

XIII. *On the action of acids on the salts usually called hyperoxymuriates, and on the gases produced from them.* By Sir HUMPHRY DAVY, LL.D. F. R. S.

Read May 4, 1815.

THE effects produced when concentrated hydro-sulphuric acid (oil of vitriol) is poured upon hyperoxymuriate of potassa, have been often objects of chemical discussion; the acid and the salt, it is well known, become deep orange, and if any moisture is present, or if heat is applied to the mixture, a detonation occurs. In a paper read before the Royal Society, I have ventured to suppose, that these phenomena depend upon the developement and sudden decomposition of the compound of chlorine and oxygene, which I have named euchlorine.

A statement, which I understand has been made by M. GAY LUSSAC, namely, that a peculiar acid, which he has called chloric acid, may be procured from the hyperoxymuriate of baryta by sulphuric acid, led me to examine the action of acids on the hyperoxymuriates under new circumstances, and I have made some observations which appear to me not unworthy of being communicated to the Royal Society.

If 30 or 40 parts of sulphuric acid be poured upon one part of dry hyperoxymuriate of potassa in a wine glass, and the salt be agitated in the acid, there is a very slight effervescence only, the acid becomes of a deep orange tint, and white

fumes, mixed with orange fumes, fill the upper part of the glass, which have a very peculiar and not a disagreeable smell.

The *slight* effervescence taking place in this process, induced me to suppose that the substance which coloured the acid must contain a larger proportion of oxygen than euchlorine, for I have shown, in a work published in 1812,* that hyperoxymuriate of potassa contains six proportions of oxygen; and by its decomposition 2.5 volumes of oxygen ought to be evolved for every volume of chlorine; and euchlorine procured from the hyperoxymuriate of potassa by solution of muriatic acid, yields only one volume of oxygen, and two volumes of chlorine.

I endeavoured to procure the substance which coloured the sulphuric acid during its action upon hyperoxymuriate of potassa, and after several failures, in which explosions took place, I at length succeeded in the following manner. Dry oxymuriate of potassa in powder was mixed with a small quantity of sulphuric acid, and they were rubbed together with a spatula of platinum till they had incorporated, and formed a solid mass of a bright orange colour. This mass was introduced into a small retort of glass, and exposed to the heat of water which was gradually warmed; a bright yellowish green, elastic fluid arose from the mixture, which was rapidly absorbed by water, giving to it its own tint, but which had no sensible action on mercury.

To make this experiment without danger, not more than 50 or 60 grains of the hyperoxymuriate should be employed, great care should be taken to prevent any combustible matter from being present, and the water should not be permitted to

* Elem. of Chem. Phil.

attain a temperature equal to 212° , which may be easily managed by mixing it with alcohol. There are dense white fumes when the mixture is first made, but there seems to be no heat produced; a small quantity of the orange gas is disengaged at this time; but the greater part of it remains attached to the sulphuric acid in the solid mass, and is expelled from it by the heat.

The gas procured by this process over mercury, when compared with the gas procured from the hyperoxymuriate, by liquid muriatic acid, is found to have a much more brilliant colour, is much more rapidly absorbed by water, has a peculiar and much more aromatic smell, unmixed with any smell of chlorine. It destroys moist vegetable blues without previously reddening them. When it is heated to a temperature about that of boiling water, it explodes with more violence than euchlorine, and greater expansion of volume, producing much light. After the explosion over mercury, rather less than three (from 2.7 to 2.9.) volumes appear for two of the gas decomposed, and of these, two are oxygene, and the remainder chlorine.

A little chlorine is always absorbed by the mercury during the explosion of the gas; and it appears reasonable to conclude, that the deep yellow gas is in reality composed of two in volume of oxygene, and one of chlorine, condensed into the space of two volumes, and that it consists in weight, of one proportion of chlorine 67, and four of oxygene 60.

None of the combustible bodies which I have tried, decompose this gas at common temperatures, except phosphorus; this when introduced into it, occasions an explosion, and burns in the liberated gases with great brilliancy.

Its saturated solution in water is of a deep yellow colour,

it does not taste sour, but is extremely astringent and corroding; when applied to the tongue, it leaves for a long while a very disagreeable sensation.

It occurred to me that the gas procured from the hyper-oxy-muriate by the action of liquid muriatic acid, might be a mere mixture of this gas and chlorine; and two in volume of this gas and three in volume of chlorine, would produce by explosion the same products as euchlorine. The only fact which I am acquainted with, opposed to the idea, is the circumstance of dutch foil not burning spontaneously in the gas from muriatic acid, which might be expected if it contained as much as $\frac{3}{5}$ of uncombined chlorine; though the force of this argument is suspended, till it is supported by an experiment showing that dutch foil inflames in a mixture of two of the deep yellow gas, and three of chlorine. I have not yet been able to procure at Rome, metallic foil fitted for this experiment.

I have ascertained that the gas from hyper-oxy-muriate and muriatic acid, though it acts much more slowly upon water than the other gas, yet in the end gives it the same tint and properties; and when much of it is exposed to a small quantity of water, it always leaves a residuum of chlorine, so that if it be not a mixture, but a compound, the new gas is formed from it by the action of water.

The action of hydro-nitric acid on the hyper-oxy-muriate, affords the same gas as that produced by the action of sulphuric acid, and a much larger quantity of nitric acid may be safely made to act on the salt; but as the gas must be procured by solution of the salt, it is always mixed with about $\frac{1}{5}$ of oxygene. From the solid mixture made with sulphuric acid, I have obtained a gas containing only $\frac{1}{20}$ of oxygene; the fifth

proportion obtained in the experiments with nitric acid, being evolved during the time the mixtures were made.

The saturated solution of the gas affords white fumes, similar to those produced at the moment the hydro-sulphuric mixture is made, from which it is probable, that these fumes consist of a hydrate of the gas.

The saturated solution, when mixed with solution of fixed alkalies, or of ammonia, does not immediately lose its colour, nor neutralise the alkalies; but after some time the effect is produced, and hyper-oxymuriates are obtained, (probably mixed with a minute quantity of muriates). The solution exposed to air, or suffered to remain in close vessels, becomes soon colourless; and I am inclined to believe that this depends upon a decomposition of water, for some of it exposed to a small quantity of air rather increased its volume.

I shall not propose to give any name to this substance, till it is determined whether euchlorine is a mixture or a definite compound, and I hope soon to have the means of making a decisive experiment on this subject.

It appears that this new substance, though it contains four proportions of oxygene, is not an acid; and hence it is probable, that the acid fluid compound of oxygene, chlorine, and water, which M. GAY LUSSAC calls chloric acid, owes its acid powers to combined hydrogen, and that it is analogous to the other hyper-oxymuriates, which are triple compounds of inflammable bases, chlorine, and oxygene, in which the base and the chlorine determine the character of the compound. Muriate of potassa, (potassane) is a perfectly neutral body; and when six proportions of oxygene are added to it, it still remains neutral. Muriatic acid (chlorine and hydro-

gene) is a strong acid; and according to the relation above stated, it ought not to lose its acid powers by the addition of six proportions of oxygene. Till a pure combination of chlorine and oxygene is obtained, possessed of acid properties, we have no right to say that chlorine is capable of being acidified by oxygene, and that an acid compound exists in the hyper-oxy muriates. We know that chlorine is capable of being converted into an acid by hydrogen, and, as I mentioned in my last paper, where this principle exists its energies ought not to be overlooked; and all the new facts confirm an opinion which I have more than once before submitted to the consideration of the Society, namely, that acidity does not depend upon any *peculiar* elementary substance, but upon *peculiar combinations* of various substances.

Rome, Feb. 15, 1815.

NOTE.

SINCE my return to England, I have made some farther investigations on oxyiodine, on the oxyiodes, and on the deep yellow gas. The portable apparatus which I employed in Italy, enabled me to operate only on very minute quantities of oxyiodine; I have lately made my experiments on a larger scale.

Thirteen grains of oxyiodine decomposed by heat, afforded 9.25 cubical inches of oxygene: and 48 grains of oxypotassame or oxyide of potassium, yielded when decomposed by heat, 31 cubical inches of oxygene gas: and 30 grains of potassame or iode of potassium (a portion of the salt so decomposed,) afforded by treatment with nitric acid 17.8 grains of dry nitre. These results give the number 246 as the number representing iodine, and prove that oxyiodine consists of one proportion of iodine and five of oxygene; and that the oxyiodes contain six proportions of oxygene.

The deep yellow gas when mixed with chlorine in the proportion of 2 to 3, or even of 2 to 2, deprives it of the power of acting upon Dutch foil, though 1 of chlorine when mixed with 2 of common air, still burns this substance. Hence it appears probable, that the deep coloured gas and chlorine have a chemical action on each other, and that euchlorine is not a simple mixture of them. I hope soon to be able to present to the Society, some new results on this subject.

London, June 12, 1815.