

### ELECTROLYTIC HYDROGENATION OF CRESOLS

BANCROFT and George<sup>1</sup> have shown that the hydrogenation of phenol at a platinised-platinum cathode is not an electrolytic process and is probably the result of oriented adsorption of the phenol molecule, the platinised-platinum acting as a source of hydrogen. It was thought that a study of the hydrogenation of the three isomeric cresols under the same conditions would throw greater light on the mechanism of hydrogenation at the cathode, besides revealing the influence of substitution on the process of hydrogenation. The results obtained in the course of the study not only supports the view of the authors referred to above but also shows that the extent of hydrogenation is different in the case of each cresol as could be seen from the results given below:

<i>o</i> -Cresol	<i>m</i> -Cresol	<i>p</i> -Cresol
33.5%	41%	24.3%

(1/20 gm. mol. of each cresol was hydrogenated in a porous pot in 22 per cent. sulphuric acid with vigorous stirring, the C.D. being 4 amps./dm.<sup>2</sup> The theoretical quantity of current, 6 F./mol. was passed in each case.)

The maximum yield of hydrogenated product is obtained with *m*-cresol. The variation is due evidently to the influence of the position of the methyl group on the oriented adsorption of the cresol molecule on the electrode surface.

The hydrogenated product was found to be a mixture of methyl cyclohexanol and the corresponding methyl cyclohexanone. Analysis by Bennett and Donovan's hydroxylamine method<sup>2</sup> showed the product in each case to contain the proportions of ketone indicated below:

	<i>o</i> -Cresol	<i>m</i> -Cresol	<i>p</i> -Cresol
Ketone %	32.8	50.0	30

An entirely different effect was noticed when a cathode consisting of a mixed deposit of platinum and palladium in equal proportions was employed. The results are summarised below:

	<i>o</i> -Cresol	<i>m</i> -Cresol	<i>p</i> -Cresol
Total yield of hydrogenated product	25%	32.9%	43%
Ketone%	55%	80.1%	62.7%

Vavon and Berton<sup>3</sup> have reported the formation of ketones during the hydrogenation of cresols in the liquid phase using platinum

black catalyst. The hydrogenation at the platinised-platinum cathode is exactly similar. It is, therefore, to be concluded that the hydrogenation is purely catalytic, and not electrochemical.

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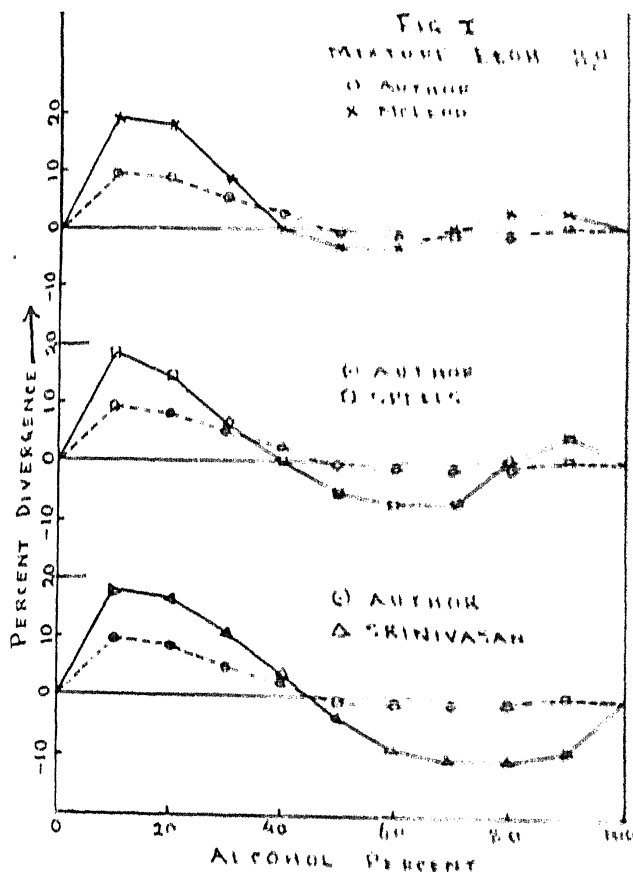
1. Bancroft, W. D., and George, A. B., *Trans. Amer. Electrochem. Soc.*, 1930, **57**, 39. 2. Bennett, A. H., and Donovan, F. K., *Analyst*, 1932, **47**, 146. 3. Vavon, G., and Berton, A. L., *Bull. So. Chim.*, 1925, (4) **37**, 294.

### AN EQUATION FOR THE VISCOSITY OF NON-IDEAL LIQUID MIXTURES

An equation developed on the basis of Newton Friend's<sup>1</sup> Rheochor, in which account has been taken of the change in density occurring on mixing two liquids, is found to represent satisfactorily the viscosity variation of non-ideal liquid mixtures with their composition. This may be stated as:

$$\eta^{\frac{1}{2}} = \left( \eta_1^{\frac{1}{2}} \cdot \frac{M_1}{\rho_1} \cdot x + \eta_2^{\frac{1}{2}} \cdot \frac{M_2}{\rho_2} (1-x) \right) \left( \frac{\rho}{M_1 x + M_2 (1-x)} \right) \left( \frac{\rho_1 + x\rho_2}{\rho_1 + (1-x)\rho} \right)^m$$

where  $\eta$ ,  $\rho$  denote viscosity and density of mixture;  $\eta_1$ ,  $\rho_1$  and  $\eta_2$ ,  $\rho_2$  the same quantities for



the two components and  $M_1$ ,  $M_2$  their molecular weights;  $x$  the weight fraction of the first component;  $m$  an arbitrary constant.

The equation represents data on a number of non-ideal binary mixtures<sup>2,3,4</sup> (showing different types of curves) quite satisfactorily, as will be apparent from a perusal of Table I which gives data for typical cases of good, fair and bad fits. In some cases, the equation agrees with data within much closer limits than other equations (McLeod,<sup>4</sup> Spills,<sup>5</sup> Srinivasan<sup>6</sup>). Thus, for the remarkably non-ideal mixture ethyl alcohol-water, which is not satisfactorily represented by any equation, the maximum divergence with the present equation is 9.7 per cent., as against 18.8, 18.1 and 18.0 per cent. for the other equations mentioned. Fig. 1 shows graphically the percentage divergence from experimental values (for each equation) plotted against composition of the mixture and the curves clearly demonstrate the superiority of the present equation.

TABLE I

Weight per cent. (first component)	Density	$\eta$ (observed)	$\eta$ (calculated)	Per cent. difference
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Good fit: Pyridine-Benzene: Curve almost linear:  
 $m = 0$ .

0	0.87374	0.006038	0.006038	0
39.73	0.91444	0.007169	0.007059	1.5
59.35	0.93465	0.007726	0.007579	1.9
79.64	0.95564	0.008345	0.008264	0.9
89.77	0.96600	0.008601	0.008367	2.7
100	0.97832	0.008775	0.008775	0

Fair fit: Pyridine-Ethyl alcohol: Curve shows minimum:  $m = -1$ .

0	0.79037	0.011532	0.011532	0
29.92	0.84317	0.010340	0.010044	2.9
49.97	0.88449	0.009591	0.009136	4.7
66.07	0.92418	0.008792	0.009077	-3.2
79.96	0.94564	0.008773	0.009107	-3.8
100	0.97832	0.008775	0.008775	0

Bad fit: Ethyl alcohol-Water: Curve shows maximum:  $m = 2$ .

0	0.99973	0.01308	0.01308	0
10	0.98393	0.02179	0.01967	9.7
20	0.97252	0.03165	0.02901	8.3
30	0.95977	0.04050	0.03833	5.2
40	0.94238	0.04399	0.04278	2.5
50	0.92162	0.04180	0.04202	-0.5
60	0.89927	0.03770	0.03822	-1.3
70	0.87602	0.03268	0.03315	-1.4
80	0.85197	0.02710	0.02734	-0.8
90	0.82654	0.02101	0.02119	0.8
100	0.79784	0.01466	0.01466	0

The constant  $m$  in the equation ranges between +4 and -4 in the cases examined and is 0 for mixtures showing almost linear or slightly sagged curves. The corresponding constant in Srinivasan's equation assumes very high values, varying from +16 to -18.5. As

compared to McLeod's two-constant equation, the present equation has one constant only.

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### A SIMPLE INEXPENSIVE HAND MICROTOME

In experiments on suction pressure, permeability and rate of uptake of salts and water by plant cells use is often made of thin discs of potato tuber, carrot, etc.<sup>1,2,3</sup> It is essential to minimize the time lag necessary for the different layers of cells to reach the same stage of water uptake by using sufficiently thin discs of uniform thickness.

In the course of work on the oxidation of potato tubers at this Institute a simple hand-microtome illustrated in Fig. 1 was developed. It consists of a cork-borer, 1.2 cm. in diameter, fitted with a glass plunger which is calibrated into 1.0 mm. marks. The scale is drawn on a piece of paper and introduced into the glass tube. Melted paraffin is then poured into the tube to hold it in position.

In order to operate the apparatus the glass plunger is removed from the cork borer and a symmetrical cylinder of potato tuber is bored out. The plunger is then introduced into the cork-borer and pushed sufficiently in to make contact with the lowest end of the cylinder of potato tuber contained in the cork-borer. The plunger is now pressed in so that the cylinder of potato tuber juts out at the upper end of the borer. A sharp blade is held in level with the rim of the cork-borer and with a quick horizontal sweep a disc is cut from the exposed end of the potato cylinder. First two or three cuttings are discarded as the discs are likely to be uneven. Thereafter the plunger is pressed in gently 1 mm. at a time and discs are cut.

Mean fresh weight per disc in mg. is given for six experiments (each with 25 discs) in table below:—

Mean weight per disc (mg.)	
Expt. No.	Disc wt.
1	142
2	136
3	138
4	140
5	138
6	133

The agreement appears to be fairly good.

This apparatus has the following advantages over a standard hand-microtome which is generally used by research workers engaged on problems of permeability and absorption and