

UNITED STATES PATENT OFFICE.

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METHOD FOR DETERMINING THE QUANTITY OF AN APPROPRIATE CHEMICAL THAT SHOULD BE ADDED PER UNIT OF VOLUME OF WATER IN ORDER TO FIT IT FOR USE IN THE ARTS.

1,405,940.

Specification of Letters Patent.

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No Drawing.

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To all whom it may concern:

Be it known that I, CYRUS WM. RICE, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a certain new and useful method for determining the quantity of an appropriate chemical that should be added per unit of volume of water in order to fit it for use in the arts, of which the following is a specification.

This application is for the same subject of invention as my application serially numbered 54,507, filed October 7th, 1915.

Some water contains what is called temporary and permanent hardness, and it is customary to treat such water by the addition of chemicals adapted to remove or absorb the hardness so as to fit the water for use in boilers and for other purposes. The hardness of a supply of water frequently changes so that it is often necessary to ascertain at comparatively short intervals of time how much of the appropriate chemical should be added to correct the changing hardness of the water.

The principal object of the present invention is to provide a method of ascertaining the quantity of chemical required to remove temporary and permanent hardness from water which is so quick and easily practiced that even comparatively unskilled persons can make the ascertainment in a very short time and so insure proper treatment of the water supply.

Generally stated, the method of ascertaining quantity of an appropriate chemical required to remove the temporary and permanent hardness as it exists from time to time in a given water supply, which embodies my invention, consists in treating a measured sample of the water with an appropriate chemical for removing temporary and permanent hardness, using such chemical in excess under heat control and determining quantitatively the unused quantity and change nature of such chemical.

Free or half bound carbonic acid present as bicarbonate is usually referred to as temporary hardness, and sulphates of calcium and magnesium are usually referred to as permanent hardness.

In practicing the present invention there is added to a measured quantity or sample of the water to be treated sodium carbonate

or potassium carbonate, which are equivalents, in excess of the quantity required to destroy or absorb any permanent and temporary hardness that might possibly be present. For example, to one hundred cubic centimeters of water there is added five cubic centimeters of one-fifth normal solution sodium carbonate or its equivalent. The sample may then be boiled in a bath. This promotes the re-action. Thereafter the sample is filtered. The result of this is that calcium and magnesium sulphates are converted into carbonates and precipitated, thus removing though not ascertaining the quantity of the permanent hardness from the sample, and that sodium bi-carbonate and sodium sulphate are formed and are present in the filtrate along with sodium carbonate. It may be remarked that sodium bicarbonate in the presence of excess sodium carbonate is stable even when the solution is boiled within a water bath. The filtrate containing sodium as bi-carbonates and carbonates and also sodium sulphate, is titrated with the same mineral acid, as sulphuric acid or hydrochloric acid of known strength or standard solution, first against an indicator of the phenolphthalein class which is peculiarly sensitive to carbonic acid, until the color of the indicator is destroyed, and then against an indicator of the cochineal class, which is more sensitive to alkalinity than indicators of phenolphthalein class. The quantity of acid required in the phenolphthalein titration does not exactly correspond to the quantity of sodium carbonate present but must be multiplied by two, so that twice the quantity of acid represents the quantity of carbonates introduced into the water and unused in any of the reactions. The quantity of acid required in the cochineal titration minus twice the quantity of acid used in the phenolphthalein titration represents the quantity of carbonate of sodium used to replace the calcium or magnesium bicarbonates originally present in the sample of water and so is a measure of the temporary hardness. The total amount of carbonate of sodium originally introduced minus the quantity of acid used for the cochineal titration, which represents the unused carbonate of sodium and the amount of carbonate of sodium used to replace the calcium and magnesium bicarbonate originally

present in the water, represents the quantity of carbonate of sodium used in the reaction by which the permanent hardness was precipitated. For example, let z , indicate in
5 terms of acid the total amount of sodium carbonate or hardness removing chemical, and x , the amount of acid used in the first titration, and y , the amount of acid used in the second titration. Then $y-2x$ =temporary hardness and $z-y$ =permanent hardness. In the described process neither the temporary nor permanent hardness were actually determined save by the above calculation. Another way of expressing the same
10 facts is to say that $2x$ =the quantity unused, y =the quantity unused and the quantity used in destroying temporary hardness, and z =the total quantity used.

A very important part of the method directly influencing the results is the use of carbonate of sodium in excess with heat under the definite control of a water bath. The use of a water bath permits a rapid absorption by the carbonates of sodium of the
20 half-bound carbonic acid gas from its loose combination with the carbonates of calcium and magnesium and also of the carbonic acid gas as it exists free in the water and forms by these means the bicarbonates of sodium. The carbonates of sodium under
25 the heat control of a water bath act as a carrier for the elements causing temporary hardness. The determination is in terms of quantity of acid or standard solution used
30 and from this chemists can calculate or ascertain the quantity of an appropriate chemical, as carbonate or hydrate of sodium or potassium or their equivalents that should be added per unit of volume of the supply
35 to free it from both the permanent and temporary hardness. In actual practice, I simplify the commercial application of my process by providing a chart graduated to show how much by weight of an appropriate
40 chemical or chemicals is to be added to each unit of volume of water for various increments in volume of mineral acid or standard solution used in the manner described. Phenolphthalein and cochineal are examples
45 of substances adapted to operate in the manner described in the volumetric analysis above explained. The feature of the invention is the use of sodium or potassium carbonate in quantities sufficient to destroy in
50 the water, being tested, both the sulphates of lime and magnesia and also absorb without their dis-association by heat all free or half-bound carbonic acid gas contained in waters as carbonic acid or the bi-carbonates
55 of lime and magnesia, the resulting carbonates or bi-carbonates of sodium or potassium indicating through a single acid titration the temporary or permanent hardnesses to be overcome in order to fit the water for use in
60 the arts. The removal of temporary and

permanent hardness from water results in the destruction of bacteria and the clarification of the water, so that my invention is useful not only in connection with water supplies but also in connection with sewage
70 and like waste.

What I claim is:

1. The method of ascertaining the quantity of an appropriate chemical per unit of volume that should be added to remove
75 hardness from a water supply, which consists in adding a measured quantity of a hardness removing chemical in excess of the quantity required to remove the total hardness from a measured sample of such water, separating the resultant precipitate from the
80 liquid by filtration, titrating the filtrate against two indicators of which the first indicates the quantity of the chemical unused and the second indicates the sum of the
85 quantity unused and the quantity used in destroying temporary hardness and thus finding the necessary factors for ascertaining the result, substantially as described.

2. The method of ascertaining the quantity of an appropriate chemical per unit of volume that should be added to remove hardness from a water supply, which consists in adding a measured quantity of a hardness removing chemical in excess of the quantity
90 required to remove the total hardness from a measured sample of such water and boiling the admixture in a water bath, separating the resultant precipitate from the liquid by filtration, titrating the filtrate against two
95 indicators of which the first indicates the quantity of the chemical unused and the second indicates the sum of the quantity unused and the quantity used in destroying temporary hardness and thus finding the
100 necessary factors for ascertaining the result, substantially as described.

3. The method of ascertaining the quantity of an appropriate chemical per unit of volume that should be added to remove hardness from a water supply, which consists in adding a measured quantity of a hardness removing chemical in excess of the quantity
110 required to remove the total hardness from a measured sample of such water, subjecting the admixture to a limited degree of heat appropriate for preventing the destruction of the bi-carbonates of sodium and filtering, and titrating the filtrate against two indicators of which the first indicates the quantity
115 of the chemical unused and the second indicates the sum of the quantity unused and the quantity used in destroying temporary hardness and thus finding the necessary factors for ascertaining the result, substantially
120 as described.

4. In the process of ascertaining the quantity of an appropriate chemical per unit of volume that should be added to remove temporary hardness from a water supply, that
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improvement which consists in subjecting an admixture of a sample of the water and carbonate of sodium in excess to a temperature appropriate for preventing the destruction of the bi-carbonates of sodium by heating it in a boiling bath, filtering, and titrating the filtrate, substantially as described.

5. The method of ascertaining the quantity of appropriate chemicals per unit of volume, that should be added to remove the temporary hardness and permanent hardness from a water supply, which consists in adding a measured quantity of a hardness removing chemical in excess of the quantity required to remove the total hardness from a single measured sample of such water, separating the resultant precipitate from the liquid by filtration, titrating the filtrate against two indicators, of which the first indicates the quantity of the chemical unused, and the second indicates the sum of the quantity unused and the quantity used in destroying temporary hardness, and the difference between the total quantity of hardness removing agent introduced and the sum of the quantity used to destroy the temporary hardness and the quantity unused equals the quantity required to destroy the permanent hardness, and thus finding the necessary factors for ascertaining the result, substantially as described.

6. The method of ascertaining the quantity of appropriate chemicals per unit of volume that should be added to remove the temporary hardness and permanent hardness from a water supply, which consists in adding a measured quantity of a hardness removing chemical in excess of the quantity required to remove the total hardness from a single measured sample of such water, and boiling the admixture in a water bath, separating the resultant precipitate from the liquid by filtration, titrating the filtrate against two indicators, of which the first indicates the quantity of the chemical unused, and the second indicates the sum of the quantity unused and the quantity used in destroying temporary hardness, and the difference

between the total quantity of hardness removing agent introduced and the sum of the quantity used to destroy the temporary hardness and the quantity unused equals the quantity required to destroy the permanent hardness, and thus finding the necessary factors for ascertaining the result, substantially as described.

7. The method of ascertaining the quantity of appropriate chemicals per unit of volume, that should be added to remove the temporary hardness and permanent hardness from a water supply, which consists in adding a measured quantity of a hardness removing chemical in excess of the quantity required to remove the total hardness from a single measured sample of such water, subjecting the admixture to a limited degree of heat appropriate for preventing the destruction of the bi-carbonates of sodium and filtering, and titrating the filtrate against two indicators, of which the first indicates the quantity of the chemical unused, and the second indicates the sum of the quantity unused and the quantity used in destroying temporary hardness, and the difference between the total quantity of hardness removing agent introduced and the sum of the quantity used to destroy the temporary hardness and the quantity unused equals the quantity required to destroy the permanent hardness, and thus finding the necessary factors for ascertaining the result, substantially as described.

8. The process of ascertaining the quantity of appropriate chemicals per unit of volume that should be added to remove temporary hardness and permanent hardness from a water supply, that improvement which consists in subjecting an admixture of a single sample of the water and carbonate of sodium in excess to a temperature appropriate for preventing the destruction of the bi-carbonates of sodium by heating it in a boiling bath, filtering and titrating the filtrate against two indicators, substantially as described.

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