

SPECIFICATION

A liquid purification device

5 The present invention relates to a device for purifying a liquid, for example water.

The purification of water, which is to be used as drinking water, requires, in general, large devices such as clarification basins, filters, etc. This is not objectionable if sufficient space is available, and the materials and parts for constructing and assembling such devices can be easily transported towards the site of the purification plant.

15 In inaccessible regions, in particular in developing countries, the supply of materials and equipment is often very difficult because of bad communications, especially since a considerable part thereof must be imported from abroad because of the absence of local industries. A further draw-back is that an insufficient number of skilled persons is often available, which sincerely hampers the construction and assembly of such installations and maintenance and repair thereof. This means that purification plants which are designed for large cities are completely unsuitable for isolated communities.

Since, however, water purification is one of the most important requirements when fighting epidemics and raising public health standards, there exists a growing need for purification installations which are suitable for such applications, and which, in particular, do not require much maintenance and supervision.

According to the invention, there is provided a device for the purification of a liquid comprising a substantially rectangular tank having a coalescence compartment, a separation compartment, and a filtration compartment, the coalescence compartment communicating with a liquid supply and comprising at least one flow channel in which coalescence will take place as a consequence of transverse velocity gradients caused by wall friction, the separation compartment being connected to the outflow end of the coalescence compartment and comprising a plate separator consisting of one or more sets of superposed inclined parallel corrugated plates defining therebetween separation passages, the corrugations being directed substantially in the direction of inclination of the plates and communicating with at least one collecting chamber for components separated from the liquid, and the filtration compartment being connected to the outflow end of the separation compartment and being arranged to contain filter material, the outflow end of the filtration compartment being arranged to be connected to a liquid discharge duct.

A preferred embodiment of the invention to be described has relative small dimensions so that it can be transported as a ready made unit towards the utilisation site on a road or a

railway vehicle, and can be placed in inaccessible places without needing highly skilled personnel. On site, the device needs only to be connected to a supply of water to be purified and to a distribution system.

The coalescence compartment generally comprises one or more substantially vertical channels which, in the case of more than one channel, are connected in series so that the flow sense therein is alternately upwards and downwards, said channels having such transverse dimensions that the wall friction will create in the liquid flow transverse velocity gradients causing the suspended particles to overtake one another, which substantially increases the probability of particles meeting and coalescing with one another. The velocity gradients can be increased by arranging auxiliary plates in said passages, thus increasing the friction surface and reducing the wall distance, which plates may be slidable in their longitudinal direction so as to vary the contact area with the liquid. If corrugated plates are used having corrugations which are directed transversally to the flow direction, it is possible to vary the phase relationship therebetween by shifting alternate plates by one half wave length of the corrugations, which has a considerable effect on the velocity gradients therebetween.

In order to prevent the coalesced particles from being disrupted again by shearing forces caused by the transversal velocity gradients, it is often advisable to reduce these gradients in the flow sense by widening the channels and/or by reducing the number of auxiliary plates in the flow sense.

The plate separator arranged in the separation compartment is, preferably, a cross-flow separator in which the corrugations of the plates are directed transversally to the flow direction of the liquid through the separation passages, the separated components collected in the corrugations then being shielded off from the flow which reduces the chance that separated particles are dragged along again by the liquid flow. A cross-flow separator will, therefore, have a better separation efficiency than a normal plate separator of the same dimensions.

Such a cross-flow separator can, in particular, be composed of two sets of plates which are arranged symmetrically in respect of a median plane. It is also possible to arrange two or more of such separators in parallel, in which case the coalescence and/or filter compartments thereof may be interconnected.

The separation effect may be improved by adding suitable substances which promote the coalescence or separation effects.

An embodiment of the invention will now be described, by way of example only, with reference to the diagrammatic drawings, in which:

Figure 1 is a simplified representation in

perspective of a water purification device according to the invention;

Figure 2 is a cross-section on line II-II of Fig. 1;

5 Figures 3 and 4 are simplified cross-sections of a part of Fig. 2 with auxiliary plates; and

Figure 5 is a cross-section on line V-V of Fig. 1.

10 The water purification device shown comprises a rectangular tank 1 having, in general, such dimensions that it can be easily transported on a normal road or rail vehicle. This tank 1 is divided into three compartments, viz. a coalescence (or particle growth) compartment 2, a separation compartment 3, and a filtration compartment 4.

The structure of the coalescence compartment 2 clearly follows from the cross-section shown in Fig. 2. This compartment is divided, by means of generally vertical partitions 5, into a plurality of successive channels 6 (three in the case shown) which are directed alternately upwardly and downwardly, the transversal cross-sectional area of the consecutive channels 6 increasing in the flow sense (i.e. from left to right).

The water to be purified is supplied through a duct or tube 7 to the first channel 6, and flows successively through these channels. Because of the wall friction, the flow velocity near the walls will be smaller than in the central parts of the flow, so that more centrally situated flow parts will overtake adjacent outwardly situated flow parts. This means that suspended particles in these flow parts have an increased probability to meet one another and, thus, to coalesce. The grown particles, however, can fall apart again when shearing forces are exerted thereon, and such forces may be generated by two adjacent flow layers having a different velocity. It is, therefore, advisable to reduce the transverse velocity gradients in the sense of flow, i.e. to use strong gradients in the first channel for starting the particle growth, and then to reduce these gradients so as to avoid the possible disruption of particles as they are growing bigger, which reduction is obtained by increasing the wall distances in the consecutive channels. It is also possible to use inclined partitions 5 so as to obtain channels with a gradually increasing cross-section.

After having passed through the last channel 6, the water enters at 8 the separation compartment 3. Heavy particles which have already separated in the coalescence compartment 2 are collected on the bottom thereof, and will be removed at 9 at regular intervals, e.g. by opening a valve (not shown).

As shown in Fig. 3 the wall friction in the first channel 6 (and, if required also in subsequent channels) can be increased by arranging auxiliary parallel plates 10, dividing the channel in question into a plurality of sub-

channels having an accordingly smaller wall distance. As shown these plates may have different lengths so as to reduce the wall effect in the sense of flow, and it is also possible to use slidable plates allowing to adjust their area of contact with the liquid.

Fig. 4 shows corrugated plates 10' for the same purpose, the corrugations being directed transversely to the flow direction. As shown at A and B the configuration of the flow paths between such plates can be considerably changed by shifting alternating plates by one half wave length of the corrugations so as to change an in-phase relationship into a phase-opposition relationship. In the latter case the successive expansions and constrictions will cause rather large velocity differences having a considerable effect on the coalescence, whereas, in the former case, velocity gradients of periodically changing direction will be obtained, which are more gradual than in the case of phase opposition. Intermediate positions will provide intermediate effects.

The number of plates may be larger than shown in the drawing, and it will be clear that such auxiliary plates 10 or 10' can be positioned either, as shown, perpendicular to the plane of drawing, or parallel thereto, i.e. parallel to the longitudinal plane of symmetry of the tank 1.

Fig. 5 shows the structure of the separation compartment 3, comprising, in the case shown, two sets of parallel plates 11, which, as also appears from Figs. 1 and 2, are provided with transverse corrugations. The number of plates shown is smaller than it will be in practice, so as not to overload the drawing.

The water leaving compartment 2 at 8 flows through the passages 12 between the plates 11. The flow is, in this manner, divided into a plurality of narrower partial flows, so that the separation path length of particles suspended in the water will be shortened accordingly. Sedimenting components are collected in the valleys of the lower plate of the various passages, and flow along these valleys towards the lower edge of the plate in question. The adjacent corrugation tops provide a shadow effect, thus protecting the sediment flows from being entrained again by the liquid flow, so that the sediment will be removed undisturbed.

Such a so-called cross-flow separator provides, within a given volume, a much better separation effect than other plate separators in which the various flows have the same or opposite direction, so that a cross-flow separator is preferred for the present purposes, where reduced dimensions are of the greatest importance.

At the lower side of the plates 11 the sediment will fall downwards from the plates. Transverse baffles 13 are arranged between the adjacent lateral wall of the tank 1 and at

least some of the tops of the superposed plates 11. These baffles 13 prevent that the water flow will pass beyond the separation passages 12, which would seriously affect the separation efficiency, and, moreover, such by-pass flows would drag along sediment falling down from the edges of the plates 11, which would also reduce the separation effect. The passages between these baffles 13 are leading towards one or more collecting funnels 14 below the assembly of plates 11, said funnels being provided with discharge openings 15 which may be closed by a valve not shown. In order to avoid passages 12 between narrower plates 11, the sets of plates consist of plates with the same width, and the corner parts are closed by triangular plates 16.

In the case shown two symmetrical plate assemblies are provided at both sides of a central vertical partition 17, there being in fact two cross-flow separators provided in parallel. It is also possible to use plates having the lower sides in the central part, in which case the partition 17 will be omitted, and the transverse baffles 13 should then be arranged in the central part.

If also floating components are present in the water, which will be collected in the tops of the upper plates 11 of the passages 12, it is to be made possible for such components to leave the tops at the higher side of the plates 11, and also in this case corresponding baffles 13 may be provided.

The baffles 13 are not always required, if the corrugated plates 11 extend up to the lateral wall or the central partition 17, as the case may be, since, then, small openings 18 will remain free, as shown in Fig. 1, through which the components in question may escape.

The separation compartment 3 is closed, at its other end, by a vertical wall 19 forming an overflow weir over which the purified water will flow into the filtration compartment 4. In the case of components floating on the water in compartment 3, an underflow weir (not shown) should be provided preventing the floating layer from spreading into the filtration compartment 4.

In the filtration compartment 4 a suitable filter will be provided for removing those components which are not sufficiently separated from the water. This filter may be any kind of filter, such as a sand filter. The clarified water is removed via a pipe of duct 20.

The purification effect can often be improved by adding chemicals which enhance coalescence and/or separation, and provisions can be made for supplying such chemicals in suitable points, e.g. to the supply duct 7.

A device of this kind can be manufactured with such dimensions that it can be transported in the fully completed state on a normal road or rail vehicle. Of course the filter

can be provided after mounting the tank 1 at the place of utilisation, and often the filter material such as sand can be found in the direct neighbourhood. The plates 11 of the separator are made of a relatively light plastic material, so that they can be mounted in the factory, and do not substantially increase the total weight to be transported.

Such a device does not need much supervision since it does not comprise moving parts, the only maintenance being the periodic backwashing of the filter material by means of a reverse water flow for removing therefrom the impurities accumulated therein.

If the water to be cleaned is flowing downwards with a sufficient height difference, even pumps can be avoided, so that, then, supervision and maintenance will be reduced to a minimum, and does not require specially schooled personnel.

For instance a tank with a length of 5 m, a width of 1.5 m and a height of 4 m can have a capacity of 50 m³/h. Although with larger tanks larger capacities will be obtained, it will, generally, be more economic to use a number of such devices in parallel, since, then, transport will be easier and, moreover, it will be possible to clean these devices separately without interrupting the water supply.

It will be clear that devices of this kind can also be used for cleaning waste liquids before draining so as to avoid pollution problems.

Within the scope of the invention many modifications are possible.

CLAIMS

1. A device for the purification of a liquid comprising a substantially rectangular tank having a coalescence compartment, a separation compartment, and a filtration compartment, the coalescence compartment communicating with a liquid supply and comprising at least one flow channel in which coalescence will take place as a consequence of transverse velocity gradients caused by wall friction, the separation compartment being connected to the outflow end of the coalescence compartment and comprising a plate separator consisting of one or more sets of superposed inclined parallel corrugated plates defining therebetween separation passages, the corrugations being directed substantially in the direction of inclination of the plates and communicating with at least one collecting chamber for components separated from the liquid, and the filtration compartment being connected to the outflow end of the separation compartment and being arranged to contain filter material, the outflow end of the filtration compartment being arranged to be connected to a liquid discharge duct.

2. A device according to claim 1, wherein the coalescence compartment consists of a plurality of channels with alternately upward and downward flow sense.



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2. A device according to claim 1, wherein the coalescence compartment consists of a plurality of channels with alternately upward and downward flow sense.



3. A device according to claim 2, wherein the cross-sectional area of the channels increases in the flow sense.
4. A device according to claim 2 or claim 3, comprising auxiliary plates arranged in one or more of the channels of the coalescence compartment, the auxiliary plates dividing the channels into subchannels connected in parallel.
5. A device according to claim 4, wherein the auxiliary plates are of different lengths.
6. A device according to claim 4 or claim 5, wherein the auxiliary plates are slidable.
7. A device according to any one of claims 4 to 6, wherein the auxiliary plates are corrugated, the corrugations thereof extending substantially transversely to the flow direction.
8. A device according to any one of claims 1 to 7, wherein the plate separator is a cross-flow separator in which the corrugations of the plates are directed transversely to the flow direction.
9. A device according to any one of claims 1 to 8, comprising guiding baffles arranged between a free extremity of the superposed plates of the separator and an adjacent wall, one edge of these baffles engaging superposed corresponding corrugations of the plates.
10. A device according to claim 8 or claim 9, comprising plates closing triangular spaces defined above and below the outer plates of the or each set of corrugated plates.
11. A device according to any one of claims 1 to 10, wherein the separator comprises two sets of corrugated plates arranged symmetrically with respect to a longitudinal plane of symmetry.
12. A device according to any one of claims 1 to 11, wherein the connection between the separation compartment and the filtration compartment is formed by an overflow weir.
13. A device according to claim 12, comprising an additional underflow weir for retaining a floating layer in the separation compartment.
14. A device according to any one of claims 1 to 13, comprising means for adding chemicals promoting coalescence and/or separation of suspended compartments.
15. A purification installation, consisting of a plurality of devices according to any one of claims 1 to 14 interconnected in parallel.
16. An installation according to claim 15, comprising means for shutting off individual devices from the parallel connection.
17. A device substantially as hereinbefore described with reference to the accompanying drawings.