teristic and unpleasant. Chloride of sulphur is decomposed by water, alcohol, ether (see Chemistry) ; and benzol and bisulphide of carbon mix with it in all proportions without decomposition. A mixture of 100 parts of bisulphide of carbon and some 2·5 of chloride of sulphur is used for the vulcanization of (chiefly sheet) india-rubber. The mixture is readily imbibed by the rubber, which when allowed to dry (at from 22° to 25° C.) gives up the bisulphide of carbon and the chlorine of the reagent, the latter as HC1, but retains its sulphur in a state of chemical combination.

The gas SO2 (see Chemistry, vol. v. p. 501), produced extempore by the combustion of sulphur, is used for the bleaching of silk, wool, straw, and wicker work, also for the disinfection of rooms and of wine-casks (to prevent acetous fermentation). A solution of the gas in water is manufactured industrially, for use chiefly in the manufacture of sugar. It is added to the beetroot or cane juice to prevent its fermentation while awaiting concentration. A solution of “bisulphite of lime” (produced by saturating milk of lime with sulphurous acid gas) is much used as an antiseptic generally. Liquefied sulphur dioxide has found an application as a frigorific for the manufacture of ice. The apparatus used is so constructed that the volatilized sulphur dioxide is all caught and recondensed. Sulphurous acid when required as such or for the making of sulphites is always produced, even industrially, from oil of vitriol, by reduction with either sulphur or charcoal. In the heat the reactions are 2SO3 + S=3SO2 and 2SO3 + C = CO2 + 2SO2 respectively, and either can be (and is) executed practically in cast- iron vessels. The presence of carbonic acid in the gas produced by the charcoal process does not interfere with the preparation of sulphites.

The soda salt Na2S2O3 + 5H2O, known commercially as hypo­sulphite of soda, is used industrially for chiefly two purposes, namely, (1) as a solvent for chloride of silver in photography (se Photography),—AgCl + Na2S2O3=NaCl + AgNaS2O3,—and (2) as an “antichlor” in paper-making, to destroy the remnants of chlo­rine in bleached paper pulp. To understand its action we need only know that chlorine and water in such cases act like oxygen,— Cl2 + H2O = 2HCl + O ; every 4 × 0 thus produced converts one S2O2 of Na2OS.2O2 into 2SO3 of sulphuric acid. For the preparation of this salt a great many methods have been invented. The simplest to explain is the treatment of a solution of normal sulphite of sodium with sulphur,—SO3Na.2 + S = S2O3Na2. Instead of adding free sulphur, Liebig prepares a solution of polysulphide of sodium (by dissolving sulphur in caustic-soda ley) and adds it to the sulphite. The surplus sulphur combines with the sulphite ; besides, the poly­sulphide contains thiosulphate from the first. Another method is to pass sulphurous acid through a solution of sulphide of sodium. Here, by first intention, if we may say so, sulphite of sodium and H2S are produced ; but the H2S and the excess of SO2 give water and sulphur, and two-thirds of this sulphur unite with the sulphite first formed into thiosulphate. The crude sulphide of calcium, which is produced so largely in the Le Blanc process (see Sodium, *supra,* p. 243), when exposed to the air gets oxidized, with forma­tion of calcium thiosulphate, which can be extracted by means of water and converted into sodium salt by double decomposition with carbonate or sulphate of soda. Pure thiosulphate of soda forms large transparent monoclinic prisms, which lose no water on exposure to ordinary air in the cold. At about 48° C. they fuse into a liquid, which may remain liquid on cooling, but solidifies sud­denly when a fragment of the solid salt is dropped in. 100 parts of water dissolve

at 16° 25° 35° 45° C.

65 75 89 109 parts of the salt (Mulder).

The solution is not subject to oxidation in the air.

The anhydride SO3 is used largely in the manufacture of tar colours. Oil of vitriol is decomposed by dropping it on a mass of platinum scrap kept at a bright red heat within a fireclay retort, —SO4H2 = H2O + SO2 + 1/2O2 ; and, after removing the water—the bulk by partial condensation aud the rest by means of vitriol—the sulphur dioxide and the oxygen are made to recombine by passing them over platinized asbestos at a dull red heat. The fumes of SO3 formed are condensed in a dry receiver by application of cold from without (Winkler’s process).

The fact that finely divided platinum, in virtue of its power of condensing oxygen, induces the union of SO2 and 1/2O2 into SO3 has been known for a long time ; but all attempts to utilize the reaction for the production of sulphuric acid from a mixture of sulphur dioxide, air, and nitrogen produced by the combustion of sulphur or pyrites in air have failed. The platinum acts too feebly in the presence of the unavoidably large mass of nitrogen, and soon loses its efficacy altogether owing to the accumulation on it of particles of incombustible matter from the kiln gases. Oxide of chromium, Cr2O3, and oxide of iron, Fe2O3, act like platinum, through transi­tory formation of the respective sulphates—the gases produced in pyrites kilns include a considerable quantity of ready-made SO3 —but they also are not available practically for the making of sul­phuric acid. In short, all attempts to produce this reagent other­wise than by means of the old Nordhausen or the chamber process

have so far been unqualified failures industrially. In regard to the chamber process we may add a few notes to what has been said under Chemistry (vol. v. p. 503 *sq*.). As stated in that article, nitrous acid, N2O3, when brought into contact with sufficiently strong vitriol unites with it, giving rise to bodies similar to chamber crystals,— + + 2gθ^ = 2SO2θ-θ ;

or, what comes practically to the same,

N2O3 + SO3(out of the vitriol) = S02yθ2.

In the presence of sufficient water this union does not take place, because the water causes the product to break up as shown by the equation if read from right to left. These facts explain why a stronger acid than one containing some 60 per cent. or so of real H2SO4 cannot be produced directly in the chamber. This incon­venience has led, in the hands of Gay-Lussac, to an important improvement on the original process. He inserts between the chamber outlet and the chimney a tower made of acid-proof stone and filled with pieces of coke, over which concentrated oil of vitriol is made to trickle down while the chamber gases ascend through the tower on their way to the chimney. The vitriol absorbs all or most of the N2O3, which would otherwise be lost. But the practical reliberation of the N2O3 was beset with very great difficulties, which have been fully overcome only by a more recent invention of Glover’s. He places between the kiln and the entrance side of the chamber a tower similar in construction to Gay-Lussac’s, which the kiln gases have to traverse before they get into the latter. Through the tower he runs at the same time a stream of nitrated (Gay-Lussac) acid and one of ordinary chamber acid. The latter acts on the nitrated acid as water ; at least it virtually sets free the combined nitrous acid, so that it is reduced by the sulphurous acid coming from the kiln to nitric oxide, which travels into the chamber with the rest of the gases to do duty there in the well-known manner. As the kiln gases are very hot, a considerable quantity of the water which goes through a Glover tower (as chamber acid) is volatilized and thus made to supply part of the steam necessary for the process. The Glover tower, besides fulfilling its primary object, serves to concen­trate part of the chamber acid and to supply part of the neces­sary steam without expense for fuel. The expenditure of nitrate of soda, which before the introduction of the two towers used to amount to from 8 to 13 parts per 100 of sulphur burned, has been reduced to from 3·5 to 6·5. The actual loss of nitrous acid of course is the less, *cæieris paribus,* the larger the chamber, and (for a given chamber) the greater the care with which the process is conducted. But even under the most skilful management more nitrous acid is lost than can be accounted for by the unavoidable imperfections in the apparatus and in the mode of working them. From the in­vestigations of Weber and of Frémy it appears that, in the presence of relatively much water more especially, part of the nitrous acid suffers reduction, not to nitric, but to nitrous oxide, N2O, which, being unsusceptible of direct oxidation, is lost for the process.

For a great many purposes *(e.g.,* the manufacture of “superphos­phate ” from bones or mineral phosphate of lime) the 60 to 64 per cent. acid which comes out of the chamber can be used as it is ; but it is not strong enough for all purposes. In the production of stronger (from chamber) acid the first step always is to run the acid into long, very shallow lead pans and to simply boil it down in these, either by the application of heat from below, in which case the bottoms of the pans must be protected by making them rest on plates of iron, or by enclosing the pans in a vault and causing the Hot gases of a furnace fire to strike along the surface of the acid. The result in either case is that, while more and more water goes away as steam, the residual acid of course gets stronger and stronger. But with the strength the boiling-point rises, and, as necessary consequences, the extent to which the acid attacks the lead (with formation of sulphate and sulphurous acid) and the danger of melt­ing down the pans by local overheating become greater and greater. When the acid has come up to about from 78 to 80 per cent. (corresponding to a specific gravity of 1·7 after cooling), it is not safe to push the concentration any further, quite apart from the fact that an acid of 80 per cent. when boiled down emits a very appreciable proportion of acid along with the volatilized water. An acid of 1·7 indeed is amply strong enough for a variety of applications, such as, for instance, the conversion of salt into sulphate. If a stronger acid is wanted the concentration must be continued in glass or platinum retorts.

The vitriol maker’s glass retort, as a rule, consists of two detach­able parts, namely, a pear-shaped body about 31/3 feet high and nearly 2 feet in diameter, and a glass alembic whose wider end fits the mouth of the pear, while its narrower outlet end points down­wards and terminates within a slightly slanting lead-pipe, which conveys the distillate to a leaden tank. The retort rests on a layer of sand contained in a closely fitting iron basin, and the lateral space between the two is filled completely with sand. The iron basin is suspended within a furnace in such a way that only it, and not any part of the retort, is touched directly by the flame. As a rule, some twelve retorts stand side by side, each in its own