CLASSICS OF SCIENCE: Smithson the Chemist

Chemistry

The founder of the Smithsonian Institution, who died one hundred years ago this week, was one of the cleverest chemists of his time. There is a story that he once caught part of a tear as it rolled down a lady's cheek and analyzed it, proving that it contained several salts, but chiefly "muriate of soda." The test for chlorine here given refers to such an analysis.

ON THE DISCOVERY OF ACIDS IN MINERAL SUBSTANCES. By James Smithson. From Thomson's Annals of Philosophy, Vol. XXI; New Series, Vol. V, 1823, *page* 384.

April 12, 1823.

Sir: Acids, it is well known, have been repeatedly overlooked in mineral substances, and hence dubiousness still hovers over the constitution of many, although they have formed the subjects of analysis to some of the greatest modern chemists.

To be able to dissipate all doubts —to ascertain with certainty whether an acid does or does not exist, and, if one is present, its species, and this with such facility that the trial may be indefinitely renewed at pleasure, and made by all, so that none need believe but on the testimony of his own experiments, is the degree of analytical power which it would be desirable to possess.

So far as I have gone in these reports, I here impart.

As the carbonates of soda and of potash precipitate all the solutions of earths and metals in acids, so do they decompose all their salts by fusion with them. Fusion with carbonate of soda or potash affords there a general method of separating acids from all other matters.

Lead forms an insoluble compound with all the mineral acids except the nitric. It may consequently be immediately known whether a mineral does or does not contain an acid element by the carbonate of soda or potash, with which it has been fused after saturation by acetous acid, forming or not forming a precipitate with a solution of lead.

If the production of a precipitate proves the presence of an acid, the determination of its species will present no great difficulty.

1. *Sulphuric Acid.*—If the alkali which has received it from the mineral is fused on charcoal, and then laid in a drop of water placed on silver, a spot of sulphuret of silver will be produced, as I have stated on a former occasion. Bright copper will likewise serve for this purpose.

Fusion in the blue flame will often be sufficient to deoxidate the sulphur.

It is needless to observe that the alkali used in this trial must itself be perfectly free from sulphuric acid. When such is not possessed, its place may be supplied by Rochelle salt, or by cream of tartar.

2. *Muriatic Acid.*—I have likewise discovered a test of chlorine, and consequently of muriatic acid, of delicacy equal to the foregoing. If any matter containing chlorine or muriatic acid is laid on silver in a drop of solution of yellow sulphate of iron, or of common sulphate of copper, a spot of a black chloride of silver, whose colour is independent of light, and which has not been attended to by chemists, is produced. The chlorine in a tear, in saliva, even in milk, may be thus made evident. When the quantity of chlorine in a liquor is very small, a bit of sulphate of copper placed in it on the silver is preferable to a solution. To find chlorine in milk, I put some sulphate of copper to it, and placed a small piece of bright silver in the mixture.

3. *Phosphoric Acid.*—The alkali containing it, after saturation by acetous acid, gives a sulphur-yellow precipitate with nitrate of silver, which no other acid does. The precipitate obtained with lead crystallizes on the blow-pipe. M. Berzelius's elegant method of detecting phosphoric acid is universally known.

4. *Boracic Acid.*—Its presence in carbonate of magnesia, and in some other of its compounds, is indicated by the green colour they give, during their fusion, to the flame of the lamp.

M. Gay-Lussac has observed that a solution of boracic acid in an acid changes the colour of turmeric paper to red, like an alkali. Borax, to which sulphuric acid has been put, does so, and the same is of course the case with a bead of soda containing boracic acid.

The most certain test of boracic acid in a soda bead, &c., is to add sulphuric acid to it and then spirit of wine, whose flame is coloured green, if boracic acid is present.

5. *Arsenical Acid.*—Alkali containing it produces a brick-red precipitate with nitrate of silver.

6. *Chromic Acid.*—Chromate of soda and its solution are yellow, and so is the precipitate with lead. That with silver is red.

Chromate of soda or potash fused on a plate of clay leaves green oxide of chromium.

Chromate of lead fused on a plate of clay produces a very dark-green mass, which is probably chromate of lead; with an addition of lead, it forms a fine red, or orange glass.

Lead added to the green oxide left by chromate of soda on the clay plate, dissolves it, and forms an orange-coloured glass.

The green oxide of chromium sometimes acts the part of an acid. I have seen a combination of it with oxide of lead found in Siberia, in regular hexagonal prisms, having the six edges of the terminal face truncated (Haüy, pl. lxviii. fig. 63); melted with lead on the clay plate this would undoubtedly produce the orange glass; and fused with nitrate of potash it would form chromate of potash.

7. *Molybdic Acid.*—If molybdate of soda or potash, or, I apprehend, any other molybdate, is heated in a drop of sulphuric acid, the mixture becomes of a most beautiful blue colour, either immediately, or on cooling.

The solution of molybdate of soda in sulphuric acid affords with martial prussiate of potash, a precipitate of the same colour (*Turn to next page*)

Wood Studies May Reduce Losses

Chemistry

No pampered child of the idle rich can claim to receive the tender care given to living wood-rot organisms at the Forest Products Laboratory. Ira Hatfield studies these little plants under the microscope in an attempt to discover some weakness in their life habits which might enable mankind to exterminate them effectively in trees, timber, or wooden structures.

Like children, decay organisms can not exist without water, food, warmth and air. Wood is the food element and water is the life element easiest to control. That is why Mr. Hatfield is singling out pure strains of the wood-decaying organisms and rearing them under conditions which are as superior to those surrounding the rich man's baby as the baby's environment is superior to that of an alley cat.

"If my observations can determine the least amount of water wood rot can thrive on or the most water it will tolerate," Mr. Hatfield said, "we will then be able to stop decay and rot in wood either by drying the wood until the wood-rot organisms die of thirst or by soaking the wood until the organisms drown."

The organisms at the laboratory must have just as much air as they would have in any lumber yard and there must be absolute assurance that undesirable alien spores of other organisms are not gaining access to the wood on which the pure wood-rot organisms are growing.

In Mr. Hatfield's series of tests the temperature of the growing decay organisms is maintained by incubator. An elaborate ventilation system, which employs both chemical and mechanical means, relieves the air supply of carbon dioxide and excess moisture. A chemical solution detains all the undesirable decay spores which are universally present in the laboratory air as they are everywhere. By means of one chemical solution through which it passes the humidity of the air—and correspondingly the moisture in the wood—is controlled to a fraction of a per cent. The growth of the wood-rot organisms under the artificialy controlled moisture conditions is measured, not by crude physical methods, but by measuring the amount of carbon dioxide given off, just as the work done by an athlete on a physician's treadmill is measured by the amount of carbon dioxide he exhales.

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Smithson the Chemist—*Continued*

that copper does. Tincture of galls gives with this acid solution a green precipitate; but with an alkaline solution of molybdic acid galls produce a fine orange precipitate. If an alkali is put to the green precipitate, it becomes orange; and if an acid to the orange precipitate, it becomes green.

8. *Tungstic Acid.*—If tungstate of soda is heated with sulphuric acid, the granules of precipitated tungstic acid become blue, but not the solution; and the phenomena cannot be confounded with those presented by molybdate of soda. Martial prussiate of potash has no effect on this acid liquor.

Tincture of galls put to the solution of tungstate of soda in water does not affect it. On the addition of an acid to this mixture, a brown precipitate forms.

If tungstate of soda is heated to dryness with a drop of muriatic acid, a yellow mass is left. On extracting the saline matter by water, yellow acid of tungsten remains. It is readily soluble in carbonate of soda. If taken wet on the blade of a knife, it soon becomes blue. This is made very evident by wiping the blade of the knife with a bit of white paper. Possibly a small remainder of muriatic or sulphuric acid among it is required for this effect.

9. *Nitric Acid.*—Nitrate of ammonia produces no deflagration when filtering paper, wetted with a solution of it and dried, is burned; the salt volatilizing before ignition, most, or all, the other nitrates deflagrate.

If metallic copper is put into the solution of a nitrate, sulphuric acid added, and heat applied, the copper dissolves with effervescence.

10. *Carbonic Acid.*—It is to be discovered in the mineral itself. The application of heat is, in some cases, required to render the effervescence sensible. It has been sometimes overlooked in bodies from want of attention to this circumstance.

11. *Silica.*—A simple and sufficient test of it is the formation of a jelly, when its combination with soda is put into an acid.

It has evidently not been intended to enumerate all the means by which the presence of each acid in the soda bead could be perceived or established. Little has been said beyond what appeared required and sufficient.

Mention has been made above of small plates of clay.

They are formed by extending a white refractory clay by blows with the hammer, between the fold of a piece of paper, like gold between skins. The clay and paper, are then cut together with scissars into pieces about 4-10ths of an inch long, and 2½-10ths of an inch wide, and hardened in the fire in a tobacco-pipe.

They are very useful additions to the blowpipe apparatus. They admit the use of a new test, oxide of lead. They show to great advantage the colours of matters melted with borax, &c. Quantities of matter too minute to be tried on the coal, or on the platina foil, or wire, may be examined on them alone, or with fluxes. Copper may be instantly found in gold or silver by fusing the slightest scrapings of them with a little lead, etc.

Cut into very small, very acute triangles, clay affords a substitute for Saussure's sappare.

James Smithson (1765-1829) was well known as an analytical chemist during his lifetime. He was an intimate friend of Cavendish and much admired by Berzelius, but his chief fame today comes from his will, which started a new fashion in philanthropy. After providing for his servants and leaving his fortune to his nephew, Smithson added, apparently as an afterthought, that if his nephew died without issue the money should go to the United States to found in Washington an institution called the "Smithsonian" for the "increase and diffusion of knowledge among men." The nephew died in 1836, and Congress passed an act accepting Smithson's bequest. Richard Rush went to England, saw the case through the courts, and brought the money, amounting to about half a million dollars, to the United States in the form of gold sovereigns. The sovereigns were taken to the United States mint and recoined into American eagles. Part of the fund was later loaned to some of the new states of the union, and lost, but Congress accepted responsibility for the full amount of the bequest, the interest furnishing the income of the Institution. After much discussion it was decided that a library, a museum, an art gallery, lectures, printed publications and reports, and rewards for important scientific advances all come within the scope of Smithson's phrase. Much of the scientific work of the United States government owes its origin to the work of the Smithsonian Institution.

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