CONCENTRATION OF DEUTERIUM BY ELECTROLYSIS OF NEUTRAL SALT SOLUTIONS. I.

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One of the most efficient methods of concentrating deuterium is the electrolytical fractionation of either caustic alkali solutions with nickel electrodes(1) or sulphuric acid solutions with lead electrodes.(2) The theories expounded in order to explain the mechanism of separation do not well agree with one another. However, it is well known that separation occurs at the cathode. For example, when NaOH is used as the electrolyte, the important rôle played by Na is that, upon reaching the cathode, it induces the separation of deuterium from protium. Hence, separation may also be effected by employing a neutral sodium salt as the electrolyte.

From this point of view, a preliminary experiment was carried out to effect the separation by using a 0.25 mol solution of Na_2SO_4, the solvent being ordinary tap water. Seven liters of this solution were subjected to electrolysis between a nickel cathode and a lead anode, both being 10 cm. long and 4 cm. wide. A current of 2.5 amperes was passed through. Experimental procedure was the same as described in the preceding paper,(3) except that the electrolyzed solution was distilled without neutralization in this case, though the solution was found to be slightly alkaline after the electrolysis, presumably owing to the disappearance of SO_4''-ions at the lead-anode. The final product of about 134 c.c. was carefully purified and the determination of density by a quartz bouyancy balance showed that this final product contained 0.85 part H^2 in 1,000. Assuming the initial concentration to be 1 part H^2 in 5,000, the total separation coefficient was found to be $a = 1.58$.(4) However, the factor b, which is the ratio of the loss due to the evaporation and spray-formation to that of the pure electrolysis, was found to be 0.58. Hence, the electrolytical separation coefficient α was calculated by the equation :

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(1) G. N. Lewis and R. T. Macdonald, *J. Chem. Phys.*, **1** (1933), 341; H. S. Taylor, H. Eyring, and A. A. Frost, *J. Chem. Phys.*, **1** (1933), 823; R. P. Bell and J. H. Wolfenden, *Nature*, **133** (1934), 25; B. Topley and H. Eyring, *J. Chem. Phys.*, **2** (1934), 217; etc.

(2) C. H. Collie, *Nature*, **132** (1933), 568; K. F. Bonhoeffer and G. W. Brown, *Z. physik. Chem.* (B), **23** (1933), 171; H. Erlenmeyer and H. Gärtner, *Helvetica Chim. Acta*, **17** (1934), 30; B. Topley, H. Eyring, loc. cit., etc.

(3) P. 269 of this volume.

(4) For the method of calculation refer to the preceding paper.

$$\alpha = \frac{a}{1-b(a-1)},$$

and found to be 2.3.

Therefore, the separation efficiency by the use of Na_2SO_4 with a nickel cathode is quite close to that of 10 per cent. sulphuric acid with a lead cathode ($\alpha = 2.2-2.7$) as was reported in the preceding paper. For the sake of comparison the electrolysis was carried out by using a 0.5 mol NaOH solution with nickel electrodes and a current intensity of 3 amperes. The result is as follows: initial volume = 6,000 c.c., final volume = 100 c.c., part of H^2 in 1,000 = 0.8, $a = 1.52$, and $b = 0.88$, hence $\alpha = 2.8$. The separation efficiency is approximately equal to that with a Na_2SO_4 solution.

There are at least two distinct advantages in using the neutral salts over acid or alkaline solutions: namely, first, it dispenses with the process of neutralization, thereby saving considerably amount of labour and time; secondly, the same electrolyte can be used throughout. The full report on the final results will be published shortly, as the process of separation are at present being carried on along the lines reported so far.

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