

rolled sheets. The copper used in our work contained metallic impurities totalling 0.0055 per cent, but we also made some observations on a sample of copper containing 0.0249 per cent of metallic impurities. Here again self-recovery was detected, but the extent of the change was less after one year than the purer specimen had shown after six days.

J. L. MILLER  
L. C. BANNISTER  
R. M. HINDE

British Insulated Callender's Cables, Ltd.,  
Prescot.  
Oct. 11.

<sup>1</sup> Van Reijen, L. L., *Nature*, **157**, 371 (1946).

<sup>2</sup> Megaw, H., Lipson, H., and Stokes, A. R., *Nature*, **154**, 145 (1944).

<sup>3</sup> Megaw, H., and Stokes, A. R., *J. Inst. Metals*, **71**, 279 (1945).

<sup>4</sup> Eisenhut, O., and Widmann, H., *Z. tech. Phys.*, **11**, 70 (1930).

<sup>5</sup> Widmann, H., *Z. Phys.*, **45**, 200 (1927).

## Behaviour of Hypochlorite and of N-Chloroamines at the Dropping Mercury Electrode

ALTHOUGH Marks and Glass<sup>1</sup> have carried out amperometric titrations using a stationary gold electrode as the polarizable cathode, no results of investigations concerning the behaviour of hypochlorite and of N-chloroamines at the dropping mercury electrode have been recorded.

In investigating methods of distinguishing between hypochlorites and N-chloroamines in aqueous solution, it has now been established that the hypochlorite ion is one of the oxygen-containing anions<sup>2</sup> which are irreversibly reducible at the dropping mercury electrode. Solutions of sodium hypochlorite and of chloramine-*T* (sodium N-chloro-*p*-toluenesulphonamide) have been found to be reducible at *pH* values between 3.6 and 11.0 and at concentrations between 0.001 and 0.01 *N*. The half-wave potentials of neutral solutions in 0.5 *N* potassium sulphate at room temperature are about +0.08 V. and -0.13 V. for solutions of hypochlorite and chloramine-*T* respectively, referred to the saturated calomel electrode.

The diffusion currents are proportional to the concentrations and are independent of the *pH* value. The irreversible electro-reduction of each compound involves two electrons per molecule.

The reduction of these two compounds by arsenite was investigated by current-time curves at a potential of -0.75 V. (sat. calomel electrode). Hypochlorite is rapidly reduced at all *pH* values in the above range, whereas chloramine-*T* is reduced slowly, the rate increasing with diminishing *pH* value, becoming rapid in the presence of iodide. The estimation of hypochlorite in the presence of chloramine-*T* is possible at *pH* 11.0 owing to the great difference in the rates of reduction of the two compounds by arsenite.

The polarographic investigation of the reaction products of sodium hypochlorite, in concentrations varying from 0.008 to 0.020 *N*, and ammonium chloride showed: (a) using a deficiency of ammonium chloride, that ammonia is almost completely oxidized in alkaline solution and that N-chloroamines are formed in neutral or weakly acid solutions; (b) using an excess of ammonium chloride, that the monochloramine, formed at *pH* 6.8-11.0<sup>3</sup>, is reducible at the dropping mercury electrode; its half-wave potential is about -0.65 V. (sat. calomel electrode) in *N* potassium chloride solution at room tempera-

ture; the electro-reduction is irreversible and involves two electrons per molecule; dichloramine, formed at *pH* 5.0<sup>3</sup>, is not reduced at the dropping mercury electrode under the conditions investigated; trichloramine, present at *pH* 3.6<sup>3</sup>, appears to be reduced at about the half-wave potential of hypochlorite; the reduction of mono- and trichloramine by arsenite is slow, becoming rapid when activated by the presence of iodide.

A detailed account of this and similar work will be published later.

We wish to thank Messrs. Milton Antiseptic, Ltd., for their interest and support.

K. HELLER

Edward Davies Chemical Laboratories,  
University College of Wales,  
Aberystwyth.

E. N. JENKINS

Research Department,  
Milton Antiseptic, Ltd.,  
London, W.1.

<sup>1</sup> Marks and Glass, *J. Amer. Water Works Assoc.*, **34**, 1227 (1942). Marks, Canadian Pat., 427092 (1944); *Chem. Abs.*, **39**, 2712 (1945).

<sup>2</sup> Kolthoff and Lingane, "Polarography", chapter 23 (New York, 1941).

<sup>3</sup> Chapin, *J. Amer. Chem. Soc.*, **51**, 2112 (1929); **53**, 912 (1931). Metcalf, *J. Chem. Soc.*, 148 (1942).

## Volume Flow of Plastic Materials

SWAINGER<sup>1</sup> has stated recently that an increase in volume occurs during the plastic flow of duralumin specimens under a tensile test. While it is generally assumed that volume is unchanged during plastic flow, we should like to point out that, in 1939, Glanville and Thomas<sup>2</sup> showed that the creep of concrete in compression was characterized by a decrease in volume. The concrete, in fact, flowed into its own voids.

The reverse of this effect has now been observed in specimens of asphalt (consisting of a mixture of fine aggregate with tar or bitumen binder) when subjected to a simple constant-load tensile test. A specimen which showed a total linear extension of 7 per cent before breaking was found to show at the same time a volume increase of about 2 per cent. The volume-change occurred at a roughly constant rate from the moment of application of the load. After breakage, the fractured surface had a rough appearance, in striking contrast to the smooth appearance of a fractured surface broken under impact. It is evident that rupture occurring as a result of plastic flow in tension is due to the progressive weakening of the structure caused by steady dilatation of the material.

It is hoped to publish later a detailed account of this phenomenon as exhibited by bituminous road materials.

A. R. LEE  
M. REINER  
P. J. RIGDEN

Road Research Laboratory,  
Department of Scientific and  
Industrial Research,  
Harmondsworth,  
West Drayton, Middlesex.  
Oct. 18.

<sup>1</sup> Swainger, K. H., *Nature*, **158**, 165 (1946).

<sup>2</sup> Glanville, W. H., and Thomas, F. G., *Building Research Technical Paper*, No. 21. (London: H.M. Stationery Office, 1939.)