APPARATUS FOR THE TREATMENT OF WATER SOLUTIONS BY ION EXCHANGE

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ABSTRACT

Treatment of watery solutions by means of ion exchange; the exchange mass through which the liquid under treatment flows is conducted from a bottom funnel of the treatment container to a regenerating-and-wash-column and thence back to the liquid treatment container. After leaving the liquid treatment container and before entering the regenerating-and-wash-column the ion exchange masses are back-rinsed in a back-rinse container; the ion exchange mass is transported from the regenerating-and-wash-column means of an immersion tube at the top of the regenerating-and-wash-column, the depth of immersion of the immersion tube being adjustable according to the volume in the bottom funnel of the treatment container; consequently the ion exchange mass in the head of the regenerating-and-wash-column which has been transported from the treatment container corresponds to the volume transported from the bottom funnel thereof.

6 Claims, 10 Drawing Figures
APPARATUS FOR THE TREATMENT OF WATER SOLUTIONS BY ION EXCHANGE

This is a continuation of application Ser. No. 135,146, filed Apr. 19, 1971, now abandoned.

This invention relates to an apparatus for the treatment of watery solutions by means of ion exchanges. Such treatment may involve, for example, the preparation, softening, and/or the desalinating of such solutions. The ion exchange mass, through which the liquid to be treated flows, is conducted through a treatment container in which it contacts the liquid being treated, and thence to a regenerating-and-washing-column from which it is returned to the treatment container.

There are already known a number of different types of installations for carrying out the liquid treatment in a continuous or a quasi-continuous manner, wherein the necessary processes for operating the ion-exchange filters, such as exchange, rinsing-and-regenerating the ion exchange mass, etc. are not carried out in one tank, but successively in different apparatus within one cycle. These installations, in contrast to the operation of the so-called fixed-bed filters, wherein the backing, regeneration and washing of the ion-exchange mass is carried out after loading in the same, one tank, have the advantage that during the regeneration practically no interruption of the working cycle occurs. With classical procedures, on the other hand, it is necessary to insert a spare filter during the down-time of the main filter. This is not necessary with a constantly working circulating process wherein the process steps for the treatment of the water as well as the regeneration of the loaded ion-exchange mass take place simultaneously.

A quasi-continuous process for operating ion-exchange filters has already been proposed, wherein the regenerating and washing of the exchange masses takes place in one tank. Specifically, the regeneration takes place in a lower part of a regenerating-and-washing-column, the pre-washing takes place in a middle part of such column, and the clear washing takes place in the upper part of the column. However, it has been found that with very dirty liquids such as a cleaning process in which the regeneration is also carried out in the same, one tank, such regeneration is not sufficient. The resins are not sufficiently loosened, so that the particles and the dirt clinging to the resin will not be washed out thoroughly enough. Because of this, the resistance of the filter to liquid flow increases and the total efficiency of the construction progressively decreases.

Among the objects of the present invention is the creation of an economical apparatus for the quasi-continuous treatment of liquids by ion-exchange masses, in a cycle wherein such ion exchange masses are conducted through a processing tank and a regenerating-and-washing-column. In accordance with the present invention the ion-exchange masses are thoroughly rinsed, and the process, in comparison to the traditional or classical processes, is carried out with little expense and with a greater security.

In accordance with the present invention, the ion-exchange masses leave the liquid processing tank through a bottom funnel, and before entering the regenerating-and-washing-column flow into a rinsing tank in which they are thoroughly re-rinsed at least once during each entire cycle. The removal of the ion-exchange masses from the rinsing tank and from the regenerating-and-washing-column is effected by means of headpieces carrying submerged tubes extending into the inner tank. The volume of the headpieces is determined with respect to the volume of the outlet funnel by varying the submerged depth of the immersion tubes as required. The ion-exchange masses located in the head of the tank and extending to the level of the submerged depth of the immersion tubes corresponds to one portion. As will be explained later on, it is possible with this process to treat very polluted liquids simply and thoroughly. The submerged or immersion tubes, in which the leaving and to be transported resin is introduced and taken off, respectively, as the transporting water is introduced via the head of the tank is inserted and drained, respectively, provide a simple determination of the portion of the resin to be transported as well as a simpler and safer transport of such resin. If the tanks are filled, water accumulates in the submerged pipes, so that at the introduction of the transport of resin there is first moved water which is mixed with the first exchange particles. Consequently, there will be predominantly water at the beginning of the transport, which will ensure a good transport security.

The installation of the invention works with great advantage under conditions in which the interval between the beginnings of successive working cycles, in which the ion exchange masses are taken off and transported (working time) is at least 8 minutes.

The apparatus of the invention can be used with the same advantages, without additional construction costs, in a mixed-bed type of installation. It is, consequently, not limited to applications in which the working tank contains only cation-exchange masses or anion-exchange masses. In such a case, according to the invention, by employing mixed-bed ion-exchange masses in the re-rinsing tank there occur simultaneously in the tank a separation of the cation and the anion-exchange masses, which are taken off from the re-rinsing tank separately and at different levels for washing and regenerating, and are transported into separate tanks and from there, after mixing, are returned to a mixed-bed treating tank.

To obtain a good degree of cleanliness of the liquid which has been treated and a total utilization of the regenerating means, in the apparatus of the invention it is provided that the regenerating means at the point of entrance thereof be provided with an impacting and diluting means which provides for a transverse water flow. To prevent a counter ion effect there is provided, for a successful continuation of the process, means whereby at the standstill of the pure water take-off of the then-stored pure water overflows into the raw water storage tank, by way, for example, of the raw water conduit. Further advantages and characteristics of the invention will become apparent from the following description and the accompanying drawings, wherein there are shown several embodiments of the apparatus in accordance with the invention.

IN THE DRAWINGS:

FIG. 1 is a circuit diagram of a quasi-continuous working full desalination plant according to the invention, comprising by way of example a twostage plant;

FIGS. 2, 3, 4, and 5 are schematic reproductions of a part of the plant, such figures demonstrating the process in different stages of the desalination process;
FIG. 6 is a view in horizontal cross-section through the flange piece disposed between the regenerating and the washing zones of the regeneration-and-wash-column;

FIG. 7 is a view in vertical cross-section through the flange piece, the section being taken along the broken section line 7—7 of FIG. 6;

FIG. 8 is a portion of a circuit of the mixing bed according to the invention;

FIG. 9 is a part of the circuit of a so-called "shock rinse installation"; and

FIG. 10 is a view in side elevation of a modified arrangement of a back-rinse regenerator-and-wash-column.

In the schematically represented circuit of FIG. 1 there is shown a quasi-continuous working circuit for treatment of liquid agents. To simplify matters, the following description is that of the treatment of water. The circuit shown is a two-stage installation in which the water to be treated flows through two treatment or operating containers, one designated K, which is a treatment-container 21 holding cations, the second stage, at the left, being a treatment-container A filled with anions. The two stages are exactly the same; the following description is mainly concerned with the right hand part of the installation as shown in FIG. 1, in which the cation-exchanger is located.

The untreated water is fed by means of a pump 40 from an untreated water container 48 via a conduit 20 into the treatment container 21. The throughput, which is indicated by means of a flow through volume meter 50, which is located in front of a back-shock valve 51, is regulated by means of a valve 1 disposed in the conduit 20. There is present in the container 21 an ion-exchange mass 22 through which untreated water flows in a direction from the bottom to the top of the container. The clean water leaves container 21 by means of a valve 2 which adjusts the rate of flow of the liquid through the discharge conduit 24. Immediately in advance of the entrance to container 21 there is provided a branch 20a with a valve 7 in the untreated water conduit 20.

At the bottom of container 21 there is a funnel-shaped collecting chamber 21a which is connected by means of a conduit 25 provided with a valve 4 with a return-rinse container 31. Connected to this conduit 25 through a valve 14 is another conduit 45 which feeds transport-and-return-rinse water from a clean water container 49 by means of a pump 47. A conduit 27, in which there is interposed a valve 9, is branched off from conduit 45 and leads toward the upper end of the return-rinse container 31. A rinse conduit 32 is also connected to the top of the return-rinse container 31, conduit 32 having an adjustable valve 11 interposed therein. A dirty water tube 34, which is selectively sealable by a valve 8, is connected to the container 31 somewhat below the top thereof. The bottom of the regenerating container 41 is connected to the top of the return rinse container 31 by means of a conduit 36 in which there is interposed a controllable valve 5. The regenerating agent is introduced through a conduit 46 and a valve 52, conduit 46 being attached to the middle part of the column 41 as shown. A circulating tube and pump 17 is provided in this region, the pump being connected in a loop composed of conduit portions 64, 18, and 63. See FIGS. 6 and 7 as to the location of the conduit portions 63, 64.

To the bottom of column 41 there is attached a drain tube 38 having a valve 13 interposed therein. The drain tube 38 has a ventilation conduit 39 secured thereto. In advance of the valve 13 there is provided a tap 15 and also the branch of a drain tube 16 provided with a valve 19. Diluting water is fed over the head of the column 41 by way of a tube 42 having a then adjustable valve 12 therein, the conduit 45 being connected to conduit 42 through a valve 6. To the upper region of column 41 there is attached a transmission tube 43 having an adjustable valve 3 interposed therein, and a further, drain tube 44 which is adjustable by means of a valve 10, the conduit or tube 43 leading to the top of the treating container 21 through the valve 3. Connected to the container 21 at different levels there are a plurality of taps 53–56, inclusive, for taking off water samples to measure the output capacity of the installation.

The above-described installation operates in the following manner:

As stated above, the installation is quasiconstantly working, the feeding or transport of the ion-exchange masses taking place cyclically. Such masses may be fed constantly by means of a time-relay which operates at intervals, or it may operate at discontinuous intervals if the interruption time is controlled by a measured value, for example, when a definite value of conduction capacity is reached, which is dependent on the degree of exhaustion of the ion exchange masses in the containers A and K. The water-conducting valve 6 is opened in order to feed freshly-regenerated ion-exchange resins from the washing-and-regenerating-column 41 into the top of the treating container 21 through the conduit 43 and to the valve 3. In such operation the valve 2 will have been closed, the untreated water conduit 20 will have been closed by shutting valve 1, and valve 7 in conduit 20a will have been opened so as to drain the untreated water in container 21 into a reservoir (not shown) for re-use.

After a short interruption, in order to accomplish the described feeding of the ion-exchange mass, the valve 1 in the untreated water conduit 20 and the valve 2 in the clean-water conduit 24 are re-opened. In the next cycle, the loaded ion-exchange masses 22 which are located in the drain funnel 21a of the container 21 are, by brief openings of valves 4 and 11, fed through the conduit 25 into the back-rinse container 31. After this, valve 14 is opened for supplying transport and return-rinse water to the container 31. A portion of the resin still present in the return rinse container 31 is conducted, with valves 5, 9, and 10 open, into the washing-and-regenerating-column 41.

After this, the return-rinse action in the return-rinse container 31 takes place. The rinse water is led into the bottom of such container through valve 14 and conduit 25, while the dirty water is drained through conduit 34 and open valve 8. At this time the valves 9 and 11 are closed. Simultaneously with the regeneration of back-rinse water the ion-exchange masses located in the washing-and-regenerating-column 41 will be regenerated. The regenerating agent is fed into column 41 through open valve 52 and is led over back-washed resin located in container 31, while diluted water is being conducted through tube 42 and open valve 12 into the top of the regenerator container 41. The used regenerating agent is drained from container 41 through tube 38 and open valve 13. The drainage of transporting water is effected through tube 44 and open valve 10 during
the influx of the backflow of ion-exchange portions into the container 41.

The clean water flowing from the top of container 21 through conduit 24 is fed to anion container A and leaves the latter through clean-water tube 30. Lye for regenerating the ions is fed through a conduit 57 to the regenerating container at the left in FIG. 1. The operation of the above-described process will be better understood upon consideration of FIGS. 2-5, inclusive. In such figures the same parts are designated with the same reference characters as those employed in FIG. 1. In FIGS. 2-5, inclusive, there is shown a treatment container 21, a backflow rinse container 31, and a regenerating-and-washing-column 41. In order to provide a greater length of column 41, as shown in FIGS. 2-5, inclusive, such column is of U-shape. As a result of such construction, much space is saved.

As shown in FIGS. 2-5, inclusive, the ion-exchange masses are drained from container 31 and 41 by means of immersion tubes 23 and 33 respectively, such tubes being submerged in the container headpieces to a depth such that just one resin portion can be drained in one cycle of the operation of the installation. In this manner, there is always possible a simple determination of the transported resin, which is that amount in the head of the column which can be drained through the tube up to the level of immersion of the tube. The resin portion formed by the depth of immersion of the tubes 23 and 33 corresponds to that amount in the drain funnel 21a of container 21. These volumes must be coordinated. The use of the immersion tubes 23 and 33 has, apart from the simple determination of the resin portion to be forwarded, the additional essential advantage in comparison with all of the other well-known methods of this kind: the forwarding of the resin portions is interrupted only by the time interval of the opening and closing times of the valve. When a minor water push follows the transport or feeding of the resin, the feeding conduits are rinsed clean and no residue of resin will be present in the tubes and valves. In this manner, the wearing of the valves and the wasting of resin are avoided.

In FIG. 2 there is illustrated a condition wherein there occurs a forwarding of the ion-exchange mass from container 21 through conduit 25, with valve 4 open, into the back-rinse container 31. In such figure the valves which are open are illustrated with an outline only whereas the valves that are closed are shown fully inked-in. A part of the partially drawn resin is already in the lower funnel part 31c of the back-rinse container 31, while a further, already used, resin portion 31a is settled over a mixing zone 31b. In order to obtain a thorough rinsing of the resin, the volume of container 31 is calculated to be able to contain at least two resin portions.

During the back-rinse process, the washing-and-regenerating process takes place in the washing-and-regenerating-column 41 in different zones thereof which are marked accordingly. The regenerating agent is fed through conduit 46 in the middle region of column 41, and the resin introduced through conduit 36 is regenerated in the countercurrent. In this way there are obtained three zones corresponding to the time of stay of the resins during three working cycles. In the region 41a, in which the resin is in contact with the used regenerating agent, there takes place a preregenera-

tion. In region 41b regeneration takes place; in region 41c the resin is in contact with the concentrated, unused regenerating agent. In order to achieve a uniform regeneration at the influx, a constant circulation is provided by a conduit 46 to which the conduit 18 is connected, the pump 17, described in detail in connection with Figs. 6 and 7, and the conduit 64. In the region 41d and 41e and 41f the newly regenerated resin is washed. The wash and diluting water is fed in through conduit 42. The water flowing through resin portion 41f (in the wash zone) which is still rather lightly clean, pre-washes the resin in region 41d. In the regenerating zones this water simultaneously serves as diluting water, so that an optimal use of the water is possible, which has favorable effects on the water consumption and the volume of water to be drained. The water entering zone 41e from zone 41d still contains an excess of regenerating agent, which, together with the regenerating agent fed, are used completely, so that consumption of regenerating agent is very small.

In FIG. 3 there is shown the same portion of the installation as in FIG. 2 but in a later portion of the operating cycle. Resin is being transported from back-rinse container 31 through open valve 5 to the washing-and-regenerating-column 41. A part of the washed resin 31a has already been drained and is located in region 41a. In the region of the clean wash zone 41f there has now occurred an accumulation of a resin portion. The displacing water is being drained through open valve 10 to the untreated water container 48.

FIG. 4 shows the portion of the installation shown in FIGS. 2 and 3, but in the condition of backrinsing. With valve 14 open, wash water is conducted through conduit 25, while the used rinsing water is being drained through conduit 34 in which the valve 8 is open. There is only one portion of resin 31a present in the back-rinse container 31, which is being loosened by the back-rinse and thus practically takes up the whole volume of the container. There are 6 portions present in 6 zones in the washing-and-regenerating-column 41, namely, in the three regenerating zones mentioned above as well as in the clean wash zone 41f, the wash zone 41e, and the pre-wash zone 41d. Regenerating agent is fed into the region 41c, and, after passing through the preregenerators zones 41d and 41a, is drained through conduit 38 and open valve 13, while wash water is led in through conduit 42.

In FIG. 5 there is illustrated the flowing of resin from the washing-and-regenerating-column 41 to the container 21 through conduit 43 and open valve 3. Through conduit 42 and open valve 12 forwarding water is being fed in, such water causing the resin to be drained through conduit 33. With the inflowing of the resin portion through the head of container 21, part of the used resin sinks to the drain funnel 21a (See FIG. 1). The untreated water supply is blocked by the closing of valve 1, and the operation is interrupted during this short phase. The raw water in container 21 is drained through open valve 7 in conduit 20a.

As shown in FIG. 5, the upper level in container 21 is not even, but is conically shaped. This results in the first advantage, that the free filler surface is increased, which is very advantageous at great speeds of flow in view of the self-resistance. A second advantage is that, likewise as shown in FIG. 5, a uniform distribution of the ion-exchange material is obtained in the operating column 21.
The different zones shown in container 21 show different grades of loading of resin. The most strongly bonded ions, for example, Cu, Ni, Cr, Al, etc. settle in the lowest zone in the region of the untreated-water inlet, while in the second zone, for instance Na, K, NH4, Ag, etc. will be found and in the third zone there will be found, for example, Na. As the heavily loaded, lowest layer is drained immediately to the back-rinsing-and-regenerating-column 31 through conduit 25, the attack by strongly oxidizing substances on the ion-exchange resins will not be so disadvantageous as with the usual processes with ionexchange columns. This follows because these substances in the following back-rinse-regenerator-exchange process are immediately again exchanged. Tensides (surface active substances) are mainly taken from the lowest layers of the resins in the operating container 21 and are immediately expelled on the next cycle. The dangerous ageing of tensides of ion-exchange substances is therefore avoided.

The degree of cleanliness of samples taken from the various taps 53-56, inclusive (FIG. 1), is dependent upon the degree of loading of the resin. As soon as a proposed value of cleanliness is attained, the cycle is terminated and the resin is automatically forwarded as above-described. The installation is designed for a minimal cycle time of 8 minutes. With decreasing salt content of the water, the loading zone in the operating container 21 travels downwardly, whereby the cycle not only exceeds 15 minutes, but, for example, will consume as much as 20 to 30 minutes or even more.

If no water is taken from the pipe 30 by a consumer, the clean water will be passed into the clean-water container 49 which is combined with the untreated water container 48. The clean water then flows from reservoir 49 into untreated-water reservoir 48 and from there passes through the untreated-water conduit 20 to the operation and treatment container 21. Since during this time there is no flow of water from the wash column 41 through the treatment column 21, the run-off from the regenerating column 41, which is not now loaded with salts, is conducted via the conduit 38 to the raw-water container 48 after reaching the predetermined degree of cleanliness which is determined through the taking of samples at the tap 15. This constant turnover is advantageous to avoid a counter-ion-effect as well as to avoid a loss of ions from the container 21.

The wash and back-wash water drained from the tubes 20a, 32 and 16 will be fed to raw water container 48, while the forwarding waters, for example, from conduit 44, will be returned to the circulation, namely in back-rinse-water-wash container 31 or in the regenerator-and-wash-column 41. The used water from conduit 38 is employed only as diluting water for the regeneration of the chemicals. Desalinated water from the clean-water container 49 is used entirely for the forwarding of resin. The washing water is used 3 times in the regenerator-and-wash-column 41, namely to clean-wash, to wash and to pre-wash, and afterwards to be used as a diluent in the regenerating process. Because of this, the amount of water needed in the process can be quite limited, which is an economic advantage. The water consumption in this installation is considerably less than that in other conventional installations having ion-exchange columns. The same is true for the necessary supply of ion-exchange materials, which are lower in this process than in other known installations.

Because of the thorough washing of resin in the back-rinse container 31 before the regeneration step, all types of mechanical pollution are avoided. Any finely-divided particles produced by the forwarding of the resin will be rinsed out. Water entering the system may be dosed with a suitable disinfectant material, for example, at the back-rinse container 31, so as to produce disinfection of the resin.

The resin portion forwarded in one cycle of operation of the installation corresponds at a maximum to about 1/12 of the total volume of the ionexchange material in the operating column 21. For the regeneration and washing process there are required the following approximate times:

a. with a cycle of 20 minutes in the washing-and-regenerating-column every 60 min.
b. with a cycle of 15 minutes in the washing-and-regenerating-column every 45 min.

An increase in the cycle volume in the wash as well as the regenerating zone leads to a predictable increase in the efficiency of the process and a decrease in water consumption.

As has been shown in FIGS. 1-5, inclusive, there is provided at the junction between the wash-and-regenerating zones of the regenerator column 41 a circulation conduit 18, 63, 64 in which a pressure pump 17 is interposed. This junction is shown in detail in FIGS. 6 and 7. The regenerating chemical fed through tube 46 is impinged upon by a transverse flow of a small amount of water, which occurs in a flange or circular piece designated 60. In a circleshaped outer flange 61 there is disposed a ring 62, which is connected with a flange through a separating piece 65. The inner ring 62 has openings 62a therethrough, so that the water entering through conduit 63 through opening 62a flows in the direction of the arrows to the inner space within the ring 62 and leaves through the diametrically opposite opening 62b and conduit 64. A fine screen 66 covering openings 62a and 62b and mounted in the inner lining of ring 62 prevents the discharge of resin. Through this transverse flow the regenerating agent is constantly acted upon throughout the whole diameter of the ring 62. By reason of this motion of the two liquids which impinge upon each other, the regenerator treatment is constantly diluted and simultaneously evenly distributed. Highly concentrated chemicals can be used, for example, 30% hydrochloric acid or 50% soda lye (caustic soda solution).

In FIG. 8 there is schematically illustrated a continuously-operating installation in accordance with the invention, such installation operating as a mixed-bed installation. Parts in FIG. 8 which are the same as those in FIGS. 1-7, inclusive, are designated by the same reference characters. In the treatment container 21 of FIG. 8 there is a mixed bed, which is cycle-and-portion-wise moved through a following backrinse and separating container 131. In this container the resins will be back-washed thoroughly, and they thereby separate according to their specific gravities. The cations will be drawn off by means of an immersion tube 131c in the bottom of the separating container, while the anion-exchanger will be drawn off through an upper immersion tube 131b. The chamber 131a is available as an additional loosening space. As the cations will be regenerated and then washed in a post or afterconnected wash
and regenerating column 71, the anions will be fed in a corresponding regenerating-and-wash column 72. These columns may be of the same construction as those described in connection with FIGS. 6 and 7. After the transporting of resins from the regenerating-and-wash column 71 and 72, the resins will be reunited in a mixing piece 73 and fed through a conduit 43 to the container 21. The mixing piece is so constructed that the anion and cation charges are intimately mixed and then reach the treatment container as a mixed bed. Thus installations in accordance with the invention may, without appreciable changes, and with equal advantages, be employed for the preparation of watery solutions in a mixing bed with circulation flow.

It was shown that with quasi-continuous working installations a significant disturbance may occur, by reason of considerable resistance in the upper distribution system of the treatment container 21 due to pollution by fine grains, for example, abraded pieces of resin and so forth. According to the invention, a so-called shock-rinsing is provided. This occurs during the short interruption phases immediately before the influx of resin through the head of treatment container 21 with a waterflow counter to clean water flow from top to bottom in the operating container 21, which results in the elimination of particles of dirt. Such a “shock-rinse-device” is schematically shown in FIG. 9. From the rinse-water tube there is provided a branch tube 80 parallel to the valve 2, to be operated by a valve 81. The water necessary for this operation will be pumped from a clean-water reservoir 49 by means of a pump 47, which also forwards transport water via rinse-and-transport-water tube 84 into the headpiece of container 21 and, with opened valve 7, is drawn off from the bottom of the container 21 via tube 26a. This whole process is finished in a few seconds.

In FIG. 10, there is shown an embodiment of a back-rinse, and a regenerating-and-wash column in a single unit construction. In a circular cylindrical container 90 there is centrally disposed in an axial direction a column 91. The back-rinse process takes place in the latter, whereby the resin is fed through an intake funnel 92. The back-rinse will take place in the inner column 91. After the inflow of the regenerating agent via an opening 93 provided on the bottom of the container 90, the resins will be regenerated and forwarded in the space 94 between the inner column 91 and the outer container 90. The resin is drawn off through an immersion tube 96 from which it flows to a discharge conduit 95. The rinse-and-transport water is led through conduit 97 into the container 90. The diameter of the column 91 is generally the same as the radial distance between the confronting walls of the column 91 and the container 90. This embodiment has the advantage that it considerably reduces the space required by the back-rinse, regenerating, and wash-column portions of the installation.

The above-described installations may be employed in a variety of manners:

- For the entire desalination of water, in combination with a carboxylic acid scrubber, weak and strong acid cation-exchangers and weak or strong basic anion-exchangers.

- As a water softener whereby a regenerated exchange column functions as a neutral exchanger with salt spring water.
way limited to the disclosure of such plurality of embodiments, but is capable of numerous modifications within the scope of the appended claims.

What is claimed is:

1. In a system for the treatment of water solutions by means of ion exchange masses, wherein the ion exchange masses through which the solutions flow are conducted in charges cyclically from a treatment container to a regeneration-and-wash column and in circulation are returned to the treatment container, the improvement which comprises,

   a backrinse container, a regeneration-and-wash column and a treatment container,

   said containers and column each having top and bottom portions and inlets and outlets for the ion exchange masses,

   conduit means operatively connected to the inlets and outlets of said backrinse container, regeneration-and-wash column and treatment container for conducting said ion exchange masses therebetween,

   said conduit means comprising a first pipe connecting the outlet of said treatment container to the inlet of said backrinse container, a second pipe connecting the outlet of said backrinse container to the inlet of said regeneration-and-wash column, and a third pipe connecting the outlet of said regeneration-and-wash column to the inlet of said treatment container,

   said regeneration-and-wash column and backrinse container having each at least one immersion tube extending therein from their respective top portions,

   the immersion tube in said regeneration-and-wash column being connected to the top portion of said treatment container by said second pipe and the immersion tube in said backrinse container being connected to the regeneration-and-wash column by said second pipe, said immersion tube in said regeneration-and-wash column taking off an amount of ion exchange mass charge for conduction to the top portion of said treatment container the volume of which corresponds to the volume of ion exchange mass charge removed from said funnel-like bottom portion of said treatment container, said immersion tubes respectively extending within said top portions of said backrinse container and regeneration-and-wash column to an extent which corresponds volumetrically to a charge of ion exchange mass, and

   means for introducing untreated water solution into said treatment container,

   means for removing clean water from said treatment container,

   means for introducing and removing backrinse water in said backrinse container,

   means for introducing and removing wash water in said regeneration-and-wash column,

   an inlet and outlet tube operatively mounted in the mid-region of said regeneration-and-wash column for introducing a regeneration agent therein,

   a recirculating device operatively connected to said inlet tube and outlet tube,

   a conduit tube connecting said inlet and outlet tube, a pump operatively mounted in said conduit tube for producing a cross-water flow in said mid-region of said regeneration-and-wash column via said inlet and outlet tube,

   a cylindrical member forming part of said recirculation device and being coaxially mounted in said mid-region, said cylindrical member having diametrically opposite openings for the cross-water flow.

2. A system according to claim 1 wherein the backrinse container as well as the wash-and-regeneration column are formed as a single unit, said unit having an outer container, an axially extending inner container arranged within the outer container and extending to the vicinity of the bottom of the outer container and defining an annular space therebetween, the inner container forming the backrinse container and the annular space between the inner and the outer containers forming the regeneration-and-wash column.

3. A system according to claim 1 wherein the regeneration-and-wash column is U-shaped.

4. A system according to claim 1 wherein the backrinse container has a volume such that it contains at least the volume of two ion-exchange mass charges.

5. A system according to claim 1, wherein both the upper and the lower ends of the treatment container are shaped conically.

6. A system according to claim 1, including a clean-water reservoir, said clean-water reservoir being combined with an untreated-water reservoir, and conduit means connecting said clean-water reservoir to said means for introducing back-rinse water and connecting said untreated-water reservoir to said means for introducing untreated water solution, and a device providing for the overflow of clean-water into the untreated-water reservoir. # # # #