XII. *Some experiments on a solid compound of iodine and oxygene, and on its chemical agencies.* *By Sir* HUMPHRY DAVY, *LL.D. F. R. S.*

Read April 20, 1815.

IN the two papers containing researches on iodine which the Royal Society has done me the honour of publishing in the Transactions, I have described a class of bodies consisting of iodine, oxygene, and different bases analogous to the hyperoxymuriates. In the last of these papers, I mentioned, that I had not been able to procure any binary combination of iodine and oxygene from these compounds, neither by the method proposed by M. GAY LUSSAC, namely, the action of sulphuric acid on the oxyiode of barium, nor by other methods of my own institution; and that in experiments on the effects of the acids on the oxyiodes, new combinations only were formed. I have lately resumed this enquiry, and by pursuing a new and entirely different plan of operation, I have at last succeeded in combining oxygene and iodine. In the following pages I shall describe the circumstances which led me to ascertain the existence of this compound, and I shall detail some experiments on its analysis and its chemical agencies.

In the course of my researches, I observed, that when a solution of the compound of iodine and chlorine was poured into alkaline solutions, or even into certain muriatic solutions, the precipitate was an oxyiode; and this fact seemed to indicate, that iodine had a stronger attraction for oxygene than chlorine; iodine, likewise, has an attraction for chlorine; it appeared, therefore, extremely probable, that euchlorine, or the gaseous combination of oxygene and chlorine, would be decomposed by heat, and two compounds formed, one of oxygene and iodine, and the other of iodine and chlorine, or that a triple compound would be produced from which chlorine could be easily separated, and on submitting the idea to the test of experiment, I found that I had not been deceived.

To produce the compound of oxygene and iodine, it is necessary merely to bring the euchlorine and iodine together at the ordinary temperature of the atmosphere. As soon as the euchlorine comes in contact with the iodine, there is an immediate action, its colour changes to bright orange, and a liquid is formed. When the euchlorine is in sufficient quantity, a white substance likewise appears. By the application of a gentle heat, the orange compound of chlorine and iodine may be made to rise in vapour; and the compound of oxygene and iodine remains.

When this compound is required to be dry, the euchlorine should be passed through dry muriate of lime (calcane) before it is admitted to the iodine. The apparatus that I have employed for producing the substance is a curved bent tube, in the form of an inverted L (┐), closed at one end, the closed leg of the tube being longest, and which serves as a retort for generating the gas; a thin long-necked glass receiver for containing the iodine, and a curved tube of smaller diameter than the first, and cemented or ground into it for conveying the gas into the receiver. The muriate of lime is placed in some dry paper in the upper part of the large curved tube;

and to produce the substance from 40 grains of iodine, 100 grains of the hyperoxymuriate should be used, and four times the quantity of solution of muriatic acid of specific gravity about 1.105; a very small spirit lamp should be employed to generate the gas; and to prevent explosions, the heat should be applied with great care, and only to the bottom of the tube.

The compound of oxygene and iodine when entirely freed by heat from the compound of oxygene and chlorine, appears as a white semi-transparent solid; it has no smell, but a strong astringent sour taste. Its specific gravity is considerable, for it rapidly sinks in sulphuric acid. When heated strongly, it decomposes, undergoing fusion at the moment, and is entirely converted into gaseous matter and iodine, leaving no residuum whatever.

It requires for its entire decomposition, a heat which is rather below the boiling point of olive oil, and there seems to be little or no increase of temperature in the process.

Its nature is proved both by analysis and synthesis, for when euchlorine acts upon iodine, the volatile substance produced, has all the characters of the body produced by the immediate action of chlorine on iodine; and when the compound I am describing is decomposed in a pneumatic apparatus, the gas formed is found to be pure oxygene, and the solid sublimate produced, is pure iodine.

I endeavoured to determine the proportions of the elements in the compound, by decomposing it in glass tubes carefully weighed, and ascertaining the loss of weight of the tube, and the volume of oxygene evolved. I have used very small quantities of the substance, but as my balance is delicate, I do not think there can be any considerable error in the results. I give those which I consider as the most accurate.

In one experiment, 3 grains of the substance afforded a quantity of oxygene equal to 517.3 grain measures of water, and lost in weight .68. In a second experiment, 2 grains afforded 348.3 grain measures of oxygene. In a third experiment, 1 grain yielded 191 grain measures of oxygene.

Many experiments that I have lately made, have convinced me, that in my first paper I rated the number representing the proportion in which iodine combines too low; indeed at the time, I stated that my results afforded rude approximations, they demonstrated merely that iodine was represented by a very high number. In an experiment recently made with care, 50 grains of the iode of potassium decomposed by nitric acid, afforded 32.8 grains of nitre. According to this result, the number representing the proportion in which iodine combines is 227.3; but I do not venture to state this number as exact, as I am not secure of the purity of the hydrate of potassa from which the iode was made.

The compound of iodine and oxygene is very soluble in water; it slowly deliquesces in a moist atmosphere, but remains unaltered when the air is dry; its solution first reddens, and then destroys vegetable blues, and reduces other vegetable colours to a dull yellow. When its aqueous solution is heated, as the water rises in vapour, it gradually thickens, gains the consistence of a syrup, becomes pasty, and at length by a stronger heat yields the solid substance unaltered; unless a sufficient heat is applied to decompose a portion of it, when it gains a purplish tint apparently from some iodine set free. The pasty substance that it forms is evidently an hydrate, for it yields moisture during its decomposition.

Its action upon inflammable bodies is such as might be expected from its composition. When it is heated, mixed with charcoal, sulphur, resin, sugar, or the combustible metals in a finely divided state, detonations are produced; and its solution rapidly corrodes all the metals which I have exposed it to, and it acts both upon gold and platinum, but much more intensely on the first of these metals.

When a solution of it is poured into solutions of the alkalies or alkaline earths, or when made to act on their carbonates, oxyiodes or triple compounds of oxygene, iodine, and the metallic bases, are the results. By its action on solution of ammonia, a substance is produced apparently the same as that which is formed by the action of the compound of iodine and chlorine, saturated with chlorine on the same solution, and which I have mentioned in a former Paper, and which, consequently, must be regarded as an oxyiode of ammonia.

When an aqueous solution of the compound is poured into a solution of the soluble salts of baryta and strontia, a copious precipitate of their respective oxyiodes is produced. The oxyiode of barium, as I have mentioned in my last communication on iodine, is a compound very slightly soluble in water, that of strontium is rather more soluble; and those of calcium, magnesium, glucinum, ittrium, aluminum, zirconum, are more so, and I believe in the order in which they have been named.

It forms combinations with all the metallic oxides I have tried its agency upon, and precipitates lead and mercury from their nitrous solutions.

The action of the compound upon acids is much more singular than that upon alkalies, earths, or metallic oxides. It appears to form combinations with all the fluid or solid acids to which I have been able to expose it, that it does not decompose. When sulphuric acid is dropped into a concentrated solution of it in hot water, a solid substance is precipitated, which consists of the acid and the compound; for on evaporating the solution by a gentle heat, nothing rises but water. On increasing the heat in an experiment of this kind, the solid substance formed, fused; and on cooling the mixture, rhomboidal crystals formed of a pale yellow colour, which were very fusible, and which did not change at the heat at which the compound of oxygene and iodine decomposes, but sublimed unaltered. When urged by a much stronger heat, it partially sublimed, and partially decomposed, affording oxygene, iodine, and sulphuric acid.

With hydro-phosphoric acid, the compound presents phenomena precisely similar, and they form together a solid, yellow, crystalline combination.

It dissolves in solution of hydro-phosphorous acid, but on heating the combination, iodine is immediately produced by a decomposition of part of the compound, and the remaining part unites to the phosphoric acid formed.

When hydro-nitric acid is poured into a concentrated solution of it, white crystals form in plates of a rhomboidal figure, and which when dried, partially decompose, and partially sublime at a much lower heat than the sulphuric or phosphoric compounds, and afford hydro-nitric acid, oxygene, and iodine.

It dissolves in solution of oxalic acid, but by a very gentle heat, the oxygene of the compound acts on the inflammable bases of the acids, and iodine and carbonic acid are disengaged in great quantities.

By liquid muriatic acid, the substance is immediately decomposed, and the compound of chlorine and iodine is formed.

When boracic acid was added to a solution of the new compound, it dissolved in it by heat, and did not crystallize on cooling. By evaporation, a solid white substance was procured, not so easily decomposed by heat as the compound itself.

The taste of all these acid compounds is very sour, though in different degrees of intensity: they redden vegetable blues, and they dissolve gold and platinum. When they are made to act on the alkalies or earths, or on saline solutions which they are capable of decomposing, common neutral salts and oxyiodes are formed at the same time.

The facts of the combination of the new compound with acids, serve to explain the phenomena of the action of these substances, on the oxyiodes which I have described in my last paper on iodine, and they confirm the opinions there stated on the nature of this action. The substance procured by M. GAY LUSSAC, by the action of sulphuric acid on the solution of the oxyiode of barium, and which he has supposed to be a pure combination of oxygene and iodine mixed with a little sulphuric acid, has evidently for its base the combination just now described of sulphuric acid and the new compound, and, as I have shown, it likewise contains baryta. However minute the quantity of sulphuric acid made to act on oxyiode of barium, a part of it is always employed to form the compound acid; and the residual fluid contains both the compound acid, and a certain quantity of the original salt.

That this compound acid is a true chemical combination, is evident from the observations already detailed, and from its crystalline form. There is every reason to believe, that the proportions of its elements are definite. In one experiment I found, that a small quantity of the new compound in being converted into the rhomboidal crystals, gained rather less than half its original weight from the addition of the acid, i. e. 2 grains became 2.8 grains.

In experiments in which the products of the decomposition of the compounds from phosphoric and sulphuric acids were collected, the acids disengaged were found in their state of hydrates, from which it is probable, that the crystalline compounds are hydrates, and that the common acids carry their definite proportion of water into the combination. It is not indeed unlikely, that the presence of water is connected with the phenomenon of combination, and there is an instance of this kind which I long ago pointed out. Sulphurous acid gas, and nitrous acid gas, appear to have no action on each other, unless water be present; but with the vapour of water they form a solid crystalline hydrate.

Reasoning from analogy, it is probable, that a compound of oxygene may be formed, containing less oxygene than the new compound. I have made many experiments with the hope of discovering a body of this kind; but without any decided success. When the solution of the new compound is made to act on the double compound of iodine and the alkaline metals, iodine is produced, which during its sublimation, yields no gaseous product. Iodine heated in a solution of the new compound slightly colours it, but this appears to be merely in consequence of its combining with the water; and the iodine rises in vapour with the water without decomposing the compound. In some experiments on the action of euchlorine on iodine, in which the iodine was in great excess, the solid substance formed had a chocolate tint; but this may possibly have depended upon a small quantity of free iodine, and when dissolved in water, it afforded by the evaporation of the water, the white compound only.

I detailed in my last paper on iodine, some unsuccessful attempts to procure a compound of oxygene and iodine from the chlorionic acid, the substance produced by the agency of the combination of iodine and chlorine in water, on the idea that water was decomposed in this experiment. I have made some further researches, on the supposition that it might contain a compound of iodine containing less oxygene than this new substance; but without any success: neither by distillation at very low temperatures, nor by the action of small quantities of oxide of silver, nor by any other means, have I been able to separate any compound of oxygene from it; and when it forms triple compounds, the oxyiodes, by its action upon alkalies, or earths, or metallic solutions, it appears that the oxygene of the alkalies or earths is only newly combined at the moment of its operation upon them, an effect assisted by the attraction of the bases of the earths for chlorine. The conclusion which I formed, that the chlorionic acid is a simple combination of the chlorionic sublimate in water, is still farther proved by the circumstances of the action of muriatic acid on the new solid compound of oxygene and iodine.* Page 209.

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* The chlorionic acid offers an easy method of procuring pure baryta. By dropping a solution of it into solution of muriate of barium, as I have shown in my last paper on iodine, a precipitate of oxyiode of barium is produced, which when decomposed by a strong heat, yields pure baryta, the attraction of oxygene for barium being, as I have stated, stronger at this temperature than that of iodine.

As I have called the compounds of oxygene, iodine, and bases, *oxyiodes*, I venture to propose a name in conformity, that of *oxyiodine* for the new solid compound, and *oxyiodic* acid, for the acid compound it forms with water. M. GAY LUSSAC, as I am informed, has proposed in a paper which I have not yet been so fortunate as to procure, but which is said to contain many new and important facts, the name of iodic acid for the compound of oxygene and iodine, the existence of which he conceived he had proved by his experiment on the action of sulphuric acid on the oxyiode of barium, and the terms iodats for the substances, consisting of oxygene, iodine, and bases. I am willing to pay every compliment to the sagacity of this ingenious chemist, in anticipating the knowledge of the nature of a body, the separate existence of which he had not demonstrated by experiment; but the term *iodic* acid does not appear to me sufficiently definite. For the hydroionic acid, and the chlorionic acid, as well as the oxyiodic acid, may be all called as a class iodic acids, or acids from iodine, and the termination in *at*, would place the oxyiodes in the common class of neutral salts, from which they differ in many respects. When they become binary compounds in consequence of their decomposition by heat, though they lose all their oxygene, their neutral and saline character remains unaltered, which is not the case with any other known class of bodies, except the hyperoxymuriates; and the terms iodes and oxyiodes which I proposed in the first paper, in which the distinction between these bodies was pointed out, sufficiently express the nature of the double and triple compound, and the difference between them.

I am desirous of marking the *acid* character of oxyiodine combined with water, without applying the name acid to the anhydrous solid. It is not at all improbable that the action of the hydrogene in the combined water is connected with the acid properties of the compound; for this acid may be regarded as a triple combination of iodine, hydrogene, and oxygene, an oxyiode of hydrogene, and it is possible that the hydrogene may act the same part in giving character, that potassium, sodium, or the metallic bases perform in the oxyiodes; and as hydrogene combined with iodine forms a very strong acid, and as this acid would remain, supposing all the oxygene to be taken away from the oxyiodic acid, it is a fair supposition that its elements must have an influence in producing the acidity of the substance.

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