THE APPLICATIONS OF CHEMISTRY TO THE ARTS: TAKEN FROM THE LECTURES OF PROFESSOR RENWICK, PP. 3-75

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THE

APPLICATIONS OF CHEMISTRY

TO

THE ARTS.

TAKEN FROM THE LECTURES OF PROFESSOR

RENWICK.

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I.

ACIDS OF COMMERCE.

1. SULPHURIC ACID. $S + 3O + (H + O)$.

Sulphuric acid was originally known as oil of vitriol; it was prepared from metallic sulphates (vitriols) by a high heat. The acid thus prepared, was impure; after the chemical composition of the acid was discovered, it was attempted to make it by the direct union of the elements, and as this could not be effected by simple combustion, it was proposed to burn the sulphur in contact with a body abounding in oxygen, and easily decomposed. The substance chosen for this purpose was *nitre* (Nitrate of Potassa), instead of which however, the Nitrate of Soda is now used. When this plan was carried into practice, it was not only found successful, but a less quantity of nitre was required than appeared to be necessary from its chemical constitution. The proportions now used are, one part of nitre to eight of sulphur. The process was originally performed in globular vessels of glass; these were expensive, and the quantity of gas obtained small. The process is now performed in chambers lined with sheet lead. Upon this metal, sulphuric acid and its vapor have but little action, and its sulphate when formed is insoluble, and takes the shape of a crust upon the metal. The form of the chamber is slightly inclined towards one corner, and is covered with water to the depth of three or four inches; the mixture is placed in an iron vessel, which is mounted on a carriage, and when the sulphur has been ignited, the carriage is shoved through a small door in the side of the chamber. When the combustion is completed, the water is found to contain sulphuric acid. To obtain this acid, the water is evaporated by heat. The evaporation is commenced in open vessels of lead, but cannot be completed in consequence of the great attraction between sulphuric acid and water. The process is therefore completed in close vessels, or retorts of glass, set in an iron vessel in a bed of sand. These retorts are liable to break, because the last portions of the vapor of water collect in large bubbles in sulphuric acid. The risk may be somewhat lessened by placing strips of platinum in the retort; but it is better to substitute retorts of platinum for glass. That the latter have not come into general use, is owing to their high price, but after allowing sufficient profit for the capital thus invested, sulphuric acid can be afforded cheaper, when platinum is used.

Other improvements have been made in the process, the most recent of which have been founded upon the chemical principles involved, which are as follows: when a mixture of sulphur and nitre is deflagrated in dry atmospheric air, sulphurous acid and deutoxide of nitrogen are generated, the latter is immediately converted into nitrous acid gas, and the two acids remain without acting upon each other, unless moisture be present; but if the air be mixed with vapor, the two acids and water unite to form a white crystalline solid, which falls into the water that covers the floor of the chamber. As soon as this solid touches the water it is decomposed; the sulphurous acid takes two equivalents of oxygen from the nitrous acids, is converted into sulphuric acid, and the nitrous acid is converted into deutoxide of nitrogen; this escapes in the form of gas, and if it meet with sulphurous acid, vapor of water, and oxygen, the process will be repeated. Thus it happens that no more of either nitrate is absolutely necessary, than is just sufficient to cause the process to begin.

The first attempt at improvement consisted in rendering the process perpetual; for this purpose the iron vessel was placed at the lower end of a cylinder of sheet lead, inserted in the floor of the chamber. Beneath the vessel a furnace was built, in which a sufficient heat was generated to cause the sulphur to take fire; and as the sulphur was consumed, a fresh supply of air was introduced.

In order to admit atmospheric air, valves were arranged for the escape of the foul air and the admission of fresh. To supply the necessary vapor of water, a small boiler was provided, whence steam flowed continually into the chamber. The high price of nitre led to the use of the nitrate of soda; but at present, sulphuric acid is manufactured, without the use of either nitrates. As a substitute, a mixture of nitric acid and molasses is placed in a platinum dish, which is supported by an iron tripod upon the iron vessel in which the sulphur is burnt. By the action of those two substances, oxalic acid is formed, and deutoxide of nitrogen is liberated. The oxalic acid is as yet of more value than the materials from which it is obtained, so that the whole cost of the nitrate is saved.

Besides the common sulphuric acid, another kind is manufactured in Germany, which is a solution of the solid anhydrous acids ($S + 3\ O$) in the liquid acid. The process by which it is manufactured is kept secret. It is chiefly employed in dissolving indigo. This kind of sulphuric acid might be prepared in the following manner: expose protosulphate of iron to a heat sufficient to drive off its water of crystallization; place the powder in a retort, and expose it to a heat sufficient to decompose it; pass the vapor through vessels containing the common acid.

Sulphuric acid is perhaps the most important of all substances in the chemical arts. By means of it nearly all the other acids are prepared, and by its action a great number of other substances are obtained. The raw material, although obtained in large quantities from metallic sulphurets, is chiefly furnished from Naples and Sicily; the government of which countries possesses a control over the arts of others, and a change in the manner of disposing of it was nearly the cause of war between France and England.

2. NITRIC ACID. $N + 5\ O + (O + H)$.

Nitric acid has long been prepared from sulphur and nitre in glass vessels. To obtain it in larger quantities, the nitre was decomposed by means of the alumina contained in clay, in large earthen vessels. At present, nitric acid is prepared by the action of the two first-named substances, in an apparatus of the following description. Open cylinders of iron are built into walls, by means of which a furnace is formed; each cylinder is provided with two heads of cast-iron; these heads have passages formed in them in an inclined position; one of the heads being set in its place, the condensing apparatus is connected with the passage. The cylinder is then charged with nitre, and the other head is inserted. To the passage in the latter head, a leaden funnel, whose tube is bent into three branches, is adapted; this funnel serves for the introduction of the sulphuric acid. The condensing apparatus is composed of a number of three-necked bottles (CHEMISTRY, p. 166). Water is placed in only one of these vessels, because nitric acid has the liquid form; in order that the acid shall be free from nitrous acid gas, an excess of nitre should be used.

The prepared nitric acid may contain some of the sulphuric acid, and if the nitre be not pure, muriatic acid may also be present. Sulphuric acid may be separated by nitrate of baryta; muriatic acid, by nitrate of silver; pure nitric acid remains.

3. MURIATIC ACID. Cl + H.

Muriatic acid was also prepared on a small scale in glass vessels. It is at present prepared in an apparatus composed of iron cylinders, and three-necked bottles, similar in general character to that used in the manufacture of nitric acid.

The solid material is common salt, the liquid material sulphuric acid. The three-necked bottles contain water.

The purest acid is found in the middle bottles of the series. Those nearest to the distilling apparatus contain some sulphuric acid; and those most distant contain a weak acid, which is used in a subsequent process for filling a part of the bottles. The residuum of the manufacture of these two acids is sulphate of soda. This is now employed in the manufacture of carbonate of soda; and the quantity of the latter subtance, which is required in the arts, is so great that the process last described is often carried on for no other purpose than to obtain the sulphate of soda. In this case the muriatic acid is not collected, but is condensed in a subterranean passage through which a stream of water flows.

4. PYROLIGNOUS ACID.

Pyrolignous acid is prepared by the distillation of wood in iron cylinders. Charcoal is left in them; and this process is often connected with the manufacture of gunpowder, for which this charcoal is peculiarly adapted. The decomposition of wood, besides condensible matter, furnishes the gaseous compounds of carbon and hydrogen; and these are conveyed from the condensing apparatus to the furnace, where they burn and thus serve as fuel. The condensing apparatus is on the principle of Woolf's; but is composed of wooden vessels, connected by wooden pipes. In these the acid is collected, being a combination of water, acetic acid, and several liquid carburets of hydrogen, which are rendered capable of mixing with the water by that acid. Pyrolignous acid is used in its original state in preserving meat; it is also employed as a source of acetic acid, which in its turn, is converted into a substitute for vinegar. For the process in which acetic acid is prepared, *see* CHEMISTRY, p. 318.

To make vinegar, the concentrated acetic acid is mixed with sixteen parts of water and one of alcohol.

II.

HYDROGEN.

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1. AEROSTATION.

Balloons were originally filled with heated air, a supply of which was kept up by a fire of straw. They are now filled with hydrogen gas.

The joint weight of the balloon and the hydrogen gas it contains, may be so much less than that of an equal bulk of atmospheric air that the vessel will not only rise, but carry a considerable weight with it. Gold-beaters' leaf may be used to make balloons of a small size.

Balloons of larger size are made of silk, rendered impervious to air by a varnish (India-rubber varnish).

The silk is cut into gores, which are sewed together; the balloon, when distended, has the shape of a sphere or spheroid. One point of each gore being cut off, a circular opening is left in the upper part. At the other end, the gores are produced in the form of ribbon-shaped strips; and these, when sewed together, form a tube. To the circular opening is adapted a valve, made by stretching silk over a hoop of rattan or whalebone Atmospheric air is removed from the balloon by compressing it; the balloon is filled from a gasometer, which is usually constructed by inverting one wooden tube within another. The hydrogen is usually prepared by the action of a dilute sulphuric acid on iron filings. The latter substance is placed in barrels, which are then closed by heads. In each head are inserted two pipes. One of these has a funnel at the top, and reaches nearly to the bottom of the barrel; the other barely enters the barrel, and is long