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we may replace the values of B_i and A_i in (16.) by

$$\left. \begin{aligned} B_i &= \frac{2}{n} \left\{ w_1 \cos \frac{i\pi}{n} + w_2 \cos \frac{3i\pi}{n} + \dots \right\} \\ A_i &= \frac{2}{n} \left\{ x_1 \sin \frac{i\pi}{n} + x_2 \sin \frac{3i\pi}{n} + \dots \right\} \end{aligned} \right\} \cdot \cdot \cdot \quad (17.)$$

Then if the particular values of $f\left(\frac{(2i'+1)\pi}{n}\right)$ be given, or tabulated, we may with very little trouble form tables of $u_1, u_2, \&c.; v_1, v_2, \&c.;$ and from these last tables of $w_1, w_2, \&c.; x_1, x_2, \&c.$ Thus the labour of computation required by (15.) would be reduced to one half of the same in (16.), and to one fourth of it in (17.).

We may reduce (14.) once in a similar manner, omitting the last terms in the values of B_i and A_i , which will be $\frac{2}{n}f(2\pi)$ and 0 respectively; but this can be done only once. It appears, therefore, that (15.) is preferable to (14.) when we have tables of the particular values.

If we employ a smaller value of n , we shall have for certain values of i

$$\sin \frac{ik}{2} = 0, \quad \sin (p-i) \frac{k}{2} = 0, \quad \sin (p+i) \frac{k}{2} = 0;$$

and we should find

$$B_0 + B_n + B_{2n} + \dots$$

$$B_i + B_{n-i} + B_{n+i} + B_{2n-i} + \dots$$

$$A_i - A_{n-i} + A_{n+i} - A_{2n-i} + \dots$$

in the place of B_0, B_p and A_i respectively. These might be employed to determine some of the quantities B_i and A_i , when a part of them has been found by the method before given.

Gunthwaite Hall, April 9, 1849.

LV. On some Combinations of Boracic Acid with Oxide of Lead.

By THORNTON J. HERAPATH, Esq.*.

NEUTRAL Borate of Lead, $PbO + BO^3$, may be obtained by digesting the heavy white precipitate which is formed when baborate of soda is added to a solution of any neutral salt of lead, for twelve or fourteen hours, in a strong solution

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of caustic ammonia (I., IV.). It would also appear to be produced when the basic acetate of lead is imperfectly precipitated by biborate of soda (II., V.), or when an acid solution of either of the subsequently described borates is supersaturated by strong *liquor ammonia* (III., VI.).

It is a heavy, white, amorphous powder, which is almost insoluble in water, both hot and cold. It is perfectly insoluble in alcohol. It dissolves with great facility in dilute nitric acid, even when cold, and likewise in boiling acetic acid; from these solutions it may be again precipitated unaltered, by adding a large excess of ammonia. It is easily decomposed by sulphuric and hydrochloric acids, and likewise by a boiling solution of caustic potash or soda. Before the blowpipe, it intumesces, gives off water, and becomes dark in colour; and at a low red heat fuses into a clear colourless glass, which possesses a specific gravity of 5.5984, at 56° F., and is softer than common flint-glass. Heated to redness on charcoal, it is partially reduced, and the fused mass contains numerous globules of metallic lead.

The following are the results of my analysis of the hydrated salt, after it had been exposed to a temperature of about 212° F., in a Liebig's drying-tube, for three or four hours.

I. 9.2 grains were heated to redness in a platina capsule; loss = 0.598 gr. = 6.5000 per cent.

II. 10 grs., treated as before, lost 0.683 gr. in weight = 6.8300 per cent.

III. 11.01 grs. lost 0.684 gr. in weight = 6.2125 per cent.

IV. 10 grs. were dissolved in dilute nitric acid, and the solution precipitated by an excess of diluted sulphuric acid; PbO , SO^3 9.77 grs. = PbO 7.198 grs. = 71.9800 per cent.

V. 20 grs. gave of PbO , SO^3 19.80 grs. = PbO 14.578 grs. = 72.8900 per cent.

VI. 20 grs. gave of PbO , SO^3 19.03 grs. = PbO 14.0221 grs. = 70.1105 per cent.

	I.	II.	III.	IV.	V.	VI.	Mean.
HO	6.5000	6.8300	6.2125	...	...	...	6.5141
PbO	...	...	...	71.9800	72.8900	70.1105	71.6601
BO ³	...	...	...	...	...	...	21.8258

Now, if we consider the composition of this hydrated salt to be represented by the formula PbO , $\text{BO}^3 + \text{HO}$, it ought to contain—

Water 1 9 or 5.7692 per cent.

Oxide of lead . . 1 112 ... 71.7939 ...

Boracic acid . . 1 35 ... 22.4369 ...

This salt begins to lose water between 250° and 300° F.; and by long-continued desiccation at a temperature of from 450°

to 500° F., it may be rendered perfectly anhydrous without experiencing any perceptible change of colour.

Sesquiborate of Lead, $2\text{PbO} + 3\text{BO}^3$.—The salt which is produced when a boiling solution of the nitrate, or any other soluble salt of lead is precipitated by a great excess of biborate of soda, has been hitherto considered by chemists to be composed of $\text{PbO} + 2\text{BO}^3$. According to my experiments, however, it would appear to consist of $2\text{PbO} + 3\text{BO}^3$. It is a white powder, like the preceding, which it closely resembles in its properties. Before the blowpipe it fuses into a colourless glass, the specific gravity of which is rather lower than that of the neutral borate, being 5·2352; its hardness is very nearly equal to that of flint-glass. The following are the results of my analysis of this salt dried at 212° F.:—

I. 10 grs., heated to redness, lost 0·918 gr. in weight = 9·1800 per cent.

II. 11·26 grs., treated as before, lost 1·106 gr. = 9·8223 per cent.

III. 25 grs. lost 2·3 grs. in weight = 9·2000 per cent.

IV. 10 grs. gave of PbO , SO^3 8·62 grs. = PbO 6·3515 = 63·5150 per cent.

V. 10 grs. gave of PbO , SO^3 8·34 grs. = PbO 6·1452 = 61·4520 per cent.

VI. 10 grs. gave of PbO , SO^3 8·411 grs. = PbO 6·1975 = 61·9750 per cent.

	I.	II.	III.	IV.	V.	VI.	Mean.
HO .	9·1800	9·8223	9·2000	...	...	...	9·4007
PbO .	...	...	...	63·5150	61·4520	61·9750	62·3140
BO ³ .	...	...	...	...	...	...	28·2853

These numbers indicate a composition very closely approximating to the formula 2PbO , $3\text{BO}^3 + 4\text{HO}$, as will be seen upon comparing them with those given below:—

Water 4 36 or 9·8630 per cent.

Oxide of lead . . . 2 224 ... 61·3690 ...

Boracic acid . . . 3 105 ... 28·7680 ...

Dried between 350° and 400° F., it loses two of its atoms of water, and its composition is now expressed by the formula 2PbO , $3\text{BO}^3 + 2\text{HO}$.

I. 10 grs. of the salt in this state of hydration lost 0·495 gr. upon being heated to redness, = 4·9500 per cent.; calculation requires 5·1873 per cent.

Biborate of Lead, $\text{PbO} + 2\text{BO}^3$, may be easily obtained by boiling either of the preceding recently-precipitated salts, whilst still moist, in a concentrated solution of boracic acid. It is a light amorphous powder, which at a red heat fuses with difficulty into a vitreous mass. From the almost impossibility,

however, of obtaining this glass free from air-bubbles, I was unable to ascertain its true specific gravity. It was slightly superior to flint-glass in hardness.

The hydrated salt, dried for some time at 212° F., yielded upon analysis the following numbers:—

I. 10 grs., when heated to redness, lost 1·579 grs. in weight = 15·790 per cent.

II. 25 grs., treated as before, lost 4·021 grs. in weight = 16·084 per cent.

III. 10 grs. gave of PbO, SO^3 7·07 grs. = PbO 5·2095 = 52·095 per cent.

IV. 25 grs. gave of PbO, SO^3 17·784 grs. = PbO 13·1040 = 52·416 per cent.

	I.	II.	III.	IV.	Mean.
Water . . .	15·790	16·084	...	...	15·9370
Oxide of lead .	...	...	52·095	52·416	52·2555
Boracic acid .	...	...	...	...	31·8075

Now, supposing its composition to be expressed by the formula $\text{PbO}, 2\text{BO}^3 + 4\text{HO}$, it ought to be composed of—

Water	4	36	or 16·513	per cent.
Oxide of lead . . .	1	112	...	52·376
Boracic acid . . .	2	70	...	32·111

Dried between 400° and 450° F., it contains 4·435 per cent. of water = one atom; calculation requires 4·712 per cent.

Nitro-Borate of Lead.—When either of the above-described borates of lead are dissolved in moderately strong nitric acid to saturation, the solution filtered and concentrated by evaporation until a pellicle appears upon the surface, and then allowed to cool, the sides of the vessel containing the solution in a short time become covered with numerous irregular, glistening crystals. These, when heated to somewhat above 250° F., become nearly opaque, slightly decrepitate, and give off water and traces of nitric acid vapour. Heated to redness, they evolve large quantities of nitrous acid fumes, and the residue fuses into a transparent colourless glass. They are, therefore, obviously a nitro-borate of lead; but from the discordant results of my analyses, I have as yet been unable to satisfy myself with regard to their true composition. They are most probably composed of $\text{PbO}, \text{BO}^3, + \text{PbO}, \text{NO}^5 + \text{HO}$.

Chloro-Borate of Lead.—This curious and interesting double salt was formed accidentally whilst attempting to prepare a borate of lead by precipitating a hot solution of baborate of soda by a boiling concentrated solution of chloride of lead. By filtering the mixed solutions whilst still warm, and wash-

ing the white flocculent precipitate which remained upon the filter with lukewarm water, the new salt was obtained in a state of purity.

This, when examined under a microscope of high power, was found to consist of exceedingly minute irregularly-acicular crystals, which depolarized light and possessed a nacreous lustre.

The compound thus obtained does not appear to be acted upon by cold water; boiling water, however, slowly but gradually decomposes it into its constituent salts. It is perfectly insoluble in alcohol. It dissolves with facility in hot dilute nitric acid, being decomposed, and chloride of lead set free, which, upon cooling, separates from the solution in long needle-formed crystals. When heated to from 250° to 300° F., it loses about 3.59 per cent. of water, and then becomes anhydrous. At a low red heat it readily fuses into a clear amber-coloured globule; this, upon cooling, solidifies into a transparent and almost colourless glass, which is slightly opalescent. When heated to redness, however, on charcoal, or in an open platina capsule, it behaves differently; white fumes are now given off, and the fused mass becomes gradually darker in colour, and of a thicker consistence, until it very much resembles melted sulphur in appearance. If it be now allowed to cool, it will be found to have undergone a very considerable change; it rapidly concretes into an opaque, straw-coloured brittle mass, which is made up of a multitude of long, radiating, acicular crystals, and bears a striking resemblance to molybdic acid.

The crystallized hydrated salt, dried by exposure to sulphuric acid at the ordinary temperature, yielded upon analysis the following numbers:—

I. 4.42 grs. were taken, and heated to redness in a tube of Bohemian glass; the aqueous vapour having been drawn off by suction, and the apparatus allowed to cool, it was found to have lost 0.180 gr. in weight = 4.072 per cent.

II. 3.86 grs., treated as before, lost 0.12 gr. in weight = 3.109 per cent.

III. 5.00 grs. were dissolved in boiling dilute nitric acid, and the solution was precipitated by nitrate of silver; Ag, Cl, (fused) = 2.60 grs. in weight = 0.6411 Cl = 12.822 per cent.

IV. 3.32 grs., treated as above, gave of Ag Cl 1.82 grs. = Cl 0.4487 gr. = 13.515 per cent.

V. 4.581 grs. gave of PbO, SO^3 4.824 grs. = Pb 3.3009 = 72.0580 per cent.

VI. 3.6 grs. gave of PbO, SO^3 3.833 grs. = Pb 2.6226 grs. = 72.8510 per cent.

	I.	II.	III.	IV.	V.	VI.	
Water . . .	4·072	3·109	...	...	...	...	3·5905
Chlorine	12·822	13·515	...	...	13·1685
Lead	72·058	72·851	72·4545
Oxygen	10·7865
Boric acid }	

The formula that agrees best with these numbers is PbO , BO^3 , + Pb , Cl + H^2O ; supposing this to be its composition, it ought to contain—

Water	1	9 or	3·040 per cent.
Chlorine	1	36 ...	12·162 ...
Lead	2	208 ...	70·030 ...
Oxygen	1	8 ...	2·703 ...
Boric acid	1	35 ...	12·065 ...

The excess of chlorine and lead shown by the analysis was doubtlessly owing to the difficulty of entirely removing the excess of chloride of lead, which was carried down by the salt, without producing a decomposition of the salt itself.

All subsequent attempts to reproduce this compound having failed, I have been unable to verify the above results by a repetition of my analysis.

Mansion House, Old Park,
Bristol, March 4, 1849.

LVI. Notices respecting New Books.

Statistics of Coal. The Geographical and Geological distribution of Fossil Fuel or Mineral Combustibles employed in the Arts and Manufactures: their production, consumption, commercial distribution, prices, duties, and international regulations, in all parts of the world; including four hundred statistical tables and eleven hundred analyses of mineral bituminous substances. With incidental statements of the statistics of Iron Manufactures, &c., derived from official reports and accredited authorities. Illustrated with Coloured Maps and Diagrams. By RICHARD COWLING TAYLOR, F.G.S. London: John Chapman, 142 Strand. Philadelphia: J. W. Moore. 1848.

COMPREHENSIVE as the title of this work appears, it does not, yet, convey a just idea of its scope, or of the extent of its subject-matter. Did its title stand, "Coal, the civilizer; its natural history, production and applications," it would perhaps convey to the casual reader a more just idea of the object and contents of the work. We confess that we ourselves closed the book with very different feelings from those with which we opened it. We have no hesitation in saying that we have long ceased to entertain that extraordinary respect for mere statistics which it has been very much the habit of late years to inculcate. We have seen too many instances, and too many instances are daily occurring, in which statistics are made the mere instrument of the partizan and the theorist.