WATER PURIFICATION AT COLUMBUS, OHIO.*

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Perhaps few cities in the world have had so difficult a public water-supply problem to solve as did the City of Columbus, Ohio. For years, it had been the practice to pump sewage polluted water from Alum Creek and the Olentangy and Scioto Rivers, into the distribution-system of the city. Even with these sources of supply, the quantity of water available, was not sufficient, and there was constant danger during the summer and fall months of a water famine.

As has been stated, the water was polluted with sewage, and was at times extremely muddy, and, as the water-sheds of the above-mentioned streams are underlaid with limestone rock, the water passing over and through this limestone was very hard. The hardness was so excessive that the water was not satisfactory for domestic or commercial uses. It would not lather freely with soap, and, when used for boiler-feed purposes, it was very injurious to the boilers, due to the large quantity of scale deposited on their tubes. The water was so impure, that severe epidemics of typhoid fever were of frequent occurrence, and Columbus was recognized as having perhaps as high a typhoid-fever death-rate as any large city in the United States. In 1904, just a year previous to the time that work was started on the improved water supply, the typhoid-fever death-rate of the city was 139 per 100,000, a disgrace to any American municipality.

After heavy rains, the water was so turbid or muddy that it was almost impossible to use it for any purpose. The reader will perhaps realize how muddy the river-water really is, by knowing that, after heavy rains, as much as one hundred and twenty-five tons of mud are removed from a day's supply of water before it is pumped to the consumer.

The Storage Dam:—In order to provide a sufficient quantity of water, a dam was built across the Scioto River about five miles above the city. This dam is a concrete structure 1006 feet long and thirty feet high. The reservoir formed by the construction of this dam, across the river, is 5.8 miles long, has an average width of 500 feet, and its capacity is 1,720,000,000 gallons.

The dam is located about 4.5 miles from the Purifying and Softening Works, and it was planned to build a gravity-conduit from it to the Purification Works but no money was appropriated for this work, therefore, the river is used as a conduit; the water flowing down the river from the dam to the Pumping Station. The water is then pumped from the river to the Purification Works, and is softened and filtered, then pumped into the distribution-system.

The Water Purification Works:—These are designed for softening as well as filtering the water, and on account of the extremely variable characteristics of the untreated water, great elasticity was sought in their operation.

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The plant comprises primarily:

1. A lime saturator, composed of six tanks, e twenty-five feet square, in which the chemical reactions begin.

2. Two Baffled Mixing-Tanks, each two hundred and four feet long, twenty-five feet wide and twenty feet deep.

3. A settling basin divided into six compartments with a total capacity of fifteen million gallons, in which the greater part of the turbidity and precipitated materials are removed by sedimentation.

4. Ten mechanical filter units, each with a net filtering area of 1089 square feet.

The above have a normal rated capacity of thirty million gallons per twenty-four hours and in addition there is:

5. A covered, filtered-water reservoir holding ten million gallons.

Included in the plant there are also a storage-house for chemicals and a Head House, in which is placed the equipment for dissolving and feeding the lime, soda-ash and coagulant into the water. The chemical and bacteriological laboratories are also housed in this building.

Purification with Alum:—When sulphate of alumina is added to a muddy, alkaline water, the aluminum combines with the alkalinity of the water, and a flocculent, gummy, gelatinous precipitate of aluminum hydroxide is formed. This precipitate entrains the mud and bacteria, and all suspended particles present in the water, and being heavy soon settles. This settling-process, or sedimentation, takes place in large, concrete settling-basins from which the material which settles from the water is washed back into the river, below the in-take.

Only minute quantities of alum are required to properly coagulate the sediment. From one to two grains of alum to a gallon of water, is usually sufficient, unless the water is extremely muddy; then as much as four grains is sometimes required.

There are seven thousand grains in a pound, so that one grain per gallon, is equivalent to one pound in seven thousand gallons of water. Even this small quantity does not remain in the purified water, because, as has already been explained, the alum is precipitated and settles out of the water with the mud and other impurities.

Softening Water:—Lime and soda ash are used to soften the water, and during the year 1912, the total hardness of the river water averaged two hundred and twenty-two parts per million, whereas, the average total hardness of the filtered water was only seventy-nine parts per million. At first, the consumers felt that the use of chemicals for softening and coagulating the water, would not be desirable, and had some hesitancy in using the chemically-treated water. This prejudice has been entirely overcome and the people are now beginning to realize that there is less chemical in the filtered water than there is in the untreated river water. The reason that there is less chemical in the filtered water than there is in the river water, being, that the chemicals which are added to the water, in order to soften and coagulate the impurities, combine with the soluble carbonates and sulphates present in the water and form insoluble compounds, which are removed from the water by sedimentation and filtration.

The following paragraph will explain more fully the nature of lime and the reactions which take place when it is added to hard water.

Lime is made by burning limestone in a kiln. Pure limestone has the chemical

formula $Ca\,CO_3$ (Calcium Carbonate). When this is burned, the following reaction takes place:

$Ca\,CO_3$ + burning = $Ca\,O$ + CO_2
Calcium Carbonate — Lime Oxide. Carbon Dioxide.

The difference, therefore, between limestone and lime is that the calcium of the limestone is combined with CO_2 (carbon dioxide) as a carbonate, and, in burning, the carbonate is broken down, carbon dioxide passing off as gas, leaving the calcium combined with oxygen as an oxide (Ca O).

Lime has a great affinity for carbon dioxide, and when it is exposed or comes in contact with carbon dioxide, the carbon dioxide is immediately absorbed and the lime is converted back to its original state, that is, limestone or calcium carbonate.

All natural, hard waters contain free and half-bound carbon dioxide, and it is the presence of this carbon dioxide, in water, that enables the water to dissolve and to hold in solution, large quantities of limestone.

It is a well known fact, that if hard water, that is, water containing lime carbonate in solution, is boiled, the CO_2 (carbon dioxide) which it contains, is expelled, and a deposit of lime forms in the bottom of the vessel in which the water is boiled, demonstrating that the limestone is not soluble in water, only in the presence of CO_2.

When lime is added to hard water, it absorbs the carbon dioxide present in the water, is, itself, converted back to limestone, and as limestone is not soluble in water in the absence of CO_2, it settles out of solution along with the mud and other impurities. The limestone originally present in the water, also is precipitated and settles out of solution as soon as the CO_2 is absorbed by lime, therefore, the lime added to the water, as well as the limestone originally present in the water, is removed, and the water contains less chemical or mineral matter than it did in its natural condition, and is therefore softer.

Lime will not remove sulphate-hardness, therefore, this condition is removed by precipitating it with soda-ash (sodium carbonate).

It has been learned at the Columbus plant, that the addition of lime not only softens the water, but that the typhoid and other intestinal bacteria, will not live in lime-softened water, because the lime absorbs the carbonic acid from the water, and these disease-producing bacteria will not live in water free from carbon dioxide.

If lime-softened water be inoculated with typhoid organisms, they will die out in a period of twenty to twenty-four hours, and if the water be softened to the lowest possible figure with lime, and an additional quantity of lime added, sufficient to introduce a small quantity of excess lime, the sterilization is accomplished in from four to five hours.

Brief Description of Process:—The water is measured, through Venturi Meters, as it enters the water-softening and purification works. Lime, and soda-ash are added to it in the proper proportions to soften it, and sufficient alum to properly sedimentize it, which are determined by two hour chemical determinations. After the chemicals are introduced into the water, the water so treated, is then passed through long mixing-tanks, where the chemicals and water are thoroughly mixed, and the chemical reactions take place. From the mixing-tanks the water passes

into settling-basins, and the mud, bacteria and precipitated limestone are deposited. Practically all of these impurities are removed by sedimentation, but, in order to remove all suspended particles, the clear water from the settling-basins is passed through sand filters. The water passes through the sand, into a large covered concrete reservoir; and from this reservoir is pumped to the distribution system.

Purity of Filtered Water:—Columbus has now one of the most modern, fully-equipped water purifying systems of the world.

The water delivered to the consumers is satisfactorily soft, is always sparkling-clear, has a wholesome taste, and is absolutely pure.

During the year 1912, the average number of bacteria present in the river water was nineteen thousand two hundred and ten per cubic centimeter, and the average number in the purified water was only fourteen per cubic centimeter, a reduction of 99.93%. Another evidence of the purity of the water, is the decrease in the typhoid-fever death-rate, which has fallen from one hundred and thirty-nine in 100,000, to about eighteen in 100,000.

THE RELATION OF PHARMACY TO MEDICINE.

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Historically, pharmacy and medicine had a common origin. If we would advance the contention that pharmacy is the mother of medicine, we must at the same time admit that the parent is subservient to its offspring. However that may be, the fact remains that, somewhere in the past there arose the necessity for a separation of the two professions. This necessity was undoubtedly an economic one, which had it foundation deep-rooted in the very nature of the two professions.

The ancient pharmacist, who spent his time in collecting and curing drugs, of both animal and vegetable origin, and making, from these drugs, the various preparations required in the treatment of disease, could not become very highly proficient in the diagnosis and treatment of human ills, crude and imperfect as these arts may have been at that time. Conversely, the physician, who devoted his time to attendance upon and treatment of the sick, had not the time to become skilful in the recognition of the growing plants used in medicine, nor in the art of their preservation and preparation for use.

Hence, the separation of the two professions, was one of the mighty factors that made for the increased efficiency of both. And, right here, it might be pointed out that the more skilful and efficient a physician became, through a conscientious devotion to his work, the more he stood in need of the services of a skilful and efficient pharmacist, while the pharmacist's profession depended wholly upon that of medicine. This mutual inter-dependence of the two professions, without doubt, increased the efficiency of both and its re-establishment in