

Transactions (*continued*).

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"On the Voltaic Circles producible by the mutual Neutralisation of Acid and Alkaline Fluids, and on various related Forms of Electromotors." By C. R. ALDER WRIGHT, D.Sc., F.R.S., Lecturer on Chemistry and Physics, and C. THOMPSON, F.I.C., F.C.S., Demonstrator of Chemistry, in St. Mary's Hospital Medical School. Received January 18, —Read February 2, 1888.

(Abstract.)

The authors have examined a variety of cells analogous to Becquerel's "pile à oxygène;" *i.e.*, containing two platinum or other non-oxidisable plates, one immersed in an acid fluid, the other in an alkaline one, the two fluids being connected by a wet wick or siphon, and either some oxidising agent being also contained in the acid or some reducing substance in the alkali. In the first case continuous evolution of oxygen was brought about from the surface of the plate immersed in the alkali; in the second the converse phenomenon was observed, *i.e.*, hydrogen was continuously evolved from the plate in the acid; in each case the quantity of gas liberated was equivalent to the current passing as measured by a small silver voltameter. Thus the following figures were obtained in various experiments, the measurements being made after sufficient amounts

of current had passed to about saturate with oxygen or hydrogen respectively the fluid in the collecting tube, and so avoid loss by solution; in the first set the alkaline fluid was strong caustic soda solution; in the second somewhat diluted sulphuric acid (1 to 4 or 5 water) was the acid liquid. Carbon plates were used in experiments G and H; platinum ones in all the others.

I. Cells in which Oxygen was evolved.

- A. Becquerel's "pile à oxygène." Concentrated nitric acid used.
- B. Diluted sulphuric acid in which potassium permanganate had been dissolved.
- C. Diluted sulphuric acid in which potassium dichromate had been dissolved.
- D. Diluted sulphuric acid in which potassium ferricyanide had been dissolved.
- E. Acid solution of ferric chloride.
- F. A stronger acid solution of ferric chloride.
- G. Hydrochloric acid saturated with chlorine.
- H. Diluted sulphuric acid containing dissolved bromine.

Time in hours.	Milligrams of silver deposited.	Cubic centimetres of oxygen at 0° and 760 mm.	
		Equivalent to silver.	Actually collected.
A. 18	102	5·3	5·1
B. 10	85	4·41	4·30
C. 18	16	0·83	0·80
D. 42	12	0·62	0·45
E. 48	5	0·26	0·25
F. 48	18	0·93	0·85
G. 18	25	1·30	1·4
H. 18	46	2·38	2·3

II. Cells in which Hydrogen was evolved.

- I. Concentrated solution of sodium hyposulphite (hydrosulphite Schützenberger) made strongly alkaline with caustic soda.
- J. Strong caustic soda containing pyrogallol dissolved therein.
- K. Alkaline fluid obtained by dissolving cuprous chloride in ammonia.
- L. Similar fluid obtained from ferrous sulphate, ammonium chloride, and ammonia.

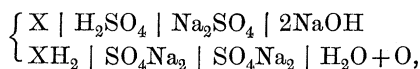
Time in hours.	Milligrams of silver deposited.	Cubic centimetres of hydrogen at 0° and 760 mm.	
		Equivalent to silver.	Actually collected.
I. 8	104	10·8	10·7
J. 22	76	7·9	7·8
K. 16	53	5·5	5·4
L. 20	36	3·7	3·6

Various reducing agents were found ineffective in causing hydrogen evolution in this way; thus no noticeable amount of hydrogen was produced when sodium sulphite or hypophosphite, potassium ferrocyanide, or manganous hydroxide and ammoniacal sal-ammoniac were used. Similarly, no oxygen evolution was observed when a mixture of sulphuric acid and barium dioxide, or hydrochloric acid containing iodine in solution, was the acid fluid. On the other hand, the oxygen absorbed by a platinum sponge aeration plate was sufficiently active to cause some four times as much permanent current to pass as was produced when a solid platinum plate was used immersed some centimetres below the surface of the acid.

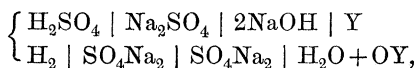
By substituting various metals and caustic soda or ammonia solution for the platinum plate and alkaline solution containing a reducing substance, tolerably energetic cells were obtained; even in the case of metals not ordinarily regarded as belonging to the oxidisable class, solution was readily brought about when the alkaline fluid contained potassium cyanide. In all cases hydrogen was evolved from the surface of the opposed platinum plate immersed in sulphuric acid solution in quantity proportionate to the current passing, whilst a quantity of metal was dissolved usually sensibly equal to that representing the formation of the lowest oxide; tin dissolved to a somewhat less extent, indicating the production of some stannic oxide, from 3 to 7 per cent. of the metal being dissolved in this form, and the rest as stannous oxide; and mercury dissolved to form mercuric potassio-cyanide, 100 parts of metal dissolving for 108 of silver thrown down in the voltameter. Gold, silver, and palladium readily evolved hydrogen when immersed in cyanide solution; but platinum was ineffective, and iron gave only a faint action. Thus the following figures were obtained in various experiments:—

Metal used.	Alkaline fluid.	Time.	Milligrams of silver precipitated in voltameter.	Hydrogen liberated in cubic centimetres at 0° C. and 760 mm.	
				Equivalent to silver deposited.	Actually collected.
Tin	Caustic soda.	3 hrs.	107	11·08	11·0
"	"	2 "	137	14·2	14·2
Lead	"	16 "	244	25·3	25·1
Copper	Ammonia.	42 "	11	1·14	1·0
"	{ Potassium cyanide and caustic potash. }	10 "	120	12·4	12·0
"	"	4 "	115	11·9	11·2
Silver	"	6 "	69	7·15	6·9
Mercury	"	24 "	78	8·08	8·0
Palladium	"	18 "	106	11·0	11·0
Gold	"	14 "	141	14·6	14·55
Nickel	"	18 "	45	4·7	4·5
Cobalt	"	4 "	15	1·56	1·55

In all the cells examined, the ultimate action may be expressed by the scheme—



where oxygen is evolved, X being some substance capable of combining with hydrogen (nitric acid, chromic anhydride, chlorine, &c.); and by the scheme—



where Y is some substance capable of uniting with oxygen (pyrogallol, ferrous oxide, copper, gold, &c.). For every gram-equivalent of silver thrown down in the voltameter, consequently, a gram-equivalent of both acid and alkali must disappear by mutual neutralisation during the passage of the current. This disappearance was verified quantitatively by titration in various experiments with no more lack of precision than the nature of the observation would lead one to anticipate.

We find that by combining two fluids, one alkaline and containing a powerful reducing agent, the other acid and containing an energetic oxidiser, with platinum plates immersed in each (*e.g.*, caustic soda solution of pyrogallol, and sulphuric acid solution of chromic anhy-

dride), continuous currents of very considerable power may be obtained when the internal resistance is diminished sufficiently by using cells of considerable magnitude; *e.g.*, when made of the stoneware and inner porous vessels usually employed for Grove's cells, the porous vessel being cemented into the outer stoneware vessel (by paraffin wax or other unattacked material) in such a fashion as to divide it into three compartments separated one from the other by porous dividing walls; the acid and alkaline fluids being placed in the two outermost compartments, and the innermost one being filled with a solution of a neutral salt, *e.g.*, sodium sulphate. A large variety of analogous cells of more or less power can thus be formed by using different organic and inorganic reducing substances soluble in alkali, *e.g.*, ferrocyanides, hydrosulphites, opianates, &c.

“On Kreatinins. I. On the Kreatinin of Urine as distinguished from that obtained from Flesh Kreatin. II. On the Kreatinins derived from the Dehydration of Urinary Kreatin.” By GEORGE STILLINGFLEET JOHNSON, M.R.C.S., F.C.S., F.I.C. Received May 5,—Read June 16, 1887.

PART I.

I was induced to undertake this investigation by a careful observation of the action of picric acid and potassium hydrate upon normal human urine at the boiling temperature.

The introduction of picric acid as a test for sugar in urine is due to my father, Dr. George Johnson, who accidentally discovered the production of a very dark colour on the addition of picric acid to a portion of saccharine urine which had been previously boiled with potassium hydrate. He made this observation in November, 1882. The dark colour was found to be due to *reduction* of potassium picrate to potassium picramate by glucose at the boiling temperature, and in presence of potassium hydrate. The reaction had been described by C. D. Braun nearly twenty years previously (“Ueber die Umwandlung der Pikrinsäure in Pikraminsäure und über die Nachweisung des Traubenzuckers,” ‘Fresenius, Zeitschrift,’ 1865), but it had not hitherto been applied to any practical purpose.

Having observed the extreme delicacy of the test, and the ease with which the reaction is effected, my father determined to introduce it to the notice of the medical profession, not merely as a trustworthy qualitative test of extreme delicacy, but also as a means of estimating quantitatively the actual amount of glucose in diabetic urines. In this latter object I did my best to assist him, and our united efforts resulted in the elaboration of a new, easy, and accurate method for