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## Work Done in Electrolysis [with discussion]

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energy necessary for the expansion of gases at the electrodes comes from the consumed electrical energy. This is a disputed question, since it might just as well come from the heat of the surroundings. Dr. C. P. Steinmetz appeared to think that this energy is part of the electrical energy consumed. On the other hand, Mr. C. J. Reed pointed out that this is very questionable; for instance, in the electrolysis of an hydrochloric acid solution no chlorine gas is set free at first, but chlorine is evolved in solution and only after the solution is saturated with chlorine the latter is given off in form of free gas.

Prof. F. B. Crocker described some other methods of finding the decomposition voltage. One is to measure the total voltage and deduct from it the resistance drop which can be calculated from the dimensions of the cell and the conductivity of the electrolyte. This would give a check on Dr. Richards' method. Another method is to open the circuit after the current has passed through the cell and measure the counter e. m. f. Dr. C. P. Steinmetz suggested with respect to the latter method to take oscillographic curves of the e. m. f. while the current flows and when the circuit is broken. With respect to the scheme of determining the decomposition voltage from the polarization voltage, Mr. W. R. Mott remarked that condenser effects might disturb the results.

In his reply, Prof. Richards said that just on account of the practical disadvantages of the purely electrical methods he had devised this thermal method. Dr. H. E. Patten asked whether the method was really free from every hypothesis since it was tacitly assumed that there is a definite decomposition voltage.

#### WORK DONE IN ELECTROLYSIS.

A paper on this subject was presented by Prof. J. W. RICHARDS. The object of his research was to determine by a new experimental method the decomposition voltage of a solution, or the voltage which is necessary to set the products free at the electrodes from a given solution.

His method is essentially colorimetric. The experiments are arranged so that one can measure exactly the rise of temperature of the system during the electrolytic action. From this rise of temperature and from the specific heat one calculates the sensible heat evolved during the operation in calories.

At the same time one measures the volts, amperes and the time. This gives the total electrical energy which is put into the cell and which may be expressed in volt-ampere-seconds, or, its equivalent, calories.

This total electrical energy consumed in the cell is the sum of the sensible heat evolved and the chemical work done by the electric current. Hence the chemical work is determined by subtracting the sensible heat from the total energy. Since the latter two quantities were measured in calories, the chemical work is also found in calories and can then, of course, be easily converted into electrical energy units, namely, watt-seconds. The amperes and the time being known, the division of the watt-seconds by the ampere-seconds gives the voltage absorbed in the electrolytic action.

In this way Prof. Richards found that, as a first approximation, the voltage absorbed in setting free hydrogen and oxygen from a dilute sulphuric acid solution is  $1.61 \pm 0.06$ ; he intends repeating the work with greater refinements so as to fix this datum with an accuracy of 0.01 volt, if the method can be so far improved.

Dr. Richards' paper was discussed at some length. Mr. C. J. Reed asked whether the heat taken away with the gases had been taken into account, and Dr. Richards replied that an approximate estimation showed this heat to be quite negligible. President Carl Hering then brought up the question whether the