AUTOMATIC TUBE CLEANER FOR ULTRAVIOLET FLUID (WATER) STERILIZER

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ABSTRACT

A circular cleaning device which scours the external surface of an ultraviolet radiation tube, which acts as a radiation source for bacteria kill in ultraviolet radiation fluid sterilizers, removes deposits, which precipitate out of the sterilizable fluid, from the external surface of the ultraviolet radiation tube, or its surrounding shield, and thereby sustains the emanation of high intensity radiation flux from the tube into the fluid which is to be sterilized.

13 Claims, 6 Drawing Figures
AUTOMATIC TUBE CLEANER FOR
ULTRAVIOLET FLUID (WATER) STERILIZER

BACKGROUND OF THE INVENTION

1. Field of the Invention
This invention relates to a cleaning device for fluid, particularly, water sterilizers.

More particularly, the present invention relates to a cleaning device for cleaning the outside surface of a protective sheath of a radiation tube of an ultraviolet radiation water sterilizer or the like, wherein the sterilizer employs a longitudinal ultraviolet radiation tube as a source of ultraviolet radiation or flux.

2. Description of the Prior Art
Water sterilizers may employ ultraviolet radiation tubes as a source of flux for the creation of ultraviolet radiation, and usually have a longitudinal ultraviolet tube, suspended coaxially along the axis of a cylindrical sterilization chamber. The water which is to be sterilized flows from one end of the cylinder (usually the bottom) in a vortex-like manner, to the other end of the cylinder (usually the top) such that a mean capture time of the fluid within the chamber is sufficient, in relation to the magnitude of the flux created by the ultraviolet radiation source, that a bacteria stat fluid is obtained at the outflow of the sterilization cylinder. When this “bacteria stat” condition is achieved, “a kill” is said to have been imparted to the bacteria suspended in the fluid; that is, all the bacteria is killed.

It is known that the bacteria stat condition can be achieved for a fluid in particular water, when the same is subjected to a minimum ultraviolet flux dose at a certain frequency, as those skilled in the art will know. It is also known that the mean resident time of a fluid within the sterilization chamber must be increased to maintain a bacteria stat dose of flux as a result of mineral deposits forming on the outside surface of the ultraviolet radiation source tube, or more accurately, the circumscriptive protective sheath thereof, when a sheath is employed; as mineral deposits have a tendency to absorb the ultraviolet radiation. It is further known that a scraping device may be employed to scrape mineral deposits off the sheath, but such prior art devices suffer from such disadvantages as they have to be manually activated with the appended result that a human may forget to do the same and that fluid does not obtain the bacteria stat dose; or, further that such prior art devices are not sufficiently efficient to significantly clean the mineral deposits away to sustain the high flux intensity of the radiation penetrating through the sheath and hence into the fluid to be sterilized.

These deficiencies of the prior art have been avoided somewhat by increasing the mean resident time of the fluid flowing through the sterilization chamber, but this reduces the rate or the volume of fluid flow and hence decreases the sterilization efficiency of the sterilizer as well as having its effect on increase manufacturing and operating costs.

SUMMARY OF THE INVENTION

The invention, therefore, contemplates an efficient cleaning device to scrape mineral and other deposits from the surrounding protective surface of an ultraviolet radiation tube, the device being activated by the combined effect of the fluid flow through the chamber on the one hand; and on the other, by the weight of the cleaning device itself, when flow stops.

The cleaning device also contemplates providing a tight piston-type arrangement in the sterilizer between the outer sterilization wall and the inner protective sheath so as to ensure adequate scraping of the deposits from the protective surface of the sheath, whereupon high flux intensities into the fluid can be sustained with minimum resident time of the fluid in the sterilizer for a kill.

The invention, therefore, contemplates in combination a liquid sterilization cylinder having an inner wall which defines a chamber and positioned in said chamber a coaxially-longitudinal located source of ultraviolet radiation disposed behind an ultraviolet transmissive cylindrical sheath protective, a cleaning device adapted to pass to and fro within the chamber, during flow and non-flow of the liquid to be sterilized, characterized in that the cleaning device comprises:

a. a first ring-like member having an orifice therein through which a liquid may flow;
b. a flexible inner member attached to and disposed radially inward of the first ring-like member with a segment of its inner margin disposed on the locus of their circumference of a circle having a radius less than the exterior diameter of said sheath such that the segment biasingly urges against the said ultraviolet transmissive cylindrical sheath;
c. a flexible resilient outer member attached to and disposed radially outward of the first ring-like member and having its outer circumference biasly urged against the inner wall of the sterilization cylinder whereby the weight of the cleaning device, during non-flow of the fluid, causes the cleaning device to fall whence the inner member scrapes the ultraviolet transmissive cylindrical sheath again to clean said sheath, and wherein during such flow orifice in said first ring-like member permits fluid to pass from one side of the cleaning device to the other and hence through the said chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described by way of example with reference to the embodiment to the accompanying drawing in which:

FIG. 1 is a perspective view of a portion of a fluid, particularly, a water sterilization chamber employing the embodiments of the invention.

FIGS. 2 and 3 are longitudinal sections for explanation, showing the profile of the cleaning device during flow and non-flow fluid conditions.

FIG. 4 is a plan view of the cleaning device.

FIG. 5 is a section along lines V—V of FIG. 4.

FIG. 6 is an expanded section along lines VI—VI of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1 a fluid, particularly water, sterilization chamber 10 includes a hollow cylindrical chamber 11 disposing coaxially to its inner longitudinal axis a protective exterior surface 52 of a circumscribing fused silica glass sheath 53 within which is disposed a longitudinal radiation source such as an ultra-violet lamp (not shown). The sheath of silica glass permits transmission of ultra-violet radiation into the region between the sheath 53 and the interior wall of the cham-
A cleaner 12 is disposed within this region (between sheath 53 and cylinder 11) and comprises a metal ring 13 to which is attached, on the outside circumference, radially projecting a flexible semi-rigid rubber-type membrane 14 of necessitate ultraviolet (or whatever radiation is to be used) resistant, and on the inside circumference, radially projecting, a semi-rigid plastic or flexible metal membrane 15, also radiation resistant, and capable of providing a scraping action against the protective surface 52 while at the same time retaining a reasonably good water tight seal between the metal ring 13 and surface 52. The metal ring 13 preferably is in two halves, 13a and 13b, referring to FIG. 5, joined together by appropriate means (not shown) sandwiching the membranes 14 and 15 between them. Small holes or orifices 16 are drilled through the metal annulus 13 symmetrically about to allow the passage of water 54 across the cleaner through these holes. The materials of construction of the two membranes 14 and 15 and of the metal ring 13 all require careful choice as the effective weight of the cleaner 12 is important as is the flex characteristics of the membrane 15 as will now be described.

In operation the fluid 54 which is to be sterilized flows into the bottom of the chamber 11 at 22 and up in a vortex-like fashion through the cylinder to be discharged off the top (not shown) as those skilled in the art will know. With the water 54 flowing, since the cleaner 12 provides a reasonably good seal across the water flow region (only imperfections around the periphery of the membranes 14 and 15 and the plurality of holes 16 in the metal annulus 13 permitting water to by-pass the cleaner) pressure builds up underneath the cleaner (FIG. 2) and produces a force, F_r, attempting to lift the cleaner upward. The seepage loss, L, reduces the force to an actual force, F_c. Resisting the rise of the cleaner 12 are the weight, W, of the cleaner and the frictional force of the cylindrical wall f_a and of the protective surface 52, f_p. If F_r is greater that these opposing forces the cleaner will rise and in doing so will scrape the protective surface 52 thus cleansing it. Careful choice of the inner membrane 15 will determine the cleaning efficiency. It has been found that a brush-like textured membrane of composite or plastic material is satisfactory. The cleaner 12 may be made to rise strongly despite the losses L and the frictional forces, f_a and f_p and the cleaner weight, W.

While the water 54 is flowing the cleaner 12 will be held at the top of the sterilizer 10. As soon as the flow stops the cleaner 12 will have the force F_c removed (the only force holding the cleaner 12 at the top of the sterilizer 10 when the cleaner is stationary) and the weight, W (see FIG. 3) will tend to pull the cleaner 12 to the bottom of the sterilizer 10. The forces resisting this movement are the frictional forces of the membranes 14 and 15 on the cylindrical wall 11, f_a, and on the protective surface 52, f_p, together with the water trapped beneath the cleaner 12. However, the holes 16 through the metal annulus 13 will allow the water below the cleaner to seep through the cleaner 12 on its downward travel providing the weight, W, is great enough to overcome the frictional forces and resistance caused by the water flow through the holes 16; the cleaning device 12 will move boldly downward and the membrane 15 will flex and again scrape the protective surface 52 and clean it (FIG. 3).

When a sterilization chamber having an inner diameter of three inches (7.62 cm.) with a protective sheath 53 having an outer diameter of one inch (2.54 cm.) was used it has been found that the cleaning device cleaner 12 could have the following dimensions.

Metal annulus 13 [inner diameter 1½ inches (3.675 cm.) outer diameter 2½ inches (6.350 cm.)]. Flexible annular membrane 15 [inner diameter 7/8 inch (2.225 cm.) outer diameter 1½ inches (3.675 cm.)]. Flexible membrane 14 [inner diameter 2½ inches (6.350 cm.) outer diameter 3½ inches (7.937 cm.)].

Diameter of orifices 16 1/16 inches (0.159 cm.). Weight (W) of the cleaning device 12 approximately ¼ pound (226.8 gms.).

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A liquid sterilization system comprising: a cylinder having liquid inlet and outlet means and having an inner wall which defines a chamber and positioned in a said chamber a coaxially-longitudinally located source of ultraviolet radiation comprising a protective ultraviolet-transmissive, cylindrical sheath containing an ultraviolet-radiation generating means, and, a cleaning device adapted to pass to and fro within the chamber, during flow and non-flow of the liquid to be sterilized, characterized in that the cleaning device comprises:

a. a first ring-like member having an orifice, therein through which a liquid may flow;

b. a flexible inner member attached to and disposed radially inward of the first ring-like member with the inner periphery of said inner member biased against the said ultraviolet-transmissive, cylindrical sheath;

c. a flexible resilient outer member attached to and disposed radially outward of the first ring-like member and having the outer circumference of said outer member biased against the inner wall of the sterilization cylinder whereby, during a liquid flow condition, the cleaning device is forced to rise within said chamber, and, during a non-flow condition of the liquid, the weight of the cleaning device causes the device to fall and whence, during each condition, the inner member scrubs the ultraviolet-transmissive, cylindrical sheath, and thereby cleans said sheath, and wherein during such flow conditions the orifice in said first ring-like member permits liquid to pass from one side of the cleaning device to the other and hence through the said chamber.

2. The system of claim 1 wherein the first ring-like member is a metal annulus.

3. The system of claim 1 wherein the flexible resilient outer member is a solid annulus composed of a semi-rigid rubber.

4. The system of claim 1 wherein the flexible inner member is a semi-rigid, plastic, ultraviolet-radiation resistant membrane.

5. The system of claim 1 wherein the flexible inner member is composed of a flexible sheet of metal.
6. The system of claim 1 wherein the flexible inner member is an annulus with an inner diameter nominally less than the outer diameter of said sheath.
7. The system of claim 1 wherein the first ring-like member has a plurality of orifices circumferentially positioned in said ring-like member.
8. The system of claim 7 wherein the flexible inner member is composed of a flexible sheet of metal.
9. The system of claim 1 wherein the first ring-like member has a plurality of orifices disposed therein.
10. The system of claim 9 wherein the first ring-like member is a metal annulus.
11. The system of claim 9 wherein the flexible resilient outer member is a solid annulus composed of a semi-rigid rubber.
12. The system of claim 9 wherein the flexible inner member is a semi-rigid, plastic, ultraviolet-radiation-resistant membrane.
13. The system of claim 2 wherein the flexible inner member is composed of a flexible sheet of metal.

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