

THE MANUFACTURE OF SALT AT SYRACUSE, N. Y.

The famous salt region of Onondaga County, in the State of New York, has for over a century been a center for the production of this all-important substance. As long ago as 1770, salt from the salt springs then in existence was used by the Delaware Indians. Eighteen years later the white inhabitants began to make salt by the boiling process, near the site of the present city of Syracuse. The territory from which most of the salt is now produced is a government reservation whose status is established by a treaty made between the Onondaga Indians and the State of New York. The wells are maintained and the brine pumped by the State government, and the brine is delivered to the manufacturers at a royalty of one cent per bushel. The bushel is an arbitrary term indicating a net weight of 56 pounds or one half hundredweight. The wells, which are sunk and maintained by the State, vary from 150 to 340 feet in depth. Brine is pumped from them which at 60° Fah. averages 50° to 70° on the salometer. According to Dr. Englehardt's standard table of equivalents, these figures range thus :

Salometer	Baume	Per cent salt	Pounds salt in gallon	Gallons to 1 bushel
50°	13°	13.250	1.206	46.41
70°	18.2°	18.815	1.755	31.89

As a more appreciable standard it may be mentioned that sea water contains 2.7 per cent of salt and that it requires 350 gallons to make one bushel of salt.

Originally the tax or royalty was much higher than at present. At one time as much as twelve cents a bushel was charged the manufacturers. Since then it has been reduced, first to six cents, and finally, in 1846, to one cent per bushel. It is evident that at the higher rate a considerable revenue was derived from the wells. For the expense of building the Erie canal a sum of \$2,300,000 was appropriated from the salt royalty. This sum represents nearly one third of the expense of construction, so that the salt makers are justified in their claim that but for the salt industry the Erie canal might never have been made.

The salt deposits lie in rocks of the upper Silurian age. The old springs were found in the marshy ground surrounding Onondaga Lake. The waters of the lake are excluded from the salt-bearing strata by impervious marl and marly clay. The wells pass through beds of fine sand and clay. After penetrating these layers a gravel is reached which contains the salt water. The brine is pumped from the gravel beds into reservoirs, whence it is delivered through log piping to the different works.

In Fig. 1 of the illustration is shown a pumping station and reservoir.

The Onondaga brine contains several impurities. The principal is calcic sulphate, more familiar in the form and under the name of gypsum or plaster of Paris. This runs as high as one half of one per cent referred to the brines, representing, therefore, two or three per cent of the dissolved salts. Calcium and magnesium chlorides, with traces of carbonic acid and oxide of iron, are also present. The iron oxide is only objectionable as spoiling the color of the salt, but owing to this its removal is imperative. The calcium and magnesium chlorides are deliquescent. Fortunately they exist in small proportions only in the brines. If in large quantity, they would make the salt moist and give it a tendency to cake, and eventually to become almost liquid. The calcium sulphate is not nearly so soluble as the other salts, and is partly precipitated in the evaporation, and most of it is removed from the concentrated brine. It is obvious that any insoluble matter would be considered an impurity, so that the manufacturer tries to remove this compound as completely as possible.

The salt is obtained by evaporation, either by solar or by artificial heat. In either case the first operation is to clarify the brine by settling. It is allowed to stand in vats in the open air, as shown in Fig. 3, or in factory buildings until the iron oxide has settled and the carbonic acid has escaped or has become precipitated.

At this stage the settling is sometimes aided by the addition of a little milk of lime. Alum or gelatine has been employed or suggested also as a clarifier. Two successive settlings in such vats are applied.

In the next step of the solar process the clarified brine is run into evaporating vats, shown in Fig. 2, where it is acted upon by the sun's heat, and gradually becomes concentrated. Movable covers or roofs are provided to be placed over the vats in case of rain.

As it becomes stronger, the comparatively insoluble calcium sulphate begins to precipitate. The slow evaporation favors crystallization, and the salt begins to separate as large crystals, and is called "coarse salt." As soon as crystals begin to appear, the saturated brine called "salt pickle" is run off into a fourth series of vats for final concentration. As the crystals accumulate in sufficient quantity they are removed and are washed in the fresh pickle. The object of this is to remove the strong brine, which contains a concentration of the calcium and magnesium chlorides. The product is then allowed to drain, and when sufficiently

dry is removed to the storehouse. This is an outline of the process of making what is known as "solar salt."

Salt made by artificial heat is known as boiled salt. The term "factory filled" is applied to the purer brands. This term is indicated by the familiar letters F. F. branded on the large sacks. The kettle process, illustrated in Fig. 4, is largely used at the Syracuse works. The brine after settling and clarifying is run into kettles heated by fires underneath. An iron pan with an upright handle is placed in the bottom of each pan.

As the liquid evaporates and the gypsum separates, it accumulates in those pans, and is from time to time removed and thrown aside. This is termed "panning from the kettle." It is here that one essential difference between the solar and boiling process appears. Calcium sulphate or gypsum is less soluble in hot than in cold brine, so that a better separation of this impurity is effected than in the solar process. Each kettle has a capacity of 100 to 120 gallons, and fifty or sixty kettles may be set in a row. As soon as salt crystals begin to appear, the gypsum pan is removed and the salt is taken out by the workmen, is washed with fresh brine and is drained in baskets suspended over the kettles, as shown in the same cut. Brine is run in as required from the central distributing pipe.

The difference in grain in solar and boiled salt is considerable. The solar salt is so coarse that to adapt it for many uses it has to be ground in mills. This is done in the factories, and the product is known as "ground solar" salt. The boiled salt is of a much finer grain, and by the addition of some suitable substance to the kettles the grain may be made still finer. This process is termed "cutting the grain." Salt thus made is called "anthracite salt." The material added consists of traces of such matter as glue, resin, soap, etc. While the process has been known for many generations, it is condemned by many salt makers.

In Fig. 5 of the illustrations we show the modern washing process. The salt is delivered at one end of the apparatus through a chute. The brine enters at the same end and permeates the mass, and as the whole is kept in agitation the washing is very perfect. The salt saturated with the purer brine is drawn off and has to be dried. In the modern process this is done in centrifugal machines, one of which is shown in Fig. 6. There it is whirled around rapidly and the brine is expelled thoroughly by centrifugal force, exactly as sugar is treated for the expulsion of sirup. The separation is, of course, much more complete than where gravity alone is relied on, as in the draining process. When it is remembered that the calcium and magnesium chlorides are mainly present as ingredients of the residual brine, the importance of reducing the amount of this brine as much as possible is evident.

What the future of this historic industry will be is not absolutely certain. The expense of making boiled salt is largely due to the cost of fuel. The kettle process, which we have illustrated, although a relic of the last century, has not yet been superseded. Success has been attained in utilizing anthracite coal dust. Forty to forty-five bushels of salt are produced with the combustion of one ton of anthracite dust costing \$1.75. Some years ago but thirty-seven bushels were produced with the consumption of one ton of bituminous coal costing \$4.10. Yet this saving is offset by the fact that the evaporation per pound of fuel is only 5.83 lb. of water—less than half the work of a good steam boiler. One most serious menace comes from the West. Michigan, Ohio, and Kansas are now strong competitors with the New York works. There are two layers of rock salt, forty-five and fifty-four feet thick, seventeen miles south of Syracuse. These may be instrumental in changing the aspect of things in the near future.

The first leases in lots under the auspices of the State took place in 1797. The product for 1798 was 59,928 bushels of solar salt, under the superintendency of William Stevens. In 1889, under Superintendent P. J. Brummelkamp, 2,916,923 bushels of solar and 2,448,138 bushels of boiled salt, making an aggregate of 5,365,061 bushels, were produced. This is not high water mark. The following table gives the years of maximum production and the amounts produced :

Year.	Solar salt.	Boiled salt.	Total of both kinds.
1862.....	1,983,023	7,070,852	9,053,874
1868.....	2,027,430	6,630,126	8,657,556
1870.....	2,847,691	6,298,422	9,146,113
1871.....	2,464,404	5,910,492	8,374,896
1882.....	3,032,447	5,307,773	8,340,220

Since 1882 the production has constantly decreased. The State exercises a certain supervision over the manufacture. The salt, after making, must be stored at least two weeks before shipment. Before and after the storage period it is inspected by the State inspector. The product as delivered to the public is exceedingly pure. It is gratifying to know that it compares with the finest foreign product in freedom from objectionable magnesium and calcium compounds.

Positives Direct in the Camera.

Colonel Waterhouse's recent investigations, which have resulted in the discovery of a simple means for producing a positive image on an ordinary gelatino-bromide film—whether on paper or glass—and by the usual exposure in the camera, seems not unlikely to be the first step toward something like a revolution in photography. Indeed, when we consider the remarkable results obtained by adding extremely small quantities of certain derivatives of carbamide (urea) to the developer, it is difficult to suppose that the tourist—and perhaps even the professional photographer—will long fail to take advantage of so ready a means of securing reversed action, especially as the positive first produced can obviously be used for making subsequent copies by the same method, just as a negative is now used. A direct camera positive on paper or other opaque base will always be reversed unless some reflecting surface intervene between the object and the sensitive film.

In lieu of reflector, the *transparent* celluloid film may be used (not the celluloid roughened or ground on one face), and the originals thus obtained will show like enameled prints if the celluloid original is held or fastened face downward on a card or on the stiff leaf of an album; at the time, this original will always be available for the production of copies, not only by the gelatino-bromide reversal process, but also by such positive methods as the aniline method, the common blue process, or the primuline method.

Waterhouse's method involves no other variation from the usual routine than a simple addition to the developer, so that the final decision as to whether a negative or a positive shall be produced may be left to the last.

Of the two derivatives of thio-carbamide recommended by Colonel Waterhouse, our own experiments were made with a sample of allyl thio-carbamide.

Having prepared a saturated solution of water of the crystals of thio-sinamine—to use the shortest of the several names by which allyl thio-carbamide is known—to each ounce of ordinary pyrogallic or eikonogen developer we added from two to eight minims of the solution. Under these circumstances varying degrees of reversal resulted, ammonia appearing to be rather favorable to the reversal, and any considerable amount of bromide being evidently unfavorable. We failed to notice any advantage in giving more than a normal exposure; indeed, less than the normal exposure appears to be rather favorable than otherwise. This result is specially interesting, as to secure the best reversal by adding hyposulphite to the oxalate developer a long exposure is required—an exposure which may perhaps be estimated at over a hundred times the normal.

There is a wide field for experiment in connection with the method now touched upon, and although the best course for the present will probably be to thoroughly study the conditions under which the two agents described by Waterhouse will cause reversal with absolute certainty, it must not be forgotten that many analogous derivatives of thio-carbamide are known to chemists.—*Abs. from the Br. Jour. of Photography.*

Acidity of the Stomach.

This condition is due to germs, and the cure lies in getting rid of the germs. Germs of fermentation in the stomach produce first alcohol, then carbonic acid, and then acetic acid. A person troubled with this form of dyspepsia should be careful to take only such articles of food as do not favor the development of germs, and thus starve them out. Another thing to do is to wash the germs out of the stomach by drinking freely of hot water before meals. If food is put into a stomach already sour, of course fermentation will be set up immediately. Some persons notice that as soon as they eat, their stomachs become sour. The third important thing to do is to stimulate the stomach to make more gastric juice, which is a natural antiseptic, and prevents fermentation and also hastens absorption. The glands may be stimulated by applying hot fomentations to the stomach for half an hour immediately after the close of a meal, or, easier still, by wearing a rubber bag filled with hot water directly over the stomach for half an hour or an hour. Heat is a natural stimulant, and there are no possible ill effects from its use in this way.—*Good Health.*

The Massachusetts Institute of Technology.

This institute is now entering on its second quarter-century of existence. Its early history was excellently summarized in an address delivered last June at its twenty-fifth anniversary. It was founded by Prof. William B. Rogers, a native of Virginia, formerly director of the Virginia Geological Survey and Professor of Chemistry and Physics in the University of Virginia. After a hard struggle it began to be more prosperous, and in 1879 entered on its new career, with about 200 students. It now has about 1,000 students. Its present president, Gen. Francis A. Walker, was the superintendent of the census of 1880.

SCIENTIFIC AMERICAN

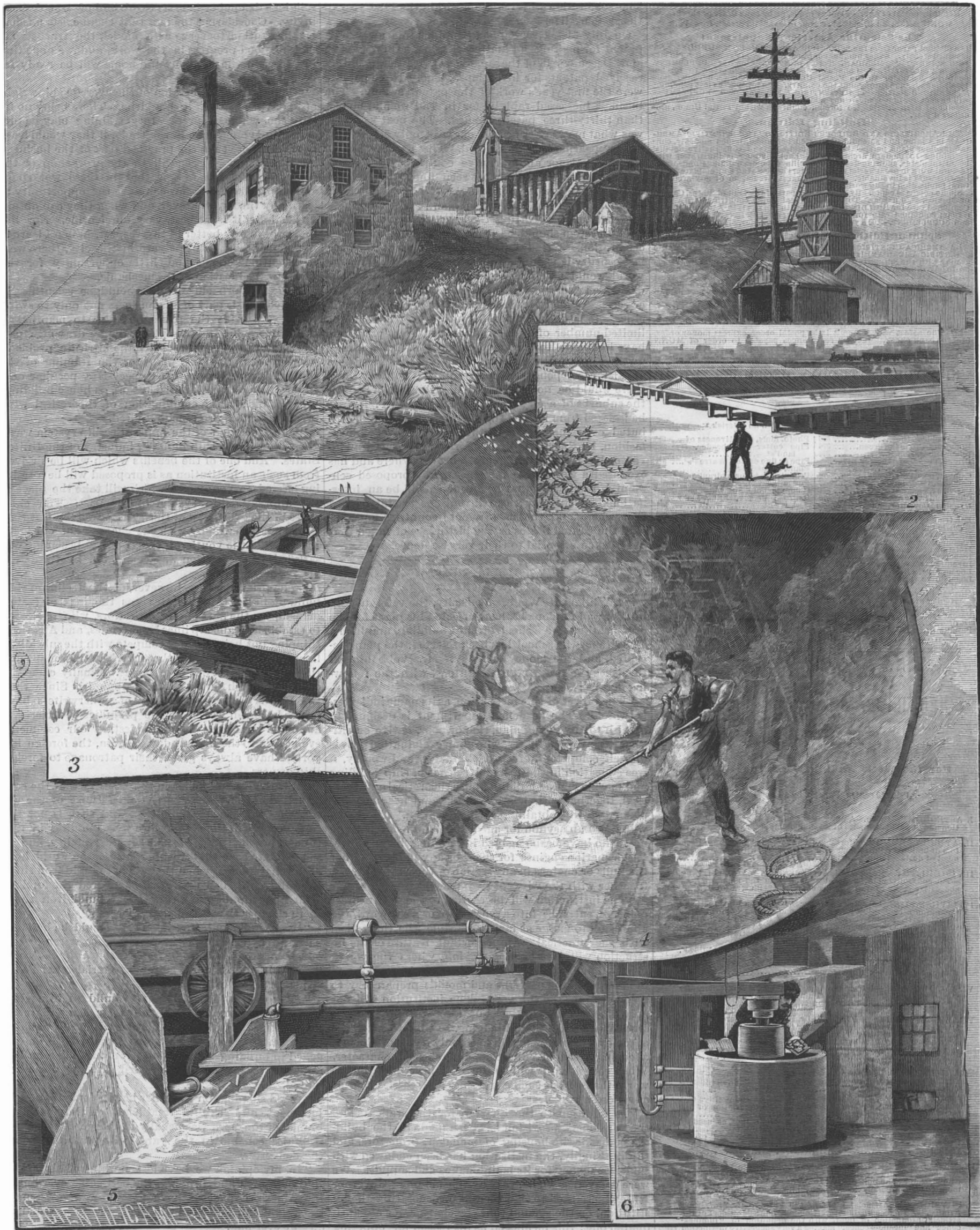
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A WEEKLY JOURNAL OF PRACTICAL INFORMATION, ART, SCIENCE, MECHANICS, CHEMISTRY, AND MANUFACTURES.

Vol. LXIII.—No. 24.
ESTABLISHED 1845.

NEW YORK, DECEMBER 13, 1890.

\$3.00 A YEAR.
WEEKLY.



1. New York State pumping station and reservoir. 2. Solar evaporation. 3. Settling vats. 4. Salt boiling in kettles. 5. Washing salt. 6. Centrifugal drier,

THE SALT INDUSTRY OF ONONDAGA COUNTY, N. Y.—[See page 373.]