

cipitated by alcohol.) By this method I have treated ovovitellin, ichtulin of cod-fish eggs, cod-fish sperm, pancreas and bacillus tuberculosis.

The very crude acid obtained from the ovovitellin contained 9.65 per cent. of phosphorus; three other samples purified contained, 10.02, 9.95, and 9.79; a copper salt contained, P, 8.57, and Cu, 12.36 per cent.; for the free acid, P = 9.78 per cent. The acid obtained from the same vitellin by Milroy in Kossel's laboratory varied in its contents of phosphorus from 7.51 to 7.94 per cent. The acid obtained from ichtulin contained 8.46 per cent. of phosphorus. Walter, who studied the chemical nature of ichtulin in Kossel's laboratory, failed to obtain from it a substance similar to nucleic acid. The acid obtained from the cod-fish sperm was biuret free after the first precipitation and contained 8.65 per cent. of phosphorus. From the pancreas an acid was obtained with the same solubility as the other nucleic acids, while the substance described by Bang as guanilic acid differed in that respect from the other nucleic acids. From the bacillus tuberculosis the acid was also obtained biuret free after the first precipitation.

The study of the chemical properties of all the above-mentioned acids is now in progress.

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[CONTRIBUTIONS FROM THE HAVEMEYER LABORATORIES OF COLUMBIA UNIVERSITY, No. 25.]

A CHROMIUM CELL FOR THE RECTIFICATION OF ALTERNATING CURRENTS.

BY J. LIVINGSTON R. MORGAN AND W. A. DUFF.

Received April 17, 1900.

MUCH attention has been given of late to aluminum rectifying cells. These consist of a platinum and an aluminum electrode in a solution of sulphuric acid or potash alum. When

the current is applied to such a cell, the aluminum electrode being the anode, the aluminum plate becomes covered with a highly resistant film which prevents, to a great extent, the further passage of the current in this direction. In the opposite direction however, *i. e.*, from platinum to aluminum through the liquid, the resistance of the electrolyte alone is encountered. If an alternating current is applied to such a cell, keeping the voltage down below a certain minimum point, an interrupted current, made up of the half waves of the alternating one, is the result. If the alternating voltage is increased gradually a point is finally reached at which the resistance of the film is overcome and the latter broken down after which the alternating current goes through unchanged. Up to this breaking-down point the current becomes less and less asymmetrical; *i. e.*, the opposite half waves become more and more alike in size. The minimum electromotive force which will cause the film to break down has been found by us as well as by others to be about 26 volts.

Our experimental work on this subject was done in the early part of 1899, but as it was not published at the time most of our results have since been found and published by others. The substitution of chromium for aluminum, however, has not yet been reported so that we propose to give our results very briefly here. At the time we did not expect to find any connection with the work of Hittorf¹ on chromium, but since such a one has been found we deem the result worthy of a short description for its bearing upon the general behavior of metallic chromium. Since our work was suspended in April, 1899, the results are fragmentary but we think of their kind, conclusive.

The electrolyte used throughout was 10 per cent. sulphuric acid. The chromium electrode consisted of a fragment of the chemically pure metal² fused into a glass tube containing mercury by which the connection was made. The platinum electrode was made of a strip of foil. The apparatus consists simply of a graded source of direct current, the amount going through the cell being measured by a low reading ammeter (0—5). A reversing switch is also used by which either the chromium or platinum may be made the anode. If the platinum

¹ *Ztschr. phys. Chem.*, 25, 729, and 30, p. 481.

² Fimer and Amend.

is first made the anode, the solution becomes yellow, and hydrogen gas is given off at the chromium electrode. If the chromium is now made the anode we find that no current goes through the cell, while when the platinum is the anode the current passes freely. We have then an asymmetrical resistance. *Using the chromium as anode and increasing very gradually the impressed electromotive force it is possible to stop any current entirely, as far as readings on the ammeter are concerned, until the pressure of about 75 volts is reached.* It is not difficult to stop this amount after the cell has once stopped it, but in starting, if the increase is made too rapidly, the current will force its way through. Of course, with the platinum as anode the resistance offered is only that of the sulphuric acid, so that the current is rectified with great efficiency.

When the increase in the electromotive force is made so rapidly that the current goes through from chromium to platinum, or after the cell breaks down by the application of more than 75 volts, a very peculiar result is obtained, and it is by this that Hittorf's results for the "active" and "inactive" states of chromium are confirmed. *Unlike the aluminum cell after it has broken down the chromium cell is still an asymmetrical resistance, but only when the platinum plate is made the anode. With chromium as the anode the current now passes freely.*

If in this condition the cell is broken down by the application of too high an electromotive force to the platinum anode another reversal takes place so that about 75 volts can again be stopped using the chromium as anode. The electromotive force necessary to cause this second reversal does not seem to be fixed, but the reversal always takes place. This change in the behavior of chromium is doubtless due just as were Hittorf's to the change from the "active" to the "inactive" state, and the change can be well shown experimentally in this way.

One other thing, we think, is proved by this work. Since chromium and aluminum act very much alike chemically, we should expect that they would both act asymmetrically in a cell and for the same reason. Aluminum has been supposed to act by a resistant layer of an oxid¹ and since chromium, when used in the same way, causes a reversal of the asymmetrical effect and

¹ Norden: *Ztschr. Elektrochem.*, 6, 159 and 188.

according to Hittorf its "active" and "inactive" states are not caused by resistant films, hence the asymmetrical effect of aluminum can only be caused by these; so that the theory of the action of the aluminum cell, as due to the formation of a resistant film, is confirmed.

REMARKS ON SOME METHODS OF DETERMINING CARBON IN STEEL.¹

BY GEORGE AUCHY.

Received April 25, 1909.

IN Blair's "Chemical Analysis of Iron"² it is stated that combined carbon in steel can be determined by loss upon ignition, 70 per cent. of the loss representing the carbon. As Blair gives the percentage of carbon in the carbon sponge as "about" 70 per cent., and as the method is not in general use, it may be inferred that it is known to be inexact. Mr. George Dougherty, in the *Iron Age* for May 11, 1899, proposes a method which is identical except that the carbon sponge is washed four times with hot nitric acid (sp. gr. 1.13) to dissolve out copper and copper sulphide. It may be questioned whether this procedure makes the method an accurate one as Mr. Dougherty's article does not throw much light on this point (only one result being given). Some experiments were made by the writer, which showed that, on the contrary, the washing with hot nitric acid is itself a source of error in one particular, and a possible source of error in another. 1. The hot nitric acid dissolves some of the carbon, and the amount dissolved varies with different steels. 2. The carbon sponge absorbs and retains a portion of the nitric acid, and this absorption is possibly not uniform in all cases. That the washing with hot nitric acid (sp. gr. 1.13) four times dissolves out carbon, and in varying amount, is shown in the following results, all from different steels:

¹ Read at the February Meeting of the Philadelphia Section.

² Blair's "Analysis of Iron," second edition, p. 151.