

4. After neutralizing the alkaline liquid by acetic acid, it gives a yellow, pulverulent precipitate with silver nitrate. This precipitate, when thoroughly washed from its saline mother liquor, is almost as insoluble in water as silver chloride; for hydrochloric acid gives no immediate opalescence with water filtered through it. It is quite stable below 100° C., or a little lower than this, and it may be washed with hot water without change. It is also unaffected by light, or by exposure to a pure atmosphere, even when in contact with paper. It is but very sparingly soluble in acetic acid; so that this acid may be added in excess to the original alkaline liquid without removing its property of being precipitated by silver salts. It is soluble in ammonia and ammonium carbonate, from solution in either of which it can be again thrown down by acetic acid, or by cautious neutralization of the ammonia by dilute nitric or sulphuric acid, or by the volatilization of the ammonia. It is soluble in either dilute nitric or sulphuric acid, and without immediate decomposition; and it can be reprecipitated from its solution in either of these acids by the cautious addition of ammonia or ammonium carbonate, or by the free addition of sodium carbonate or sodium hydrate, in either of which it is insoluble. It is immediately oxidized by concentrated nitric acid, copious red fumes being produced. Moderately diluted nitric, sulphuric, or hydrochloric acid decomposes it, with the evolution of nitrogen, and the production of apparently both nitrous and nitric acids in the solution. It is also decomposed by soluble chlorides and by hydrosulphuric acid. When precipitated from the original liquid, it sometimes becomes dark-coloured; but this change is due to the formation of a black matter derived from the sodium or naphtha and the silver acetate. After washing it, dissolving it in very dilute nitric acid, and filtering the solution, it may be reobtained by the cautious addition of ammonia, or by the addition of ammonia to alkaline reaction and then a little acetic acid, in a condition in which it is no longer liable to discoloration. It is decomposed by a moderate heat into nitric oxide, metallic silver, and a little silver nitrate—in this respect resembling silver nitrite. My experiments on silver nitrite, about being published, show that nitric oxide may serve as a carrier of atmospheric oxygen to silver nitrite; and it is therefore most probable that in this case also some of the nitric oxide liberated serves to carry a little oxygen to the still undecomposed new silver-salt. During its decomposition by heat it does not fuse or exhibit any other change except that from a bright yellow to a silver-white colour. After a red heat nothing remains but pure silver.

5. The following determinations of the amount of silver in the salt have been made:—

I. .3317 grm., dried at a gentle heat, was suspended in water and digested

ride, phosphate, and sulphate, that any ammonium salt would give ammonium amalgam with sodium amalgam. Ammonium nitrate yields no ammonium amalgam with sodium amalgam; more than this, the presence of a nitrate prevents the formation of this body by other salts of ammonium.

with hydrochloric acid. The silver chloride weighed $\cdot 3386$ grm. = $\cdot 2549$ grm. silver.

II. $\cdot 5703$ grm. of some of the salt which had been dissolved in ammonia, filtered, and precipitated by acetic acid, was dissolved in dilute nitric acid and treated with hydrochloric acid. It yielded $\cdot 5858$ grm. silver chloride = $\cdot 4410$ grm. silver.

III. $\cdot 9462$ grm. of some of the salt which had been dissolved in nitric acid, filtered, and reprecipitated by ammonia, was dissolved in very dilute nitric acid and precipitated by hydrochloric acid. It gave $\cdot 9722$ grm. chloride = $\cdot 7318$ grm. silver.

IV. $\cdot 6111$ grm. of the same preparation as the last was heated at first moderately and then to redness. It left $\cdot 4737$ grm. silver.

V. $\cdot 3685$ grm. kept for sixty hours at a temperature varying from 100° to 175° , left a residue weighing $\cdot 2921$ grm., of which $\cdot 2775$ grm. was metallic silver and the rest silver nitrate = $\cdot 0093$ grm. silver.

VI. $\cdot 5937$ grm. heated moderately till red fumes ceased to appear yielded $\cdot 4274$ grm. silver and $\cdot 0557$ grm. silver nitrate = $\cdot 0354$ grm. silver.

The percentage numbers for the silver found and that required by the formula NOAg are :

Calc.	I.	II.	III.	IV.	V.	VI.
78.26	76.85	77.33	77.34	77.48	77.83	77.95

so that there can be no doubt as to the composition of the salt, although the silver comes out about one per cent. too low. But in several of the samples traces of brownish or black matters were detected on solution ; and in the last preparation analyzed, the presence of a little moisture was detected, an attempt to expel which in some of the unused salt by a stronger heat caused partial decomposition.

6. If the product of the ultimate action of sodium on the nitrate be treated with acetic acid, as directed, until it is neutral to test-paper, it gives no precipitate with any metallic solution except that of silver, so far at least as trial has yet been made. But the precipitation of the silver-salt leaves the solution of an acid reaction to litmus ; and even if the solution before precipitation be rendered a little alkaline to litmus, it will, after precipitation, generally react slightly acid. The reason of this is clearly that the sodium salt has a markedly alkaline reaction ; and this is further shown to be the case by adding some of the washed silver-salt to a solution of potassium or sodium chloride, which it at once renders alkaline in reaction to litmus. To obtain a solution of the salt free from acid or caustic alkali, the original alkaline liquid is to be treated with acetic acid in successive quantities until it just ceases to yield a brown precipitate with silver nitrate. Such a solution will yield the yellow silver-salt with silver nitrate as before, and also precipitates with the salts of most of the common metals. Instead of acetic acid dilute nitric acid may be used in this method for thus neutralizing the caustic soda, with the same result as to

the alkalinity of the solution to test-paper, and its capability of being precipitated by many metallic salts.

7. The following reactions having as yet been only observed with a solution thus obtained, it is possible that some of them may not be due simply to the new acid :—

Barium chloride gives no precipitate.

Lead acetate gives a cream-white flocculent precipitate, which generally, on standing, changes to a very dense, full yellow precipitate. This precipitate is unchanged by boiling in water or in its mother liquor, is soluble in acetic and other acids, slowly, if at all, affected by ammonia or sodium carbonate, and instantly decomposed by caustic soda.

Mercuric chloride gives a cream-white flocculent precipitate.

Mercurous nitrate gives a blackish-grey precipitate, not improbably a mixture of mercury and the mercuric salt.

Cupric sulphate, a yellowish olive-green flocculent precipitate, soluble in acids and ammonia, insoluble in caustic soda, and unaffected by boiling in water or its mother liquor. The colour of this precipitate closely resembles the colour of a copper-salt mixed with a nitrite.

Zinc chloride gives a white precipitate.

Manganese chloride gives a whitish precipitate.

Nickel chloride gives a greenish, almost white precipitate.

Cobalt nitrate gives no precipitate (?).

Alum gives a white precipitate.

Ferric chloride gives a slight reddish-brown precipitate.

Ferrous sulphate gives a whitish precipitate, instantly darkening to dirty blackish green and eventually reddish brown. On addition of ferric chloride effervescence slowly commences; and with ferrous sulphate the same thing happens, but still more slowly. It is very probable that the iron and aluminium precipitates are simply hydrates; and if so, the action of this salt in these cases closely resembles that of a carbonate.

Silver nitrate behaves as already described.

Sodium chloride gives an alkaline solution with the silver-salt, which is changed to chloride.

Ammonium chloride gives the same result as sodium chloride, but the solution at once evolves ammonia. The existence, therefore, of the ammonium salt of the new acid is problematical.

Potassium permanganate gives the beautiful changes of colour from its own violet, through purple, blue, and chrome-green, to manganate green, and then a brown precipitate. The exhibition of this series of colours is more certain in the presence of a little caustic alkali. In this reaction the new salt resembles a nitrite, but it is much more sensitive than this.

Potassium iodide gives no reaction; it does with nitrite.

Iodine solution is decolorized immediately; so that if a nitrite, not in excess, is added to a solution of the new salt, the addition of starch and potassium iodide produces no coloration.

The solution acidified with acetic or hydrochloric acid still gives no reaction with *potassium iodide*, decolorizes *iodine solutions*, and prevents the action of a nitrite on an iodide.

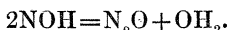
The acidified solution gives no coloration with *ferrous sulphate*. In contact with strong sulphuric acid, the mixture gives the coloration like a nitrate. As is well known, a nitrite, even without addition of acid, gives an immediate colour with ferrous sulphate.

The acidified solution immediately decolorizes *potassium permanganate*.

The acidified solution does not reduce *potassium dichromate*.

The solution which has been neutralized with nitric acid instead of acetic acid will not do for the iron and iodine tests, as this behaves, so far as it has been tried, as though it contained a nitrite.

The acidified acetic-acid solution, when heated, evolves *nitrous oxide*. Here again, therefore, the new salt is analogous to a carbonate,—



8. When silver nitrite is heated until a greenish-yellow, semifused mass remains, and this is washed out with water, the residue consists of metallic silver and a little bright yellow matter, unaffected by light, soluble in ammonia, and decomposed by boiling in water, as will be found described in my paper on the action of heat on silver nitrite already referred to. From the properties of this yellow substance, and from the manner in which it is formed, it is probable that it is the silver-salt of the new acid; but in consequence of the small quantity of it obtainable, and of the admixture of this with metallic silver, a fuller examination of it has not been attempted. If it be this salt, its formation is analogous to that of silver nitrite by heating silver nitrate.

9. There is also reason for believing that Hess* came across this salt by first treating a solution of barium nitrate which had been deoxidized by heat with a solution of silver sulphate and evaporating the mixture, and then decomposing the crystals thus obtained by the action of water.

10. In his 'Researches on Nitrous Oxide'†, Sir Humphry Davy described some experiments by which he obtained what appeared to him to be a combination of nitrous oxide with potash. He prepared it by exposing a mixture of solid potassium hydrate and potassium sulphite to the prolonged action of nitric oxide, dissolving the resulting product in water, crystallizing out the potassium sulphate formed, and then evaporating to dryness. The mass thus obtained evolved when heated pure nitrous oxide, amounting to about a fourth of its weight.

Since then, however, Pelouze‡ has obtained, by a modification of Davy's method, the alkali nitrosulphates; and it seems to be now universally

* Pogg. Ann. vol. xii. (1828) p. 257.

† Researches, Chemical and Philosophical, chiefly concerning Nitrous Oxide (1800). Res. ii. Div. i. sect. 6, pp. 254-277.

‡ "Sur quelques combinaisons d'un nouvel Acide formé d'Azote, de Soufre et d'Oxygène," Ann. de Chim. et de Phys. vol. lx. (1835) p. 151.

believed that Davy must have in reality obtained a nitrosulphate and not a simple salt of nitrous oxide. I have not yet had time to repeat Davy's experiments myself, but I wish to point out one well-marked and essential difference between the body obtained by Davy and Pelouze's nitrosulphate, which is that, whereas the former body evolved pure nitrous oxide when heated, the latter gives off nitric oxide; and also that, according to Davy's experiments, Pelouze's modification of the former's process would be fatal to its success in forming the salts of nitrous oxide.

11. There is some difficulty in selecting an appropriate name for the new acid. That of hyponitrous acid naturally suggests itself, as being framed according to the usual method of naming a rising series of oxygen acids, and as associating the new acid with the similarly constituted acid of chlorine; but I feel that in naming the nitrous-oxide acid regard ought to be had to the possible existence of salts of nitric oxide, in which several chemists have believed, indeed, and on better evidence, I think, after a perusal of some of their papers, than is generally supposed. Now, if the nitric-oxide acid should be discovered, and if the term "hyponitric" is to be retained for the acid intermediate to the nitrous and nitric acids, the term "hyponitrous" would belong by analogy to the nitric-oxide acid rather than to the new acid.

This difficulty, however, will vanish if the term hyponitric be allowed to fall out of use and that of nitroso-nitric, already adopted by several chemists, be generally substituted for it as the name of the nitrogen-peroxide acid; for then, the term "hyponitrous" being given to the new acid, there remains the compound term "hyponitroso-nitrous" for the nitric-oxide acid, should this acid ever be obtained.

There will thus be the following series of names:—

Hyponitrous acid	.....	HNO
Hyponitroso-nitrous acid	.....	H ₂ N ₂ O ₃
Nitrous acid	.....	HNO ₂
Nitroso-nitric acid	.....	H ₂ N ₂ O ₅
Nitric acid	.....	HNO ₃

If, however, the terms "hyponitrous" and "hyponitric" are to be retained for the second and fourth members of the above series, the term "hydro-nitrosylic" may serve for the new acid, according to its constitution:—

Hydrogen.	Nitrosyl.
H	NO

I am at present engaged in the further study of this interesting acid and its salts, and hope, before very long, to have the honour to make known the obtained results to the Society.

ADDENDUM, April 26, 1871.

When the above paper was presented to the Royal Society I was not

aware that the action of sodium amalgam upon alkali nitrites had been recently investigated by M. Fremy* and M. Maumenét†, neither of whom, however, have anticipated me in the discovery of the new class of salts here described. The latter chemist finds that in one set of circumstances this action gives rise to a body allied in composition and properties to oxyammonia, and in another only to ammonia. M. Fremy finds that it produces oxyammonia, nitrogen which escapes, and nitrous oxide which remains in solution.

So far as I have since been able to experiment, I have found that, by proceeding in different ways, a very small and variable amount of oxyammonia, or a substance resembling it, is often obtained along with the sodium hyponitrite, which is always formed in material quantity; and, further, that, under the circumstances which favour the formation of oxyammonia, there are also obtained, together with nitrous oxide, the products of the decomposition of oxyammonia by alkalis—nitrogen and ammonia (Lossen). The presence of oxyammonia in the product of the action of sodium on sodium nitrate affords a more satisfactory explanation than that I have given of the darkening of the silver-salt after precipitation which I have sometimes observed to occur.

M. Fremy states that alkali nitrites do not decompose potassium permanganate; and I now find that my assumption to the contrary is an error, based on an observation of considerable interest, which is that some good commercial nitrite in my possession slowly reduces the permanganate. I have since ascertained that other samples of sodium nitrite have no action on the permanganate, and that the one which does react with it behaves also with copper- and lead-salts in such a way as to render very probable the presence in it of a minute quantity of my new salt. This formation of hyponitrite, by heating sodium nitrate, if it does really take place, is in accordance with Hess's observations of the action of heat on barium nitrate, and with mine on silver nitrite.—E. D.

III. "Research on a New Group of Colloid Bodies containing Mercury, and certain Members of the series of Fatty Ketones." By J. EMERSON REYNOLDS, Member of the Royal College of Physicians, Edinburgh, Keeper of the Mineral Department, and Analyst to the Royal Dublin Society. Communicated by ROBERT H. SCOTT, F.R.S. Received January 19, 1871.

Introduction.—About ten years ago, when engaged in the examination of some of the constituents of the rectified wood-naphtha of commerce, I observed that moist and freshly precipitated mercuric oxide was dissolved by the naphtha in the presence of potassium hydrate, and that the resulting alkaline solution possessed highly characteristic properties. It was ascer-

* Comptes Rendus (1870), vol. lxx. pp. 66 & 1208.

† Ibid. p. 149.