

with ours that the value of α for any given metal must depend in some unknown way on the experimental conditions. For example, instead of 1.2 for sodium, we find 2.9, and this figure appears insensitive to the variations of conditions we have tried (2.8, 2.8, 3.0, 2.9 for media ranging from strongly alkaline to strongly acidic). Our ratios for calcium, 1.3-1.6, and aluminium, 4.0-4.9, seem to show a more definite dependence on conditions, the higher value in each case relating to reaction in an alkaline medium. The case of zinc requires special comment because pure zinc is scarcely soluble in dilute sulphuric acid, and, when impure zinc dissolves, the hydrogen is probably liberated at least partly at the impurities. The most nearly pure zinc we could get to dissolve, containing only a minute trace of carbon, gave the value 5.6, but commercial zinc gave a higher value, 6.8, and zinc-copper couples, prepared from pure (insoluble) zinc and varying quantities of deposited copper, yielded values ranging to 8.0. It seems possible that the use of metallic couples may prove a useful auxiliary method of concentrating the heavier isotope of hydrogen.

Our isotopic analyses have in all cases been carried out by determinations of the density of water, and in this connexion we would acknowledge the receipt of valuable help from Mr. J. N. E. Day. We should mention that our experiments include the study of a number of other metals and also of some compounds which, on reaction with water, give volatile hydrides.

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Electrolytic Concentration of the Heavy Hydrogen Isotope

MESSRS. R. P. BELL and J. H. Wolfenden¹ have recently given their experience in concentrating the hydrogen isotope, namely, that nickel, platinum and copper are about equally efficient as cathodes, and in general the efficiency is surprisingly insensitive to the conditions of electrolysis. Broadly speaking, this is also the conclusion we have reached in a study of the electrolytic separation. There are, however, real differences between different metallic cathodes.

It is a convenience to have a name for the quantity α defined by $d \log H = \alpha d \log D$, and we propose the term "electrolytic separation coefficient" (this α is the inverse of the one used by Bell and Wolfenden).

The electrolytic separation coefficients of the metals which we have examined all lie between 7.9 and 2.8, the series in descending order being:

Smooth Pt, Pb, Fe, Cu, Ag, Ni, W, Pt black, Ga liquid, Hg.

The coefficient is slightly lower in acid than in alkaline solution. In agreement with Bell and Wolfenden, moderate changes in current density do not make much difference. The position of lead relative to platinum and to mercury is remarkable.

With regard to the application of the over-voltage theory of Gurney, we should like to refer to one point. The theory in its original form implied that the atoms of H (or D) formed by neutralisation of

the H_3O^+ (or H_2DO^+) ions are at a very high energy level, namely, the energy of free atoms further increased by the large positive potential energy possessed by the group H_3O at the moment of neutralisation. This involves a very high activation energy, and calculation shows that even if the whole of the applied over-voltage is drawn upon to reduce the activation required, no reasonable amount of current would pass from the solution to the cathode. It must, therefore, be supposed that the activation energy (known to be of the order of 10,000 calories from Bowden's measurements) is not so high as corresponds to the production of free atoms, because of the forces acting between hydrogen atoms and the metal atoms of the cathode surface. These forces modify both the potential energy curves $H^+ - H_2O$ and $H - H_2O$; and since the isotopic separation depends on the steepness of these curves, different metals would give different electrolytic separation coefficients. But it seems to us that serious difficulties lie in the way of accepting the over-voltage mechanism proposed by Gurney, which we discuss in a forthcoming article.

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Nature of Antibodies

It was found by Breinl and Haurowitz¹ that when proteins of an agglutinating serum had been coupled with diazotised atoxyl (*p*-amino-benzene-arsinic acid), the agglutinating power of the serum was not wholly lost. In this process, the proteins are themselves converted into azo-dyes, but the products are not strongly coloured. If, however, benzidine is tetrazotised, and coupled to *R* salt and to the serum proteins, according to the method of Heidelberger, Kendall and Soo Hoo², a deep red compound is formed, and the agglutinin again is not wholly destroyed.

If the agglutinins of the serum are proteins, this coloured product should be adsorbed specifically by homologous bacteria. Actually the protein dyes thus formed are readily adsorbed non-specifically. Nevertheless, if weak solutions are used, a striking quantitative difference can be shown between the degree of adsorption by homologous and heterologous bacteria. For example, two tubes (*A* and *B*) were put up. *A* contained a suspension of typhoid bacilli, eight minimal agglutinating doses of typhoid-agglutinin-dye (prepared from the euglobulin of typhoid agglutinating serum) and untreated cholera agglutinating serum. *B* contained a suspension of cholera vibrio in place of typhoid bacilli, the other constituents being the same as in *A*. After agglutination was complete, the agglutinated bacteria deposited in *A* were pink, while those in *B* were colourless. In the converse experiment, using cholera-agglutinin-dye, the cholera vibrios were coloured, the typhoid bacilli uncoloured.

This specific adsorption of the dye from the homologous coloured agglutinin is compatible with the theory that the agglutinins are proteins, but still leaves room for the alternatives: (1) that the agglutinin is attached to protein and not removed