

WATER TREATMENT APPARATUS

Technical Field.

This invention relates to water treatment apparatus typically for use in aquaculture systems but also suitable for use in other applications.

5 Background Art

Aquaculture has commonly been conducted by growing fish, prawns and other marine invertebrates in outdoor ponds. The ponds however eventually become polluted because faeces, uneaten food and algae work their way to the bottom of the ponds. This makes the ponds almost impossible to clean. In addition large quantities of valuable
10 water are required to keep these systems functional. Other disadvantages are also associated with outdoor aquaculture systems. For example pests can eat stock, adverse weather conditions such as floods can cause stock loss by washing the stock away and very hot weather can cause growth of algal blooms which can kill the stock. In addition in very hot or very cold weather, the stock will stop growing. Muddy waters or disturbed
15 water can also cause the stock to have an unpalatable taste.

In order to overcome the above disadvantages, indoor commercial aquaculture systems were introduced where fish or other marine invertebrates are grown in tanks placed in large buildings or sheds.

A disadvantage of the known systems is that the buildings or sheds housing the
20 aquaculture system resemble a maze of pipes and plumbing as water is pumped between the system components such as tanks, filters, biological filters, foam fractionators, ultraviolet water treatment units and other water treatment components. These components are individual components which have to be set up in different parts of the building.

25 With regards to the individual components, if ultraviolet water treatment units are installed, they are installed into the main water flow pump line which reduces flow thus increasing the electricity consumption. In the foam skimmers or foam fractionators which are used in the conventional systems, insufficient bubbles or foam are created or forced out of the top of the units. If insufficient bubbles or foam are created, the
30 fractionators simply do not function. To make them function correctly, high pressure high energy pumps fitted with air venturis are employed but these do not always overcome the problem of inefficient operation.

Summary of the Invention

The present invention aims to provide improved water treatment apparatus typically for use in aquaculture systems but also suitable for use in other applications. Other objects and advantages of the invention will become apparent from the following
5 description.

The present invention thus provides in a first preferred aspect water treatment apparatus including an elongated first water chamber, an inlet for water at one end of said chamber, an outlet for water at the opposite end of said chamber and at least one ultraviolet light source within and extending longitudinally of said chamber.

10 Preferably, the first water chamber is arranged in a substantially upright attitude with the one end of said chamber comprises a lower end of the chamber and the opposite end of said chamber comprising an upper end of said chamber. The apparatus may also include a second water chamber with the outlet from the first chamber being connected to an inlet to the second chamber with means for exposing water in the second chamber to
15 ozone and/or air.

Preferably the second chamber is disposed in a substantially upright attitude and the inlet to the second chamber is disposed at an upper end of the second chamber and the second chamber having an outlet at a lower end thereof. An ozone and/or air outlet or outlets are suitably provided at the lower end of the second chamber for supplying
20 ozone and/or air to the chamber for the passage of ozone and/or air through water in the second chamber.

An air pump may be connected to the air outlet or outlets.

An ozone reactor or generator may be provided externally of the second chamber, the ozone reactor or generator being connected to the ozone outlet or outlets.

25 Collecting means may be provided at the upper end of the second chamber for collecting foam at or adjacent the surface of water therein and a waste outlet is connected to the collecting means. The collecting means may comprise a conical member or funnel. A float may be provided for supporting the conical member at or adjacent the surface of water.

30 The water treatment apparatus may be used in combination with a reservoir for containing water to be treated, the inlet to the first chamber and the outlet from the second chamber being connected to the reservoir.

Means such as an air supply may be associated with the second chamber outlet for assisting flow of water from the second chamber into the reservoir.

The ultraviolet light source may comprise an elongated ultraviolet lamp.

5 In an alternative arrangement, the first chamber may include the means for exposing water in the chamber to ozone and/or air and the second chamber is not required. Thus an ozone and/or air outlet or outlets may be provided at the lower end of the first chamber for supplying ozone and/or air to the chamber for the passage of ozone and/or air through water in the chamber.

10 As above an air pump may be connected to the air outlet or outlets. Suitably also an ozone reactor or generator may be provided externally of the first chamber, the ozone reactor or generator being connected to the ozone outlet or outlets.

The first chamber may include collecting means at its upper end for collecting foam at or adjacent the surface of water therein and a waste outlet is connected to the collecting means. The collecting means may comprise a conical member or
15 funnel. The conical member or funnel may be adjustably supported for height variations within the chamber of the foam fractionator. Alternatively, and as referred to, the funnel member may be supported by a float or floats at or adjacent the level of water in the foam fractionator chamber.

The ultraviolet light source is arranged centrally in the first chamber. A plurality
20 of ultraviolet light sources may be provided. The ultraviolet light sources may be arranged circumferentially in the chamber.

The first chamber may be used in combination with a reservoir for containing water to be treated with the inlet and outlet from the first chamber being connected to the reservoir. Means such as an air supply may be associated with the outlet for assisting
25 flow of water from the first chamber into the reservoir.

The outlet may communicate with the reservoir through a return line. Air may be supplied to the return line to assist in water flow back to the main chamber. The return line suitably includes a portion within the main chamber which extends in a direction to assist in circulating flow of water in the main chamber. The return line
30 portion in the main chamber may be apertured to allow controlled escape of air in the form of bubbles from the return line.

Brief Description of the Drawings

In order that the invention may be more readily understood and put into practical

effect reference will now be made to the company drawings which illustrate the preferred embodiments of the invention and wherein:

Fig. 1 illustrates in perspective view, a building module defining an aquaculture system incorporating water treatment apparatus according to a first embodiment of the present invention;

Fig. 2 is a sectional elevational view of the building of Fig. 1;

Fig. 3 is a sectional plan view of the building of Fig. 1;

Fig. 4 illustrates the building of Fig. 1 with the end flaps open;

Fig. 5 illustrates the layout of the plumbing pipes of the system incorporated in the base or foundation of the building module;

Fig. 6 illustrates in sectional view the water treatment apparatus comprising a foam fractionator and associated ultraviolet and ozone generator units as used in the system of Figs. 1 to 4; and

Figs. 7 and 8 illustrate in sectional view further forms of water treatment apparatus for use in the aquaculture systems.

Detailed Description of the Preferred Embodiments

Referring to the drawings and firstly to Figs 1 to 4, there is illustrated an aquaculture system 10 in the form of a modular building 11 comprising and defining a main chamber 12 for holding fish or marine invertebrates, a swirl chamber 13 which serves as a primary filter and a biological filter-drum or screen filter chamber 14 of a secondary filter. The chambers 12, 13 and 14 have their bases at substantially at the same level however the water level in each chamber is controlled such that the level in chamber 14 is less than the level in chamber 13 and the level in chamber 13 is less than the level in chamber 12. This then allows flow of water from the main chamber to the swirl chamber 13 and then to the chamber 14 under the influence of gravity without pumping. The building module 11 also defines a biological filter tank 15 which is elevated and located above the main chamber 12. Opposite end integral hip roof and wall sections 16 and 17 extend from opposite sides of the tank 15 and over the main chamber 12 and swirl chamber 13 and filter chamber 14 respectively to define enclosed air spaces over the main chamber 12 and chambers 13 and 14.

The building 11 may be constructed of any suitable materials such as steel, timber, fiberglass or any other mouldable materials, or any other materials however the preferred material of construction is concrete suitably a concrete which is waterproof and

provides sufficient strength to the building 11 and additionally has high insulation properties such that no additional insulation is required and further facilitates moulding of the tank 12 and chambers 13,14 and 15. The main chamber 12 and chambers 13 and 14 may be formed as one moulding indicated generally at 18, and the tank 15, and roof and wall sections 16 and 17 as separate mouldings which are then assembled and jointed to the lower moulding 18. Opposite end walls of the tank 15 and roof and wall sections 16 and 17 are thus aligned with the opposite side walls of the moulding 18 and the outer ends walls of the roof and wall sections 16 and 17 are aligned with opposite end walls of the moulding 18. The opposite end walls of the roof and wall sections 16 and 17 are closed by hinged panels 19 which may be pivoted upwardly as shown in Fig 4 to provide access at one end to the chamber 12 or at the other end to the chambers 13 and 14. The biological filter tank 15 is also closed by upper lid panels 20 which are hingedly mounted by central hinges 21 to enable them to be lifted to provide access to the interior of the tank 15. It will be apparent that when they panels 19 are closed, the building 11 defines a fully enclosed air space over the chambers which facilitates control of air and water temperature.

The main chamber 12 is of a generally rectangular or square configuration with the corners thereof being truncated as at 22. A spillway 23 is provided on one side of the chamber 12 and at an elevated location to convey water in the chamber 12 above the level of the spillway 23 into the swirl chamber 13. This acts as a skimmer to remove any floating scum or other materials from the surface of the water in the chamber 12. A screen 24 of mesh-like form is provided across the spillway 23 to prevent fish from escaping from the main chamber 12 into the swirl chamber 13. The main chamber 12 also includes a central drain outlet 25 with which communicates through a passage 26 with the periphery of the base of the swirl chamber 13 at 27 which directs water from the chamber 12 into the chamber 13 in a generally circumferential direction such as to effect anti-clockwise swirling motion of water in the chamber 13. The passage 26 carries fish and food waste from the main chamber 12 into the swirl chamber 13 without the use of pumping equipment which may breakup particles within the chamber 12. The passage 26 may also have a branch line 28 through which water may be drained from the chamber 12 under the control of a valve 29 externally of the building module 10 (see Fig. 5).

The main chamber 12 also includes in the outer pair of truncated corners 22, a

pair of foam fractionators 30 for oxygenating and cleaning the water in the main chamber 12. Associated with each foam fractionator 30 is an ultraviolet unit 31 for killing pathogens in the water and one or more ozone reactor or generator units 32 for introducing ozone into the water in the fractionator 30 for sterilizing the water. The foam fractionator 30 as more clearly shown in Fig. 6 includes a chamber 33 moulded or incorporated into a corner section 22 in an upright attitude. The chamber 33 may be formed by a tubular pipe 34 having an upper end which extends above the corner 22 and which is closed by a removable cap 35. A return line 36 connected to the bottom of the chamber 33 extends upwardly and then through the wall of the chamber 12 and terminates in an outward flow duct 37 (see also Fig. 2) which extends in a generally circumferential direction relative to the tank 12. An air inlet 38 into the return line 36 at the lower end thereof directs a flow of air into the line 36 to assist in the flow of water back into the chamber 12. The duct 37 may be apertured to allow controlled escape of air into the chamber 12 in the form of air bubbles.

The chamber 33 communicates with the main chamber 12 via the ultraviolet unit 31 which has a chamber 39 which may also be defined by a tubular pipe 40 and which houses an elongated ultraviolet light generator 41 which is removably mounted in the chamber 39 by means of an end cap 42 engaged with the upper end of the pipe 40. A duct 43 communicates the lower end of the chamber 39 with the main chamber 12 and a further duct 44 communicates the upper end of the chamber 39 with the chamber 34. Thus the level of water in the chambers 33 and 39 is the same as the level of water in the chamber 12 and water before passing into the chamber 33 is exposed to ultraviolet light.

The ozone generator unit 32 also includes a chamber 45 which is also defined by a tubular pipe 46 located in an upstanding attitude in a tank corner 22 and which houses an ozone reactor or generator 47. An outlet duct 48 passes upwardly from the bottom of the chamber 45 and then downwardly in the chamber 33 to terminate in an air stone 49 to inject ozone into the water in the chamber 33 for passage as bubbles upwardly through water in the chamber 33 to expose the water therein to ozone.

A drain cone or funnel 50 is provided in the chamber 33 and is connected to a drain pipe 51 which leads outwardly of the chamber 33 to waste or for collection in a container if desired. Air for creating bubbles in the chamber 33 is supplied to the lower end of the chamber 33 to air stones 52 which are suspended via air supply ducts 53 connected to an air supply manifold 54 above the chamber 33. Air is supplied to the air

manifolds 54 via piping 55 in the slab of the building 11 (see Fig. 5) connected to an air pump 56 in the air space in the building module 11 within the roof and wall section 17 (see Fig. 2).

Thus water for treatment in the chamber 33 initially passes via duct 43 through
 5 the ultraviolet chamber 39 where it is exposed to ultraviolet light from the generator 41 which will destroy pathogens in the water and then the water passes through the duct 44 into the chamber 33. Air supplied to the air stones 52 via the ducts 53 exits as bubbles in the water which pass upwardly through the chamber 33 against the flow of water circulating through the chamber 33 in the opposite direction for flow through the return
 10 line 36 back to the chamber 12. Bubbles passing upwardly through the chamber 34 carry dirt and fat particles or other impurities in the water to the surface. In addition, the ozone reactor or generator unit 32 creates bubbles of ozone which also pass upwardly through the chamber 33 to sterilize and clean the water.

Bubbles upon reaching the surface of the water will froth up and create foam
 15 which flows into the drain funnel 50 carrying the dirt and fat particles through the drain pipe 51 to waste. The height of the drain funnel 50 can be adjusted to vary the extent to which bubbles are discharged and for this purpose may be supported adjustably on brackets 57. Alternatively, the drain funnel 50 may be attached to floats 58 to support the funnel 50 at or adjacent the level of water within the chamber 33. The foam is thus
 20 collected just above the water level and flows out through the funnel 50 under the influence of gravity. Water flowing outwardly from the chamber 33 and into the chamber 12 via the duct 36 and duct 37 creates a circulating flow of water in the tank 12 in an anti-clockwise direction (Fig. 3).

As the system 10 operates under low pressure, the foam fractionator 30 can be
 25 cleaned without stopping operation of the system 10 and similarly, the ultraviolet light generators 41 can also be removed for replacement of bulbs or repair whilst the system 10 continues to run. The ozone generator unit 32 can also be serviced whilst the system is operating. This is facilitated by having the foam fractionator 30, ultraviolet unit 31 and ozone generator unit 32 arranged to one side of the chamber 12 in a truncated corner 22
 30 or a wall of the chamber 12 and thus out of the main flow of water.

Referring now to Fig. 7, there is illustrated a further embodiment of foam fractionator 69. In this case, the separate ultraviolet chamber 39 of the embodiment of Fig. 6 is eliminated and the ultraviolet light generators 41 provided as a single tube set or

a multiple tube set arranged circumferentially about the funnel 50. The chamber 70 of the foam fractionator 69 communicates through upper and lower ducts 71 and 72 with the main chamber 12.

5 In the configuration of Fig. 8, the foam fractionator 73 has a foam collector 74 which is in the form of an inverted cone which is located around the sides of the fractionator chamber 75 so that the foam 76 is collected around the outer sides of the chamber 75. Multiple outlets 77 are provided to direct the collected foam 76 outwardly of the chamber 75 to waste. The foam collector 74 surrounds a central ultraviolet light generator 41 which kills pathogens and bacteria in the water. It will be noted that in this
10 embodiment, a submersible pump 78 is provided in the chamber 75 to assist in flow of water back into the main chamber 12 through duct 79 whilst water for treatment flows from the upper portion of the chamber 12 into the chamber 75 through duct 80.

As in the embodiment of Fig 6, an air stone or stones 52 are provided at the lower end of the chambers 70 or 75 to serve as an outlet or outlets for ozone and/or air for
15 bubbling through the water in the chambers 70 and 75.

The described water treatment apparatus may be employed in aquaculture systems other than aquaculture systems described above or in any other water treatment applications. Furthermore the separate components of the described water treatment apparatus may be used individually or separately.

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Claims

1. Water treatment apparatus including an elongated first water chamber, an inlet for water at one end of said chamber, an outlet for water at the opposite end of said chamber
5 and at least one ultraviolet light source within and extending longitudinally of said chamber.
2. Water treatment apparatus as claimed in claim 1 wherein said first water chamber is arranged in a substantially upright attitude and wherein said one end of said chamber
10 comprises a lower end of said chamber and wherein the opposite end of said chamber comprises an upper end of said chamber.
3. Water treatment apparatus as claimed in claim 2 and including a second water chamber, said outlet from said first chamber being connected to an inlet to said second
15 chamber and means for exposing said water in said second chamber to ozone and/or air.
4. Water treatment apparatus as claimed in claim 3 wherein said second chamber is disposed in a substantially upright attitude and wherein said inlet to said second chamber is disposed at an upper end of said second chamber and said second chamber having an
20 outlet at a lower end thereof.
5. Water treatment apparatus as claimed in claim 4 and including an ozone and/or air outlet or outlets at the lower end of said second chamber for supplying ozone and/or air to said chamber for the passage of ozone and/or air through water in said second
25 chamber.
6. Water treatment apparatus as claimed in claim 5 and including an air pump connected to said air outlet or outlets.
- 30 7. Water treatment apparatus as claimed in claim 5 or claim 6 and including an ozone reactor or generator externally of said second chamber, said ozone reactor or generator being connected to said ozone outlet or outlets.

8. Water treatment apparatus as claimed in any one of claims 4 to 7 and including collecting means at the upper end of said second chamber for collecting foam at or adjacent the surface of water therein and a waste outlet connected to said collecting means.

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9. Water treatment apparatus as claimed in claim 8 wherein said collecting means comprises a conical member.

10. Water treatment apparatus as claimed in claim 9 and including a float for supporting said conical member at or adjacent said surface of water.

11. In combination, water treatment apparatus as claimed in any one of claims 4 to 10 and a reservoir for containing water to be treated, said inlet to said first chamber and said outlet from said second chamber being connected to said reservoir.

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12. The combination of claim 11 and including means associated with said second chamber outlet for assisting flow of water from said second chamber into said reservoir.

13. Water treatment apparatus as claimed in any one of claims 1 to 12 wherein said ultraviolet light source comprises an elongated ultraviolet lamp.

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14. Water treatment apparatus as claimed in claim 1 or claim 2 and including means for exposing water in said chamber to ozone and/or air.

15. Water treatment apparatus as claimed in claim 14 and including an ozone and/or air outlet or outlets at the lower end of said chamber for supplying ozone and/or air to said chamber for the passage of ozone and/or air therethrough.

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16. Water treatment apparatus as claimed in claim 15 and including an air pump connected to said air outlet or outlets.

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17. Water treatment apparatus as claimed in claim 15 and including an ozone reactor or generator externally of said chamber, said ozone reactor or generator being connected to said ozone outlet or outlets.
- 5 18. Water treatment apparatus as claimed in any one of claims 15 to 17 and including collecting means at the upper end of said chamber for collecting foam at or adjacent the surface of water therein and a waste outlet connected to said collecting means.
- 10 19. Water treatment apparatus as claimed in claim 18 wherein said collecting means comprises a conical member.
20. Water treatment apparatus as claimed in any one of claims 14 to 19 wherein said ultraviolet light source comprises an elongated ultraviolet lamp.
- 15 21. Water treatment apparatus as claimed in claim any one of claims 14 to 20 wherein said ultraviolet light source is arranged centrally in said chamber.
22. Water treatment apparatus as claimed in any one of claims 14 to 20 and including a plurality of ultraviolet light sources.
- 20 23. In combination, water treatment apparatus as claimed in any one of claims 14 to 22 and a reservoir for containing water to be treated, said inlet and outlet from said first chamber being connected to said reservoir.
- 25 24. The combination of claim 23 and including means associated with said outlet for assisting flow of water from said first chamber into said reservoir.