Sp. gr.	% $Na_2S_2O_3 \cdot 5\ H_2O$.	% $Na_2S_2O_3$.
1.0052*	1	0.637
1.0264	5	3.185
1.0529	10	6.371
1.0807	15	9.556
1.1087	20	12.742
1.1381	25	15.927
1.1676	30	19.113
1.1986	35	22.298
1.2297	40	25.484
1.2624	45	28.669
1.2954	50	31.855

Sodium thiosulphate solution dissolves the iodides and bromides of silver, mercury, and lead, forming soluble double salts.

It is largely used as an "anti-chlor" for bleached fibers and as a solvent for the silver bromide and chloride in photography.

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92. STANNIC CHLORIDE.

$SnCl_4$. M.W. = 260.

(*a*) Take of

Stannous chloride (crystals),	1000 gr.
Hydrochloric acid, 25° Tw. (sp. gr. 1.125),	1170 cc.
Nitric acid, 44° Tw. (sp. gr. 1.220),	435 "
Water,	1000 "

Put the stannous chloride into a 12-inch evaporating dish, and add the 1170 cc. of hydrochloric acid; warm on the steam bath, and stir until the salt is dissolved. Then dilute with 1 liter of hot water. If the solution does not remain clear, there is a deficiency of hydrochloric acid, in which case add very concentrated hydrochloric acid, a few drops at a time,

* H. SCHIFF, Ann. **113**, 188.

until the solution becomes clear. Add the nitric acid, a few cc. at a time, to the warm solution, stirring well after each addition. After a considerable part of the nitric acid has been added, test a few drops of the solution with a drop of mercuric chloride solution. If a white precipitate falls, stannous chloride is present, and more nitric acid is needed. $SnCl_2 + 2\ HgCl_2 = SnCl_4 + 2\ HgCl$. When no white precipitate falls, the oxidation is complete, and no more nitric acid should be added. Put the liquid product into a tightly stoppered bottle.

Reaction:

$$3\ SnCl_2 \cdot 2\ H_2O + 6\ HCl + 2\ HNO_3 = 3\ SnCl_4 + 10\ H_2O + 2\ NO.$$

Instead of using nitric acid, the stannous chloride may be treated with chlorine gas or with hydrochloric acid and potassium chlorate, in the proportions required in the following reactions:

$$SnCl_2 \cdot 2\ H_2O + Cl_2 = SnCl_4 + 2\ H_2O.$$

$$3\ SnCl_2 \cdot 2\ H_2O + 6\ HCl + KClO_3 = 3\ SnCl_4 + KCl + 9\ H_2O.$$

(*b*) For anhydrous stannic chloride:*

Heat 150 gr. of granulated or bar tin, in a tubulated retort, on the gas stove until melted, and lead a strong stream of dry chlorine gas into the retort through a glass tube which opens just above the surface of the melted tin. To the neck of the retort join a long condenser, which connects with two Wolff's bottles acting as receivers, and placed in a pan of ice-water to condense the volatile stannic chloride. Then distill the stannic chloride collected in the Wolff bottles, from a fractionation flask provided with a thermometer and containing some bits of tin foil. The distillate coming over between

* Bender and Erdmann, Chemische Präparatenkunde, 1, 435.

112–114° C. is pure; this should be collected in the glass-stoppered bottle in which it is to be preserved.

Reaction:

$$Sn + 2\ Cl_2 = SnCl_4.$$

Properties:

Stannic chloride is a colorless or faintly yellow liquid, which fumes on exposure to the air and boils at 114° C. When mixed with small quantities of water, crystallized salts, such as $SnCl_4 \cdot 3\ H_2O$ and $SnCl_4 \cdot 5\ H_2O$, are formed. These are very soluble in water. The dilute aqueous solution, when boiled, yields a precipitate of stannic acid, H_2SnO_3.

The specific gravity of the aqueous solution at 15° C. containing

2%	$SnCl_4 \cdot 5\ H_2O$	is	1.012.*
10%	"	"	1.059.
20%	"	"	1.124.
30%	"	"	1.195.
40%	"	"	1.276.
50%	"	"	1.366.
60%	"	"	1.468.
70%	"	"	1.587.
80%	"	"	1.727.
90%	"	"	1.894.
95%	"	"	1.988.

Stannic chloride solutions prepared as in (*a*) are largely used in the dyeing and printing of cotton and silk. It forms double salts with the alkali chlorides, which are easily crystallized; the most important of these is the stannic-ammonium chloride, formerly much used as a mordant under the name of "pink salt." Mixtures of stannic and stannous chlorides are found in commerce under such names as "tin spirits," "cotton spirits," "oxymuriate of tin," "pink-cutting liquor," etc.

* Gerlach, Dingl. J. **178**, 49.

93. STANNOUS CHLORIDE.

$SnCl_2 \cdot 2\,H_2O$. M.W. = 225.

Take of

Tin,	500 gr.
Hydrochloric acid, 36° Tw. (sp. gr. 1.180),	750 cc.

"Feather" the tin, as directed on page 86, and put into a deep beaker of at least 1200-cc. capacity, and add the hydrochloric acid in portions of about 75 cc. each. Heat gently until the reaction starts, and allow to stand, covered with a watch glass, on the steam table until the reaction moderates before adding the next portion. When about one-half of the acid has been added, let the beaker stand quietly, keeping it hot until all action ceases. Decant the solution of stannous chloride from the residue of tin, and add the remainder of acid as above directed. Heat on the steam bath until the tin is all dissolved, or the acid all neutralized. Allow to settle, and decant the liquid from any residue. Combine the two solutions, evaporate to a specific gravity of 1.985, and let the liquid cool in a covered evaporating dish. Drain the mass of crystals in a funnel covered with a watch glass. Dry in a desiccator over sulphuric acid, and bottle as soon as dry.

Care must be taken to protect the preparation from dust during the entire process, and to keep the vessels covered to exclude the air as much as possible. If filtration is necessary, use glass wool. No water should be added to the solution at any time, for turbidity may result, due to the formation of oxychloride of tin.

Reaction:

$$Sn + 2\,HCl = SnCl_2 + H_2.$$

Properties:

Stannous chloride forms colorless crystals with $2\,H_2O$, which are sold in commerce under the name of "tin crystals."

It is very soluble in water, dissolving in 0.37 parts of water at 15° C.

The specific gravity of the aqueous solution at 15° C. containing

5%	$SnCl_2 \cdot 2\ H_2O$	is	1.0331.*
10%	"	"	1.0684.
20%	"	"	1.1442.
25%	"	"	1.1855.
30%	"	"	1.2300.
35%	"	"	1.2779.
40%	"	"	1.3298.
50%	"	"	1.4451.
60%	"	"	1.5823.
70%	"	"	1.7452.
75%	"	"	1.8399.

The aqueous solution absorbs oxygen from the air and becomes turbid, owing to the formation of oxychloride, $3\ SnCl_2 + H_2O + O = SnCl_4 + 2\ SnCl(OH)$. The crystals also decompose in this way when exposed to the air. The oxychloride is dissolved by the addition of hydrochloric acid.

The salt is largely used in dyeing textile fabrics and somewhat as a reducing agent in analytical work. Commercial samples often contain arsenic, alkaline earths (magnesium, etc.), and sulphates.

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94. STRONTIUM CHLORIDE.

$SrCl_2 + 6\ H_2O$. M.W. = 266.

(*a*) Take of

Strontianite (powdered),	1000 gr.
Hydrochloric acid, 37° Tw. (sp. gr. 1.185),	1150 cc.
Strontium hydrate,	25 gr.
Water,	500 cc.

* GERLACH, Dingl. J. **186**, 131.