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PROCESS AND MEANS FOR PURIFYING WATER

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Fig. 1.

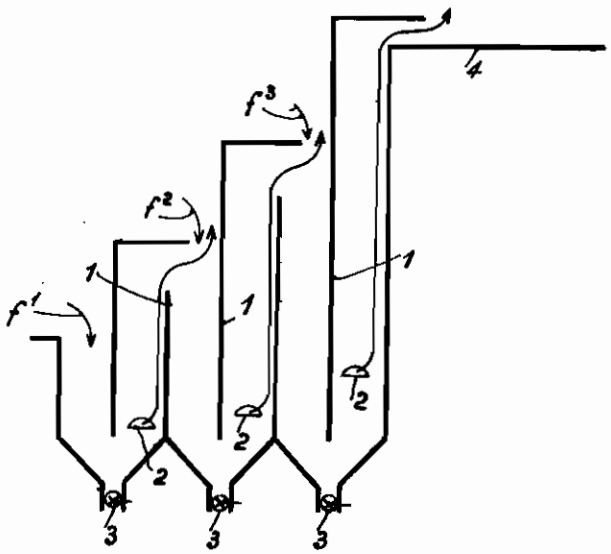
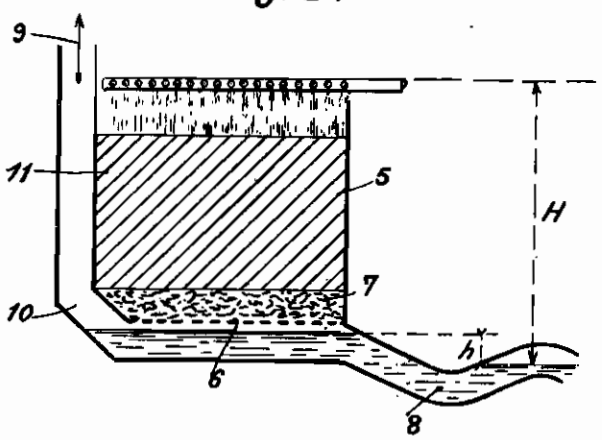


Fig. 2.



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PROCESS AND MEANS FOR PURIFYING WATER

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vested in the Alien Property Custodian

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The present invention, which is due to Mr. Eugène Desroches, relates to the art of purifying, preliminary filtration and filtration of water.

In the present processes, it is often necessary to decant for a long time, after the ingredients have been introduced. It is nearly always aluminum and iron salts that are used, and this causes the formation of colloids, but also of calcium sulphate or chloride, which are undesirable substances. Water thus treated soon clogs the apparatus.

The invention has for its object to overcome these drawbacks and, more particularly, to eliminate or considerably reduce decantation by introducing into the water to be treated ingredients such that, with the substances contained in the water, a porous complex is obtained which gives little loss of head in the apparatus and facilitates cleaning.

Said ingredients are:

(1) Elementary substances in powder (zinc, iron, carbon, etc.).

(2) Acids, the salts of which, apart from those they form with the alkaline metals, are insoluble, viz.: phosphoric, boric, silicic, fluosilicic, carbonic, etc. acids.

(3) Strong bases, in particular lime.

(4) Substances readily yielding lime or oxygen (calcium dioxide, calcium hypochlorite, calcium permanganate, etc.).

(5) Natural or artificial compounds which are insoluble in water: the oxides, hydroxides, carbonates, phosphates, borates, silicates, fluosilicates, of calcium, of magnesium, of zinc, of iron, of manganese, of aluminum, of chromium, of lead, of copper, etc.

(6) The complex compounds known by the name of cements, natural or artificial pozzolanas, in which must be included blast-furnace slag, various clinkers and scoriae, dephosphorization scoriae, etc.

(7) Celluloses and particularly celluloses that readily go into suspension, such as cellulose wool, alfa sponge.

(8) Resins and gums.

All these solid products have to be finely pulverized. It is not necessary for them to be pure, a fact which generally permits the use of natural rocks, industrial products and by-products.

As the nature of the water varies from one region to another and with meteorological conditions and users' requirements are likewise variable, a large number of ingredients have been mentioned above, in order to meet all requirements.

By way of example, a treatment is given hereunder which applies to water containing carbonic acid, whether such water be too acid, too soft, too hard:

(1) Aeration.

(2) Introduction of the sterilizer.

(3) Introduction of lime in excess, that is to say in greater quantity than that necessary for neutralizing the carbonic acid.

(4) Introduction of one or a plurality of the substances mentioned above (with the exception of the simple compounds of calcium), so as to absorb the excess of lime and cause the formation of a porous complex. Pozzolanas are particularly suitable and scoriae of dephosphorization have the advantage of producing sludge that can be used for agriculture.

The aeration can often be eliminated (particularly if preliminary filtering materials with aeration are used) and also the introduction of a sterilizer. The introduction of lime is only useful if there is carbonic acid in the water. In certain cases (some ferruginous waters for example) it is necessary to rely solely on aeration, which is effected either beforehand, or by passing through the preliminary filtering materials.

Experience has shown that for numerous applications, the addition, to the water to be treated, of an excess of lime with respect to the substances contained in the water, then of pozzolanas, by causing the formation of a porous complex, is advantageous in many cases.

This method of treatment with lime and pozzolanas is particularly advantageous in the case in which carbonates have to be eliminated (softening of water), for removing the iron, for removing the manganese from water.

In this connection, it should be noted that by pozzolana should be understood, according to the invention, in a general manner, a substance which forms stable and insoluble compounds with free lime, at the ordinary temperature.

As, for the treatment of water, questions of mechanical strength do not have to be taken into consideration as for pozzolana mortars, the word pozzolana applies, in the spirit of the invention, in addition to the substances formed by silica, alumina, or silicates:

(1) to elementary substances in powder which are insoluble (iron, zinc, carbon, etc.);

(2) to all forms of silica (fossil silica, Tripoli silica, etc.);

(3) to celluloses, resins and gums;

(4) to the natural or artificial compounds formed by the following substances, alone or

mixed: oxides, hydroxides, carbonates, phosphates, borates, silicates, fluosilicates, aluminates, ferrates, tungstates, etc., of magnesium, of iron, of aluminum, of manganese, of zinc, of chromium, of tungsten, of cobalt, of nickel, of tin, of lead, of copper, of titanium, etc., conditionally on their not containing too great a quantity of lime.

As such natural compounds, may be mentioned in particular, the following natural rocks: clay, bauxite, laterite, ores of various metals, gaize, possolanic sand.

Roasting, if it is necessary, does not generally require to be continued as far as for the manufacture of mortars.

Industrial scoriae, although they often contain a fairly large proportion of calcium, may be considered to be pozzolanas, and also glass.

If, in certain cases, the pH of the treated water is rather high owing to the absence of carbonic acid, this is remedied, if necessary, either by introducing into the treated water a strong acid salt (iron sulphate for example) after the pozzolanas have been added, or by introducing carbonic acid.

When it is necessary to introduce a sterilizer at the beginning of the treatment, a permanganate, a hypochlorite, a zinc, iron, copper salt, phosphoric, fluosilicic, etc. acid, metallic powders, may be chosen for this purpose.

The lime may be replaced by substances which readily yield same (permanganate, hypochlorites, salts of weak acids) and the solutions used may themselves be saturated with lime, be distributed simultaneously or even mixed.

A means for preparing said solutions consists moreover in economically using untreated water instead of treated water. The solution tanks being provided, at the lowest point, with a cock for evacuating the sludge, it suffices to fill said tanks with untreated water, to introduce therein an excess of lime (at least 2 gm. per litre), the decantation is very quick and the substance readily yielding lime is then added and it will even often be possible to make an excess of lime soluble. The advantage of this process is the facility of dosing.

It ensues from the forcgoing that the invention makes it possible:

(1) To introduce an excess of lime and then to neutralize with substances which only give insoluble products.

(2) Not to await the decantation before sending the water to the filters and to the preliminary filters.

(3) In the case of preliminary filter, to reduce the amount of air to be sucked in and sometimes eliminate the aeration.

In a general manner, a selection among the above-mentioned ingredients, which is determined by preliminary laboratory tests, results in:

(1) Less loss of head for the same output.

(2) Easier and less frequent washing.

(3) Improvement in the quality of the water.

The applicant has observed that the quick forming insoluble substances present in the water, by becoming fastened to a suitable support, viz: cloth of a colloidal nature, wall of porous material (candle and the like), heap of inert materials in a finely divided state (sand, etc.), contribute to the formation of a membrane or pseudo-membrane which ensures filtration and from which it is very easy to remove the support, for cleaning purposes. The process according to the invention therefore advantageously applies to the process and devices described in applicant's co-pending U. S. application Serial No. 181,894, filed on January 22, 1937.

In other words, the porous complex which is formed by the addition to the water of the ingredients according to the invention, contains the impurities to be eliminated from the water and, being stopped by a filtering membrane, does not clog the latter and can be easily removed, but in addition, said porous complex itself also contributes to the filtration and for this reason may be considered to be a filtering membrane or a pseudo-membrane.

In certain cases, for example for water containing a large amount of impurities, it is advisable to form before hand on the support, one or a plurality of filtering membranes on which the porous complex is subsequently superposed so as to form a complementary membrane.

In other cases, on the contrary, a filtering membrane is not formed before hand on the support and filtration is effected solely by the porous complex becoming fastened on said support.

The support may be formed, for example, by

(1) A colloidal cloth of organic or mineral origin, either natural or artificial: cotton, silk, wool, asbestos, hemp, glass, etc.

(2) A porous wall: terra cotta, porous rubber, porous ebonite, etc.

(3) A very fine or colloidal material: various sands, all forms of cellulose (including, for certain applications, wood fibre, rags, straw, etc.).

Hereinafter, for a number of cases, a table is given by way of example which gives accurate details of the composition of the two filtering membranes formed before hand on the filter support and of the ingredients which are added to the water to form the porous complex which is superposed on said two membranes. In some cases of easy filtration, it is of course understood that the first membrane may suffice or even that no membrane formed before hand is necessary.

1st membrane	2nd membrane	Ingredient to be added to the water
Mixture of cellulose or of asbestos with silica or alumina.	----------	Silica
Alumina	Silica	Carbon.
Chalk	Carbon	Silica
Kaolin	Silica	Silica or carbon
Cement	----------	Carbon
		Lime+pozzolana
Alumina	----------	Do.
Manufactured cement or cement formed on the spot with lime and pozzolana.		
Do	----------	Silica
		Lime+pozzolana

If there is no filtered water available for washing the filter, the untreated water may be decanted with the action of trisodium phosphate, the soda water obtained being particularly appropriate for the washing. It may moreover be made more active by adding soda lye thereto.

Cloths of organic origin may be impregnated, for preserving them, with products such as chestnut extract fixed with copper oxy-chloride, by means of an immersion process similar to dyeing.

This method of impregnation may not only be applied to cloths intended to serve as supports for the filtering membranes, but also to the cloths forming the chanels serving for the preliminary aeration of the water.

In the case in which the filter support is formed by a sand, the method of treatment which consists in adding lime and a pozzolana to the water is particularly suitable, using large proportions at the beginning so as to facilitate the fastening of the first membrane.

It is possible to replace the sand by materials such as slag-wool. Cleaning can be effected simply from the upper part and becomes very easy.

As regards filters formed by cloths of any shape and of any kind (natural or artificial threads of organic or mineral origin which are treated or not by means of porous walls of any shape and made of any material, with the above indicated treating processes, it is possible, by feeding the water to the upper part of the filter, to effect cleaning without using filtered water by closing the filtered water supply cock and operating several times the sludge outlet cock placed at the lower part, usually without its being necessary to carry out the cleaning thoroughly.

If from time to time it is desired to effect a thorough cleaning, the operation will be effected as usual by a return of clean water, but it will be sufficient to use water at low pressure (a few metres), particularly if a little compressed air is injected from time to time through the washing water pipe and through the sludge outlet pipe.

An economical operation of these filters is obtained, owing to the small loss of head required and the economy of filtered water for cleaning.

The operation of sand filters of all systems can be considerably improved by the introduction of the above indicated ingredients, particularly if very fine sand is used, so that a membrane is really formed and a depthwise choking of the sand does not occur as it does at present.

In order to obtain the best results, sand filters should comprise from bottom to top:

(1) A grating or a slab provided with holes.

(2) A small transition layer formed by calibrated gravel and sand of decreasing sizes.

(3) A small layer of fine sand.

The object of the transition layer (2) is to prevent the fine sand from passing through the grating or the slab. In order to prevent, after washing, the fine sand from mixing with the transition sand, it is advisable to form the latter with very dense materials.

All the known systems of cleaning can be applied, with this advantage, viz: that a pressure of a few metres of water is sufficient and that it will generally not be necessary to effect a thorough cleaning.

The invention also relates to the combination of the aeration with the preliminary treatment of the water for speeding up the reactions. But it must be pointed out that as in the known processes untreated water can be aerated beforehand so as to eliminate as much carbonic acid gas as possible and to reduce in particular the amount of lime to be introduced.

As regards aeration in combination with precipitation of the insoluble compounds, the invention is characterized by the fact that the circulation of the air is effected in the same direction as the water. It has been found that the efficiency of the apparatus was thus improved and that at the same time an elevation of the water was obtained as in the apparatus known by the name of emulsifiers.

Figure 1 of the accompanying drawings, which are only given by way of example, is a diagram of a plant for the aeration and the combined treatment of untreated water.

The untreated water is caused to circulate in columns 1 which are provided with baffles and in which the precipitation ingredients are introduced, as shown by the arrows f^1, f^2, f^3, etc. Air inlet pockets 2 are provided in said columns, the direction of circulation being that of the water, as indicated by the arrows. The sludge is extracted through the drain gates 3 placed at the lowest point of the hoppers which form the bottoms of the columns. The treated water issues at 4 and is conveyed to the preliminary filters or to the filters.

Figure 2 is a diagram showing an improvement made in the preliminary filters, in particular those described in applicant's co-pending U. S. application Serial No. 161,690 filed on August 30, 1937, for the purpose of decreasing the loss of head H. The depression that is required for the suction is h, which is the difference between the levels of the water under the grating and at the outlet.

The improvement consists in providing on the side a continuous slab which is inclined at 10 to enable the treated water to reach its maximum level without hindering the movement of the air. 5 is the tank, 6 the grating or the perforated slab, 7 the transition layer composed of gravel and sand of calibres which decrease from bottom to top, 11 is the active material.

The untreated water, to which the ingredients have or have not been added, is supplied from the top. Suction is effected through 9 and the treated water flows out through a retaining syphon 8.

The preliminary filters may be used for the neutralization of water which is pure but charged with volatile acids. In this case, the active material must be impervious to the action of said acids (siliceous sand, for example).

They may also be used without essential modification for the filtration of gases. It suffices to close the upper part which receives the gas to be treated. The questions of neutralization and the choice of materials will, as for water, be treated after tests on a small scale.

It is necessary, in the recuperation of the material by heating, to provide dust removal by means of a current of air or of impact, either outside the apparatus, or in the apparatus itself.

For the preliminary filtering, all kinds of sands are used, the word "sand" being used in its most general meaning and designating natural sands and sands obtained by crushing the most varied insoluble materials, including the solid waste that is found in sewage.

In a general manner, all colloidal or very finely divided materials which do not dissolve in water can be used. Cellulose can be used in the following forms: wood waste, wood fibre, straw, twigs, grasses. These forms are particularly suitable for the preliminary filtering of waste water.

The improvements according to the invention only limit the fineness of the materials for economical reasons of efficiency.

In order to eliminate, or at any rate reduce the number and the quantity of the ingredients used, the material employed may be so treated as to increase its power of absorption. For example, mineral wool may be treated first of all with strong bases and then with aluminum, iron, zinc, or copper salts, alone or mixed. Natural colloids or colloids manufactured beforehand may also be used, instead of forming same in the material itself.

Certain insoluble or not very soluble ingredients (carbonate of lime for example), may also, for the purpose of simplification, be arranged in

a layer at the upper part of the preliminary filter, instead of being distributed in the water.

The most suitable quantity of air to be introduced is determined experimentally. Its rate of flow may vary from 0 to 200 times that of the water, the maximum applying to water which is heavily charged with organic materials.

It should be observed that the softening of water is obtained both with the filters of the various systems and with the preliminary filters and that previous sterilization may always be provided (as far as possible with calcium compounds, or pure gases). In the case of water that is heavily charged with organic materals, it is advisable, in order to obtain an economical operation, to pass the water first of all over a preliminary filter with air suction, without any other ingredient than lime or carbonate of lime if the water is acid.

When the water is heavily charged, it is advantageous to start the filters by first of all supplying clean water in which the selected ingredients have been introduced.

It can be seen that the process according to the invention permits of the most varied applications. For example, to convert very heavily charged water (drain water, for example) into drinkable water, the operation may be carried out in the following manner:

(1) add lime or carbonate of lime, in the case of acid water;

(2) pass the water over a preliminary filter with intense aeration, the air circulating in the same direction as the water;

(3) introduce an ingredient;

(4) pass over a second preliminary filter;

(5) introduce an ingredient;

(6) filter.

Summary decantations may be effected, if necessary, between the phases (3) and (4).

In certain cases, it is more advantageous to effect a first decantation, using solely powdered natural carbonate of lime.

If sewage has been poured into the drain-water, it may be necessary from time to time to remove the superficial layer which forms on the first preliminary filter, said layer being then, for example, subjected to fermentation in an appropriate cell.

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