \gamma^2 = 2 \times 0.5065 \sqrt{C_i}$$

in which C_i is the ion concentration. The results for the more dilute solutions are given in Table I.

TABLE I
RESULTS FOR THE MORE DILUTE SOLUTIONS

Concentration, equivalents per liter $\times 10^3$	Ion concn., C_i $\times 10^3$	K' $\times 10^3$	γ^2	K $\times 10^3$
0.028014	0.015092	1.7626	0.9910	1.747
.15321	.044005	1.7733	.9846	1.746
.21844	.054096	1.7766	.9830	1.746
1.0283	.12714	1.7937	.9741	1.747
1.3638	.14779	1.7961	.9721	1.746
2.4139	.19992	1.8053	.9776	1.747
3.4407	.24069	1.8104	.9645	1.746
5.9115	.31895	1.8189	.9592	1.745
9.8421	.41517	1.8285	.9536	1.744

Although extraordinarily constant in the range given, at higher concentrations there is a decrease in the value of K . This variation is due to several effects which may for the present be lumped together as "effect of the medium." The bearing of this value of K on the *PH* scale will be discussed later and full accounts of these researches will shortly be submitted to THIS JOURNAL.

LABORATORIES OF
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FOR MEDICAL RESEARCH
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D. A. MACINNES
THEODORE SHEDLOVSKY

THE DIRECT REACTION BETWEEN OXYGEN AND ETHYLENE

Sir:

The direct reaction between oxygen and ethylene is of general theoretical and technical interest. Study of the reaction in this Laboratory has shown that the slow non-explosive thermal reaction is complex. Two compounds have been found to be formed in the reaction whose presence has not been demonstrated before; these compounds are ethylene oxide and dioxy-

methyl peroxide,¹ $\text{CH}_2\text{OHOCH}_2\text{OH}$. Investigation of the reaction at temperatures from 300 to 525° under widely different conditions has shown that the two principal primary reactions are the formation of ethylene oxide and of formaldehyde. The other reaction products, dioxymethyl peroxide, acetaldehyde, formic acid, the oxides of carbon, hydrogen and water are formed in a step-wise sequence² of follow reactions. At temperatures above 500° the thermal polymerization of ethylene becomes an important reaction even in the presence of appreciable amounts of oxygen and inert gases.³

The velocity of reaction is proportional to the cube of the ethylene concentration and is almost independent of oxygen, as has been shown by Thompson and Hinshelwood.⁴ Comparison of the rates of reaction in packed and unpacked vessels shows that the reaction is mainly homogeneous. The reaction has an induction period which decreases with increase in temperature. It appears that the reaction follows a chain mechanism though it is necessary to assume that the chains can be both continued and stopped by the surface of the vessel.

Evidence of the formation of hydrogen peroxide as a reaction product has been obtained.

A full account of this work will appear shortly.

EXPERIMENTAL STATION
E. I. DU PONT DE NEMOURS AND CO.
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SAMUEL LENHER

INTERATOMIC FORCES IN BINARY LIQUID ALLOYS. QUANTITATIVE DETERMINATION FROM THERMODYNAMIC DATA

Sir:

It is generally agreed that the attractive force between non-polar molecules varies inversely as some high power (*e. g.*, the 9th) of the distance. Langmuir [This JOURNAL, **38**, 2246 (1916)] has emphasized that the forces holding together such molecules are acting almost wholly between molecules *in contact* and that, as a very good approximation, all forces acting at greater distances may be neglected. The quantitative treatment of the properties of liquids in terms of power laws of force involves great mathematical difficulties when one attempts to consider molecules of irregular shape. Langmuir has shown that the problem may be greatly simplified

¹ Legler, *Ann.*, **217**, 381 (1883); Nef, *ibid.*, **298**, 202 (1897); Baeyer and Villiger, *Ber.*, **33**, 2479 (1900); Fenton, *Proc. Roy. Soc. (London)*, **A90**, 492 (1914); Rieche, "Alkylperoxide und Ozonide," Theodor Steinkopff Verlag, Dresden und Leipzig, Germany, 1931, p. 48.

² Bone and Wheeler, *J. Chem. Soc.*, **85**, 1637 (1904); Blair and Wheeler, *J. Soc. Chem. Ind.*, **42**, 415T (1923).

³ Willstätter and Bommer, *Ann.*, **422**, 36 (1921).

⁴ Thompson and Hinshelwood, *Proc. Roy. Soc. (London)*, **A118**, 170 (1928).