XXXIV.—*The Magnetic Rotation and Refractive Power of Ethylene Oxide.*

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ALREADY several kinds of oxides of the saturated series have been examined in reference to their magnetic rotation, namely, ethyl and isoamyl ethers, acetic and propionic acids, and pyrotartaric anhydride. The results these have given, when compared with those obtained from their hydroxylic representatives, are fairly comparable, as will be seen further on. It was therefore of interest to measure the rotations of other oxides, and that remarkable compound discovered by Würtz, ethylene oxide, appeared to be of especial interest, as it differs in structure from any of the above, though, in some respects, resembling pyrotartaric anhydride, inasmuch as it is the oxide corresponding to a dihydroxy-alcohol, whilst the latter is the oxide corresponding to a dicarboxylic acid. Advantage was therefore taken of the winter season to measure this, as on account of the volatility of this substance it would not be easy to do so later on in the year. It was thought desirable also to determine its refractive power at the same time.

The ethylene oxide was obtained from Kahlbaum. It boiled constantly at 12·5° (corr.), the bulb of the thermometer being covered with cotton-wool to prevent superheating. This is 1° lower than that given by Würtz (*J. Chem. Soc.*, 1862, **15**, 388).

The density determinations gave

$$d\,4°/4° = 0·8909. \qquad d\,7°/7° = 0·8867.$$
$$d\,10°/10° = 0·8824.$$

* Dobbie and Lauder, Trans., 1892, 244 and 605.

† Freund and Josephy, *Ber.*, **25**, 2412.

The magnetic rotation found was as follows:—

	t.	Sp. rotation.	Mol. rotation.
	8·0°	0·7044	1·945
	8·0	0·7082	1·956
	8·0	0·6973	1·926
	8·0	0·6992	1·931
	8·0	0·6970	1·925
	8·0	0·6985	1·929
	8·0	0·7000	1·933
	8·0	0·7022	1·939
	8·0	0·7014	1·939
	8·0	0·7000	1·933
Average	8·0	0·7008	1·935

The determination of the refractive and dispersive power of this substance gave

$$d\ 7°/4° = 0·88654.$$

Line.	t.	μ.	$\frac{\mu - 1}{d}$.	$\frac{\mu - 1}{d} p$.
A.....	7°	1·35623	0·40183	17·680
C.....	7	1·35816	0·40399	17·776
D.....	7	1·35965	0·40568	17·850
F.....	7	1·36390	0·41048	18·061
G.....	7	1·36730	0·41431	18·230

Dispersion G—A = 0·550.

Before considering these results, it will be as well to see the relationship which the other oxides that have been examined bear to their respective hydroxyl compounds.

2 mols. ethyl alcohol = 2·780 × 2	=	5·560
Ethyl oxide	=	4·777
Variation for diff. of composition by OH_2	=	0·783
2 mols. propionic acid = 3·462 × 2	=	9·924
Propionic anhydride	=	6·185
		0·739
Pyrotartaric acid (calc.)		5·482
„ anhydride.....		4·750
		0·732

The average variation for the difference in composition by OH_2 in these three examples is 0·751, or 0·249 less than the value of water. If this, therefore, be subtracted from the rotation of glycol, it will give what might be expected to be the rotation of ethylene oxide.

Glycol	2·943
Less	0·751
Calculated value of ethylene oxide	2·192

On reference, however, to the experimental results, it will be seen that the rotation of this substance is much *lower* than this, and if subtracted from that of glycol will give a much larger difference than that found in the above instances.

Glycol.....	2·943
Ethylene oxide (found)	1·935
	1·008

The difference, it will be seen, is practically the same as that of water or 1·000.

The rotation of this substance is very remarkable, not only on account of its differing from glycol by about 1·000 but also on account of its smallness, considering its composition, its value being less even than the carbon and hydrogen it contains ($CH_2 \times 2 = 2·046$), its series constant is, therefore a *minus* quantity (−0·111), whereas in all other compounds yet examined, with the exception of one—not related to this—the series constants have been *plus* quantities (Trans., 1884, **45**, 574).

With reference to the refractive and dispersive power of ethylene oxide, the results are also low, the calculated molecular rotation for A by Dr. Gladstone, or C by Brühl's, values being 18·000, whereas the found numbers are, for A 17·680, and C 17·775. The dispersion, though nearly normal, is apparently a trifle low. These results are, therefore, in agreement with the magnetic rotation.

From the above results it appears desirable to extend this inquiry, and examine more substances containing oxygen united to two carbon atoms in the same molecule, and to see whether ethylene oxide is a typical example of this kind of combination or an exception; it is remarkable that it should give results which are not in agreement with those of ethyl ether and the other substances referred to above. The examination of the lactones will also be interesting.

In the unsaturated series, maleïc and citraconic acid differ from their anhydrides by a little more than the value of water, and, there-

fore, in this respect, correspond to glycol and ethylene oxide (Trans., 1888, **53**, 597); but from the boiling points of these unsaturated compounds and other properties (Trans., 1888, **53**, 710), they appear to possess peculiarities of their own which are not clear at present, and render them unsuitable for comparison with saturated compounds.