

Fluid Sanitizing Device And Method Of Sanitizing A Fluid

Cross-Reference to Related Applications

[0001] The present application claims the benefit of Singapore Provisional Application No. 10201809775Y filed 4 November 2018 which is incorporated by reference herein.

Technical Field

[0002] The present invention relates to a fluid sanitizing device and a method of sanitizing a fluid.

Background

[0003] Sanitizing apparatus, or purifier, is now commonly available to sanitize or disinfect fluid, e.g. air or liquid. Such sanitizing apparatus typically uses a UV source to emit UV light to sanitize the fluid. There are commercially available UV sanitizing apparatus and they usually come in the form of UV mercury lamps. Such sanitizing apparatus tends to be bulky due to the size of mercury lamp therein and are not suitable for small and portable devices for disinfecting fluid.

[0004] Apart from the large size, the UV sanitizing apparatus generates loud noise, and is able to sanitize the fluid at a slow flow rate. If the flow rate is increased, the fluid will not be exposed sufficiently and there will not be sufficient time to effectively kill microbes in the fluid. Hence, the fluid would not be sanitized and be safe to be consumed or used.

[0005] While UVC is used for sanitizing fluid, it is not widely used for disinfecting fluid due to the EPA warning against its ineffectiveness due to insufficient pollutant UV exposure. This is because microbes must be exposed to UVC for a certain period of time to render it inactive. Therefore, it is not likely that UVC is used to disinfect fluid.

[0006] A solution is required to solve the above mentioned problems.

Summary

[0007] According to various embodiments, the present invention relates to a fluid sanitizing device including a chamber adapted to channel a fluid therethrough in a longitudinal direction, the chamber includes a tubular chamber wall extending in the longitudinal direction from a proximal end to a distal end of the chamber opposite the proximal end, an inlet at the proximal end for fluid flow into the chamber and an outlet at the distal end of the chamber for fluid flow out of the chamber, such that the fluid enters the chamber via the inlet at a speed, a sanitizing light emitter disposed within the chamber, such that the sanitizing light emitter is adapted to emit a sanitizing light to sanitize the fluid through the chamber, such that the chamber is adapted to reduce the speed of the fluid flowing from the inlet to the outlet.

[0008] According to various embodiments, the inlet may include an inlet opening area through which the fluid flows into chamber, the outlet may include an outlet opening area through which the fluid flows out of the chamber, and the chamber may include a cross-sectional area through which the fluid flows through, such that the cross-sectional area may be larger than the inlet opening area and the outlet opening area.

[0009] According to various embodiments, the fluid sanitizing device may further include a disruptor disposed at the proximal end and adapted to disrupt at least a portion of the fluid flowing into the chamber from the inlet.

[0010] According to various embodiments, the disruptor may include a rotatable element adapted to be rotated to cause the fluid flowing into the chamber to flow turbulently.

[0011] According to various embodiments, the disruptor may include a deflector adapted to deflect the fluid flow in a direction away from the longitudinal direction and towards the chamber wall.

[0012] According to various embodiments, the sanitizing light emitter may be disposed at the outlet.

[0013] According to various embodiments, the deflector may be disposed at a middle portion between the proximal end and the distal end and the deflector extends across the middle portion and spaced from the chamber wall, forming a gap between the deflector and the chamber wall and adjacent the chamber wall, such that the sanitizing light emitter may be disposed at the gap, and such that the fluid may be directed to flow via the gap.

[0014] According to various embodiments, the chamber may include a length along and a width across the longitudinal direction, such that the width may be longer than the length.

[0015] According to various embodiments, the outlet may be disposed adjacent the chamber wall.

[0016] According to various embodiments, the device may include a pair of outlets disposed adjacent and at opposite sides of the chamber wall.

[0017] According to various embodiments, the fluid sanitizing device may further include a plurality of panels disposed within the chamber and adapted to alter the direction of the fluid flow as the fluid flows from the inlet to the outlet.

[0018] According to various embodiments, the plurality of panels may be adapted to direct the fluid to flow in a zig-zag direction.

[0019] According to various embodiments, the inlet may be adapted to direct the fluid flow in a direction tangential to the chamber wall, such that the fluid flow into the chamber via the inlet may be circulated spirally from the proximal end to the distal end.

[0020] According to various embodiments, the chamber further may include a tube disposed in the centre of the chamber and extends from the proximal end to the distal end, the tube may include a near end at the proximal end of the chamber and a far end at the distal end of the chamber, such that the tube may be adapted to guide the fluid to flow spirally in the chamber.

[0021] According to various embodiments, the sanitizing light emitter may be disposed at the proximal end of the chamber.

[0022] According to various embodiments, the outlet of the chamber may be disposed at the far end of the tube and the tube extends out of the chamber at the proximal end, such that the fluid may be directed out of the chamber through the tube.

[0023] According to various embodiments, the far end may be wider than the near end.

[0024] According to various embodiments, the near end may be wider than the far end.

[0025] According to various embodiments, the sanitizing light emitter may be disposed at the distal end of the chamber and adapted to emit sanitizing light onto the fluid flowing through the outlet.

[0026] According to various embodiments, the fluid sanitizing device may further include a plurality of optical cables in optical communication with the sanitizing light emitter and adapted to transmit the sanitizing light from the sanitizing light emitter to at least one of the proximal end, the distal end, and a middle portion between the proximal end and the distal end.

[0027] According to various embodiments, the present invention relates to a method of sanitizing a fluid. Method may include channelling the fluid through a chamber in a longitudinal direction from an inlet at a proximal end to an outlet at a distal end opposite the proximal end, such that the fluid enters the chamber via the inlet at a speed, sanitizing the fluid through the chamber, and reducing the speed of the fluid flowing from the inlet to the outlet.

[0028] According to various embodiments, reducing the speed of the fluid flow may include disrupting at least a portion of the fluid flowing into the chamber from the inlet.

[0029] According to various embodiments, disrupting the at least a portion of the fluid flow may include causing the fluid flowing into the chamber to flow turbulently.

[0030] According to various embodiments, reducing the speed of the fluid flow may include deflecting the fluid flow in a direction away from the longitudinal direction and towards a chamber wall of the chamber.

[0031] According to various embodiments, the fluid may be directed to flow via a gap adjacent the chamber wall.

[0032] According to various embodiments, the fluid may be directed to flow in a zig-zag direction.

[0033] According to various embodiments, reducing the speed of the fluid flow may include directing the fluid flow in a direction tangential to the chamber wall, such that the fluid flow into the chamber via the inlet may be circulated spirally from the proximal end to the distal end.

[0034] According to various embodiments, the method may further include directing the fluid out of the chamber through a tube disposed in the centre of the chamber, such that the tube extends from the distal end to the proximal end and out of the chamber at the proximal end.

[0035] According to various embodiments, the method may further include transmitting the sanitizing light from the sanitizing light emitter to at least one of the proximal end, the distal end, and a middle portion between the proximal end and the distal end.

Brief Description of Drawings

[0036] Fig. 1 shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device.

[0037] Fig. 2A shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device.

[0038] Fig. 2B shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device.

[0039] Fig. 3A shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device.

[0040] Fig. 3B shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device.

[0041] Fig. 3C shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device.

[0042] Fig. 3D shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device.

[0043] Fig. 3E shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device.

[0044] Fig. 4A shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device.

[0045] Fig. 4B shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device.

[0046] Fig. 4C shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device.

[0047] Fig. 5A shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device.

[0048] Fig. 5B shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device.

[0049] Fig. 5C shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device.

[0050] Fig. 6A shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device.

[0051] Fig. 6B shows a schematic diagram of a sectional view of the fluid sanitizing device along line A-A in Fig. 6A.

[0052] Fig. 7A shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device.

[0053] Fig. 7B shows a schematic diagram of a sectional view of the fluid sanitizing device along line A-A in Fig. 7A.

[0054] Fig. 7C shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device.

[0055] Fig. 8A shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device.

[0056] Fig. 8B shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device.

[0057] Fig. 8C shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device.

[0058] Fig. 8D shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device.

[0059] Fig. 9 shows a method of sanitizing a fluid.

Detailed Description

[0060] In the following examples, reference will be made to the figures, in which identical features are designated with like numerals.

[0061] Fig. 1 shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device 100. Fluid sanitizing device 100 includes a chamber 110 adapted to channel a fluid therethrough in a longitudinal direction 110L, the chamber 110 includes a tubular chamber wall 116 extending in the longitudinal direction 110L from a proximal end 110P to a distal end 110D of the chamber 110 opposite the proximal end 110P. Chamber 110 further includes an inlet 112 at the proximal end 110P for fluid flow into the chamber 110 and an outlet 114 at the distal end 110D of the chamber 110 for fluid flow out of the chamber 110, such that the fluid enters the chamber 110 via the inlet 112 at a speed. Chamber 110 includes a sanitizing light emitter 120 disposed within the chamber 110, such that the sanitizing light emitter 120 is adapted to emit a sanitizing light to sanitize the fluid through the chamber 110. Chamber 110 is adapted to reduce the speed of the fluid flowing from the inlet 112 to the outlet 114. By reducing the speed of the fluid flow through the chamber 110, the fluid may sufficiently be exposed to the sanitizing light so that the microbes in the fluid are inactivated and the fluid is safe for consumption or use. Sanitizing light emitter 120 may include UV light emitter, UVC light emitter, etc. Due to the reduced speed of the fluid flow through the chamber 110, it is possible to use the UVC light emitter to inactivate the microbes in the fluid. Tubular chamber wall 116 may have a circular cross-sectional profile, square profile, rectangular profile, hexagonal profile, etc. Fluid may include air or liquid or both.

[0062] Referring to Fig. 1, the inlet 112 may include an inlet opening area 112A through which the fluid flows into chamber 110. Outlet 114 may include an outlet opening area 114A through which the fluid flows out of the chamber 110. Chamber 110 may include a cross-sectional area 110A through which the fluid flows through. The cross-sectional area 110A may be larger than the inlet opening area 112A and the outlet opening area 114A. Based on the principle of the continuity equation, i.e. $A_1V_1=A_2V_2$, by increasing the cross-sectional area 110A of the chamber 110 with respect to the inlet opening area 112A, the speed of the fluid after entering

the chamber 110 may be lower than the speed of the fluid flow through the inlet 112 due to the increase in the cross-sectional area 110A. Similarly, based on the continuity equation, as the outlet opening area 114A is smaller than the cross-sectional area 110A of the chamber 110, the speed of the fluid flow through the outlet 114 may be higher than the speed of fluid flow in the chamber 110. The desired speed of the fluid through the chamber 110 may be obtained by determining the ratio of the inlet opening area 112A and the cross-sectional area 110A and the speed of the fluid through the inlet 112. The reduction in the speed of the fluid through the chamber 110 provides sufficient time to enable the sanitizing light to inactivate the microbes in the fluid thus sanitizing the fluid. The speed of the fluid flow exiting the chamber 110 may be obtained by determining the ratio of the outlet opening area 114A and the cross-sectional area 110A. Inlet opening area 112A may be the same or substantially the same as the outlet opening area 114A so that the speed of the fluid flow after exiting the chamber 110 through the outlet 114 may be the same as the speed of the fluid flow entering the chamber 110. Compared to a sanitizing apparatus having a tubular body with a constant cross-sectional area 110A throughout the length of the apparatus, the time taken for the fluid to flow through the chamber 110, e.g. from the inlet 112 to the outlet 114, is relatively or substantially longer than the fluid flow through the sanitizing apparatus of the same length. In this way, the duration of the fluid being exposed to the sanitizing light is longer and therefore allowing the fluid to be sanitized completely. Sanitizing light emitter 120 may be disposed at the outlet 114 so that the slow flowing fluid may be exposed to the sanitizing light sufficiently before exiting the chamber 110. In this way, the fluid through the chamber 110 will be sanitized before leaving the chamber 110.

[0063] Fig. 2A shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device 200. Fluid sanitizing device 200 in Fig. 2A is the same as the fluid sanitizing device 100 in Fig. 1 except that the fluid sanitizing device 200 may include a disruptor 230 disposed at the proximal end 210P and adapted to disrupt at least a portion of the fluid flowing into the chamber 210 from the inlet 212. As the fluid flows into the chamber 210 via the inlet 212, the fluid flow may be disrupted by the disruptor 230 and slows down. Coupled by the reduction of speed due to the increase in cross-sectional area 210A of the chamber 210, the speed of the fluid flow would be further reduced. Disruptor 230 may include a rotatable element 230R adapted to be rotated to cause the fluid flowing into the chamber 210 to flow turbulently. Rotatable element 230R may include at least one rotatable vane. When the rotatable element 230R is being rotated

or spun, it may disrupt the fluid flow into the chamber 210 result in a turbulent flow. Rotatable element 230R may cause a vortex within the chamber 210. In this way, due to the turbulent flow, the duration of the fluid in the chamber 210 may be increased to provide a longer period of time for the fluid to be sanitized. In addition, the turbulent flow allows the fluid to be well mixed so that the exposure of the fluid to the sanitizing light is optimized. Disruptor 230 may be made of a transparent material to allow the sanitizing light to pass through so that the fluid blocked by the disruptor 230 may be exposed to the sanitizing light. Disruptor 230 may be made of quartz glass or polymer. In addition, the disruptor 230 may be made of opaque material, e.g. aluminium. Disruptor 230 may be coated with low friction material, e.g. Teflon.

[0064] Fig. 2B shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device 200. Fluid sanitizing device 200 in Fig. 2B is the same as the fluid sanitizing device 200 in Fig. 2A except that the fluid sanitizing device 200 may include a plurality of optical cables 240 in optical communication with the sanitizing light emitter 220 and adapted to transmit the sanitizing light from the sanitizing light emitter 220 to at least one of the proximal end 210P, the distal end 210D, and a middle portion 210M between the proximal end 210P and the distal end 210D. One end of each of the optical cable 240 may be optically connected to the sanitizing light emitter 220 and the other end thereof may be disposed at one of the other portions of the chamber 210. As shown in Fig. 2B, the other ends may be disposed at portions of the chamber 210 that are further away from the sanitizing light emitter 220. For example, if the sanitizing light emitter 220 is disposed at the distal end 210D of the chamber 210, the other ends of the optical cables 240 may be disposed at the proximal end 210P and the middle portion 210M. Optical cable may be disposed along the centre of the chamber 210 from the proximal end 210P to the distal end 210D to transmit the sanitizing light along the centre of the chamber 210. The use of plurality of optical cables 240 enable the fluid sanitizing device 200 to effectively emit sanitizing light onto the fluid throughout the chamber 210, e.g. areas away from the sanitizing light emitter 220, corners, etc., using a single or lower number of sanitizing light emitter 220. As shown below, the plurality of optical cables 240 may be used on any one of the embodiments described herein.

[0065] Fig. 3A shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device 300. Fluid sanitizing device 300 in Fig. 3A is the same as the fluid sanitizing device 200 in Fig. 2A except that the disruptor 330 may include a deflector 330D adapted to deflect the

fluid flow in a direction away from the longitudinal direction 310L and towards the chamber wall 316. By deflecting the fluid flow away from the longitudinal direction 310L, the speed of the fluid flow is reduced. Further, by deflecting the fluid towards the chamber wall 316, the flow path of the fluid is lengthened, hence increasing the time required to travel from the inlet 312 to the outlet 314. Deflector 330D may extend across the chamber 310 and spaced from the chamber wall 316 such that a gap 332 is formed between the deflector 330D and the chamber wall 316. Fluid from the inlet 312 may be diverted towards the gap 332 and flows therethrough. Thereafter, the fluid may flow towards the centre of the chamber 310 as it flows towards the outlet 314 and be sanitized by the sanitizing light emitter 320 at about the distal end 310D of the chamber 310. Deflector 330D may be disposed at about the proximal end 310P of the chamber 310.

[0066] Fig. 3B shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device 300. Fluid sanitizing device 300 in Fig. 3B is the same as the fluid sanitizing device 300 in Fig. 3A except that the fluid sanitizing device 300 may include a plurality of optical cables 340 in optical communication with the sanitizing light emitter 320 and adapted to transmit the sanitizing light from the sanitizing light emitter 320 to at least one of the proximal end 310P, the distal end 310D, and a middle portion 310M between the proximal end 310P and the distal end 310D. One end of each of the optical cable 340 may be optically connected to the sanitizing light emitter 320 and the other end thereof may be disposed at one of the other portions of the chamber 310. As shown in Fig. 3B, the other ends may be disposed at portions of the chamber 310 that are further away from the sanitizing light emitter 320. For example, if the sanitizing light emitter 320 is disposed at the distal end 310D of the chamber 310, the other ends of the optical cables 340 may be disposed at the proximal end 310P and the middle portion 310M. Optical cable may be disposed along the centre of the chamber 310 from the proximal end 310P to the distal end 310D to transmit the sanitizing light along the centre of the chamber 310.

[0067] Fig. 3C shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device 300. Fluid sanitizing device 300 in Fig. 3C is the substantially similar to the fluid sanitizing device 300 in Fig. 3A. Unlike the embodiment in Fig. 3A, the deflector 330D may be disposed at the middle portion 310M between the proximal end 310P and the distal end 310D and the deflector 330D may extend across the middle portion 310M and spaced from the chamber wall 316, forming the gap 332 between the deflector 330D and the chamber wall 316

and adjacent the chamber wall 316, such that the sanitizing light emitter 320 may be disposed at the gap 332, and the fluid may be directed to flow via the gap 332. Sanitizing light emitter 320 may be disposed at about the gap 332 so that the fluid flowing through the gap 332 may be sanitized by the sanitizing light from the sanitizing light emitter 320. Another sanitizing light emitter 320 may be disposed at about the outlet 314 for the earlier mentioned purpose. Further, the fluid sanitizing device 300 may include another disruptor 330 disposed at about the inlet 312 to disrupt the fluid flow into the chamber 310. Another disruptor 330 may include the rotatable element 330R adapted to rotate to whirl the fluid within the chamber 310. As the chamber wall 316 may be tubular, the chamber 310 may include a plurality of sanitizing light emitters 320 disposed along the chamber wall 316 and spaced apart from each other and the gap 332 may be in the form a ring. As shown in Fig. 3C, the sanitizing light emitters 320 may be disposed at the gaps 332 shown. In this embodiment, the fluid may be diverted towards and through the gap 332 and exposed to more sanitizing light emitters 320. With a reduced speed flow and increase in the exposure to the sanitizing light, the fluid may be sanitized sufficiently to be used or consumed.

[0068] Fig. 3D shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device 300. Fluid sanitizing device 300 in Fig. 3D is the same as the fluid sanitizing device 300 in Fig. 3C except that the fluid sanitizing device 300 may include a plurality of optical cables 340 in optical communication with the sanitizing light emitter 320 and adapted to transmit the sanitizing light from the sanitizing light emitter 320 to at least one of the proximal end 310P and the distal end 310D. One end of each of the optical cable 340 may be optically connected to the sanitizing light emitter 320 and the other end thereof may be disposed at one of the other portions of the chamber 310. As shown in Fig. 3D, the other ends may be disposed at portions of the chamber 310 that are further away from the sanitizing light emitter 320. For example, if the sanitizing light emitter 320 is disposed at the middle portion 310M of the chamber 310, the other ends of the optical cables 340 may be disposed at the proximal end 310P and the distal end 310D of the chamber 310.

[0069] Fig. 3E shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device 300. Fluid sanitizing device 300 in Fig. 3E is the substantially similar to the fluid sanitizing device 300 in Fig. 3C. Chamber 310 may include a length L along the longitudinal direction 310L and a width W across the longitudinal direction 310L. The width W may be

longer than the length L such that the path of the fluid flow is longer in a traverse direction perpendicular to the longitudinal direction 310L than in the longitudinal direction 310L. Width W may be as long as the length L. Chamber 310 may include the deflector 330D disposed in the middle portion 310M of the chamber 310. Fluid may be diverted to flow transversely away from the centre of chamber 310 before flowing through the gap 332 at the middle portion 310M, where the fluid flow makes a U-turn to flow towards the centre of the chamber 310 before exiting the chamber 310 via the outlet 314. In this way, the change in the direction of the fluid flow enables the speed of the fluid to be reduced. Sanitizing light emitter 320 may be disposed at the gap 332 so that the fluid, due to the U-turn, may be flowing at the slowest speed and may be exposed to the sanitizing light for a longer period of time.

[0070] Fig. 4A shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device 400. Fluid sanitizing device 400 may include a plurality of panels 450 disposed within the chamber 410 and adapted to alter the direction of the fluid flow as the fluid flows from the inlet 412 to the outlet 414. Plurality of panels 450 may extend from opposite sides of the chamber wall 416 and may be interlaced to form a zig-zag path from the proximal end 410P to the distal end 410D such that the plurality of panels 450 are adapted to direct the fluid to flow in a zig-zag direction. Sanitizing light emitter 420 may be disposed at the outlet 414 of the chamber 410. Speed of the fluid flow may be reduced due to the change in the directions of the fluid flow such that the fluid may be exposed to the sanitizing light for sufficient duration to be sanitized. In addition, as the flow path of the fluid increases, the duration that the flow is exposed to the sanitizing light increases to allow the fluid to be sufficiently exposed to the sanitizing light. Plurality of panels 450 may be made of a transparent material to allow the sanitizing light to pass through so that the fluid blocked by the plurality of panels 450 may be exposed to the sanitizing light. Plurality of panels 450 may be made of quartz glass or polymer. In addition, the plurality of panels 450 may be made of opaque material, e.g. aluminium. Plurality of panels 450 may be coated with low friction material, e.g. Teflon.

[0071] Fig. 4B shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device 400. Fluid sanitizing device 400 in Fig. 4B is the same as the fluid sanitizing device 400 in Fig. 4A except that the chamber 410 may include a sanitizing light emitter 420 at each of the at least one turn of the zig-zag path. Fluid may receive sanitizing light at every turn of the

zig-zag path where the speed of the fluid flow may be the lowest so that the fluid may have sufficient time to be exposed to the sanitizing light. In addition, the fluid may also flow within an effective distance from the sanitizing light emitter 420 so that the fluid may be sanitized effectively. Sanitizing light emitter 420 may also be disposed at the outlet 414 of the chamber 410.

[0072] Fig. 4C shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device 400. Fluid sanitizing device 400 in Fig. 4C is the same as the fluid sanitizing device 400 in Fig. 4A except that the fluid sanitizing device 400 may include a plurality of optical cables 440 in optical communication with the sanitizing light emitter 420 and adapted to transmit the sanitizing light from the sanitizing light emitter 420 to at least one of the plurality of turns along the zig-zag path. One end of each of the optical cable 440 may be optically connected to the sanitizing light emitter 420 and the other end thereof may be disposed at one of the respective turns. Fluid may receive sanitizing light at every turn of the zig-zag path where the speed of the fluid flow may be the lowest so that the fluid may have sufficient time to be exposed to the sanitizing light.

[0073] Fig. 5A shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device 500. Fluid sanitizing device 500 in Fig. 5A is substantially similar to the fluid sanitizing device 200 in Fig. 2A. Referring to Fig. 5A, the outlet 514 the fluid sanitizing device 500 may be disposed adjacent the chamber wall 516 at the distal end 510D of the chamber 510. Sanitizing light emitter 520 may be disposed along the chamber wall 516 to emit sanitizing light onto the fluid flowing pass it. Sanitizing light emitter 520 may be disposed at or spaced from the outlet 514 or at the middle portion 510M of the chamber 510. Outlet 514 may include a plurality of outlets. As shown in Fig. 5A, the fluid sanitizing device 500 may include at least a pair of outlets 514 disposed adjacent and at opposite sides of the chamber wall 516. Sanitizing light emitter 520 may include a plurality of sanitizing light emitters 520 disposed on the chamber wall 516 and adapted to emit sanitizing light onto the fluid flowing pass them. As shown in Fig. 5A, a sanitizing light emitter 520 may be disposed before each of the plurality of outlets 514. As the fluid flows towards each of the pair of outlets 514, the fluid flows closer to the sanitizing light emitter 520 to be within the effective sanitizing range of the sanitizing light emitter 520. Fluid sanitizing device 500 may include the disruptor 530 as shown in any

one of the earlier embodiments to disrupt the fluid flow from the inlet 512. By disposing a plurality of sanitizing light emitters along the circumference of the chamber wall 516, a uniform and efficient distribution of sanitizing light onto the fluid may be achieved. By disposing the outlet 514 adjacent the chamber wall 516, the fluid may be directed to flow towards the chamber wall 516, hence towards the sanitizing light emitter 520 before exiting the chamber 510 via the outlet 514. In this way, the fluid may flow within an effective sanitizing distance from the sanitizing light emitter 520.

[0074] Fig. 5B shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device 500. Fluid sanitizing device 500 in Fig. 5B is substantially similar to the fluid sanitizing device 500 in Fig. 5A. Similar to Fig. 3E, the chamber 510 may include a length L along the longitudinal direction 510L and a width W across the longitudinal direction 510L. The width W may be longer than the length L such that the path of the fluid flow is longer in a traverse direction perpendicular to the longitudinal direction 510L than in the longitudinal direction 510L. Width W and the length L may be of the same length. Fluid may be diverted to flow transversely away from the centre of chamber 510 towards the outlet 514. As the width W is substantially longer than the length L, the fluid may flow towards the sanitizing light emitter 520 and chamber wall 516 before being directed to flow in the longitudinal direction 510L towards the outlet 514. In this way, the change in the direction of the fluid flow enables the speed of the fluid to be reduced at about the location of the sanitizing light emitter 520 so that the fluid may be exposed to the sanitizing light for a longer period of time. The ratio between the length L and the width W may be determined to provide an optimal sanitizing effect on the fluid. Sanitizing light emitter 520 may be disposed on the chamber wall 516 at the outlet 514 or spaced from the outlet 514. Sanitizing light emitter 520 may be disposed at the middle portion 510M. Fluid sanitizing device 500 may include the disruptor 530 as shown in any one of the earlier embodiments to disrupt the fluid flow from the inlet 512.

[0075] Fig. 5C shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device 500. Fluid sanitizing device 500 in Fig. 5C is the same as the fluid sanitizing device 500 in Fig. 5A except that the fluid sanitizing device 500 may include a plurality of optical cables 540 in optical communication with the sanitizing light emitter 520 and adapted to transmit the sanitizing light from the sanitizing light emitter 520 to at least one of the proximal end 510P and the distal end 510D. One end of each of the optical cable 540 may be optically connected

to the sanitizing light emitter 520 and the other end thereof may be disposed at one of the other portions of the chamber 510. As shown in Fig. 5C, the other ends may be disposed at portions of the chamber 510 that are further away from the sanitizing light emitter 520. For example, if the sanitizing light emitter 520 is disposed at the middle portion 510M of the chamber 510, the other ends of the optical cables 540 may be disposed at the proximal end 510P and the distal end 510D of the chamber 510.

[0076] Fig. 6A shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device 600. Sanitizing light emitter 620 may include a plurality of sanitizing light emitters 620. Each sanitizing light emitter shown in any one of the figures may represent a plurality of sanitizing light emitters 620. As shown in Fig. 6A, the plurality of sanitizing light emitters 620 may be disposed around the outlet 614. Sanitizing light emitter 620 may include a UV light source. For example, sanitizing light emitter 620 may include a UVC light source, e.g. UVC LED.

[0077] Fig. 6B shows a schematic diagram of a sectional view of the fluid sanitizing device 600 along line A-A in Fig. 6A. As shown in Fig. 6B, the plurality of light emitters 620 may be disposed around the outlet 614. By having a plurality of sanitizing light emitters 620 surrounding the outlet 614, the distribution and intensity of the sanitizing light on the fluid would be improved.

[0078] Fig. 7A shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device 700. Fluid sanitizing device 700 may include the chamber 710 adapted to channel a fluid therethrough in a longitudinal direction 710L, the chamber 710 may include a tubular chamber wall 716 extending in the longitudinal direction 710L from a proximal end 710P to a distal end 710D of the chamber 710 opposite the proximal end 710P. Chamber 710 may further include an inlet 712 at the proximal end 710P for fluid flow into the chamber 710 and an outlet 714 at the distal end 710D of the chamber 710 for fluid flow out of the chamber 710, such that the fluid enters the chamber 710 via the inlet 712 at a speed. Chamber 710 may include a sanitizing light emitter 720 disposed within the chamber 710, such that the sanitizing light emitter 720 is adapted to emit a sanitizing light to sanitize the fluid through the chamber 710. Chamber 710 is adapted to reduce the speed of the fluid flowing from the inlet 712 to the outlet

714. Chamber 710 may include a tube 760 disposed in the centre of the chamber 710 and extends from the proximal end 710P to the distal end 710D. Tube 760 may include a near end 760N at the proximal end 710P of the chamber 710 and a far end 760F at the distal end 710D of the chamber 710, such that the tube 760 may be adapted to guide the fluid to flow spirally in the chamber 710. Sanitizing light emitter 720 may be disposed at the proximal end 710P of the chamber 710. Sanitizing light emitter 720 may be disposed at or spaced from the inlet 712. Sanitizing light emitter 720 may be disposed at or spaced from the outlet 714. As the inlet 712 is disposed at one side of the chamber 710 (see Fig. 7B), the fluid flowing into the chamber 710 via the inlet 712 may circulate the fluid therein. As the fluid moves towards the outlet 714, a spiral fluid flow or vortex is created. As the fluid flows along a longer path, i.e. spiral path, than it would if it flows directly from the proximal end 710P to the distal end 710D, the fluid would be exposed for a longer period of time to the sanitizing light. Far end 760F of the tube 760 may be wider than the near end 760N of the tube 760. For example, tube 760 may include a conical profile. As the near end 760N is narrower thus occupying less space, the volume of fluid that can be accommodated at the proximal end 710P is larger than the distal end 710D of the chamber 710, where the far end 760F of the tube 760 is wider and occupies more space.

[0079] Fig. 7B shows a schematic diagram of a sectional view of the fluid sanitizing device 700 along line A-A in Fig. 7A. Inlet 712 may be adapted to direct the fluid flow in a direction tangential to the chamber wall 716, such that the fluid flow into the chamber 710 via the inlet 712 is circulated spirally from the proximal end 710P (not shown in Fig. 7B) to the distal end 710D (not shown in Fig. 7B). Referring to Fig. 7A, as the proximal end 710P of the chamber 710 is substantially larger in volume, hence has a greater cross-sectional area 710A than the inlet opening area 712A, the speed of the fluid entering the chamber 710 is lower than the speed of the fluid at the inlet 712 based on the continuity equation as explained earlier. Therefore, the slower fluid flow at the proximal end 710P may be exposed to the sanitizing light emitter 720 to be sanitized sufficiently. As the cross-sectional area of the chamber 710 reduces gradually from the proximal end 710P to the distal end 710D, the speed of the fluid increases as it spirally flows from the proximal end 710P to the distal end 710D of the chamber 710. Hence, the speed of the fluid exiting the chamber 710 via the outlet 714 will be higher than the speed of the fluid flow at the proximal end 710P.

[0080] Fig. 7C shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device 700. Fluid sanitizing device 700 in Fig. 7C is the same as the fluid sanitizing device 700 in Fig. 7A except that the fluid sanitizing device 700 may include a plurality of optical cables 740 in optical communication with the sanitizing light emitter 720 and adapted to transmit the sanitizing light from the sanitizing light emitter 720 to at least one of the middle portion 710M and the distal end 710D. One end of each of the optical cable 740 may be optically connected to the sanitizing light emitter 720 and the other end thereof may be disposed at one of the other portions of the chamber 710. As shown in Fig. 7C, the other ends may be disposed at portions of the chamber 710 that are further away from the sanitizing light emitter 720. For example, if the sanitizing light emitter 720 is disposed at the proximal end 710P of the chamber 710, the other ends of the optical cables 740 may be disposed at the distal end 710D and/or the middle portion 710M of the chamber 710. In addition, the other ends may be disposed at the centre of the chamber 710 in the direction of the longitudinal direction 710L from the proximal end 710P to the distal end 710D.

[0081] Fig. 8A shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device 800. Fluid sanitizing device 800 in Fig. 8A substantially the same as the fluid sanitizing device 700 in Fig. 7A. Inlet 812 may be adapted to direct the fluid flow in a direction tangential to the chamber wall 816, such that the fluid flow into the chamber 810 via the inlet 812 is circulated spirally from the proximal end 810P to the distal end 810D of the chamber 810. Unlike the embodiment in Fig. 7A, the outlet 814 of the chamber 810 may be disposed at the far end 860F of the tube 860 and the tube 860 may extend out of the chamber 810 at the proximal end 810P, such that the fluid may be directed out of the chamber 810 through the tube 860. As the fluid spirally moves from the proximal end 810P to the distal end 810D of the chamber 810, the fluid may exit the chamber 810 via the outlet 814 and flow through the tube 860 from the far end 860F to the near end 860N and exit therefrom. Due to the change in direction of the fluid flow, i.e. from spiral flow in the longitudinal direction 810L, to the direction of fluid flow in the tube 860 against the direction of the longitudinal direction 810L, the speed of the fluid flow at the distal end 810D may be reduced drastically. In this way, the fluid would have sufficient time to be exposed to the sanitizing light from the sanitizing light emitter 820 that is disposed at about the outlet 814. A suction device, e.g. suction fan, (not shown in Fig. 8A) may be disposed at the near end 860N of the tube 860 to draw the fluid out of the chamber 810.

[0082] Fig. 8B shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device 800. Fluid sanitizing device 800 in Fig. 8B is substantially the same as the fluid sanitizing device 800 in Fig. 8A. Far end 860F of the tube 860 may be wider than the near end 860N of the tube 860. As the near end 860N of the tube 860 is narrower than the far end 860F, the fluid flow at the far end 860F may be faster than the fluid flow at the near end 860N. Hence, the speed of the fluid exiting the tube 860 may be relatively high.

[0083] Fig. 8C shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device 800. Fluid sanitizing device 800 in Fig. 8C is substantially the same as the fluid sanitizing device 800 in Fig. 8A. Near end 860N of the tube 860 may be wider than the far end 860F of the tube 860. As the near end 860N of the tube 860 is wider than the far end 860F, the fluid flow at the far end 860F may be slower than the fluid flow at the near end 860N. Hence, the speed of the fluid exiting the tube 860 may be relatively low.

[0084] Fig. 8D shows a schematic diagram of an exemplary embodiment of a fluid sanitizing device 800. Fluid sanitizing device 800 in Fig. 8D is the same as the fluid sanitizing device 800 in Fig. 8A except that the fluid sanitizing device 800 may include a plurality of optical cables 840 in optical communication with the sanitizing light emitter 820 and adapted to transmit the sanitizing light from the sanitizing light emitter 820 to at least one of the distal end 810D and the middle portion 810M between the proximal end 810P and the distal end 810D. One end of each of the optical cable may be optically connected to the sanitizing light emitter 820 and the other end thereof may be disposed at one of the other portions of the chamber 810. As shown in Fig. 8D, the other ends may be disposed at portions of the chamber 810 that are further away from the sanitizing light emitter 820. For example, if the sanitizing light emitter 820 is disposed at the distal end 810D of the chamber 810, the other ends of the optical cables 840 may be disposed at the proximal end 810P and/or the middle portion 810M of the chamber 810.

[0085] Fig. 9 shows a method 9000 of sanitizing a fluid. Method 9000 includes channelling the fluid through a chamber in a longitudinal direction from an inlet at a proximal end to an outlet at a distal end opposite the proximal end, such that the fluid enters the chamber via the

inlet at a speed in block 9100, sanitizing the fluid through the chamber in block 9200 and reducing the speed of the fluid flowing from the inlet to the outlet in block 9300.

[0086] Fluid sanitizing device as shown in any one of the above embodiments may be small in size, portable and light weight. To power the sanitizing light emitter and optionally the disruptor, a power source, e.g. small sized batteries, may be incorporated into it. As the fluid sanitizing device does not use a mercury lamp, it may be made small. Compared to conventional fluid sanitizing apparatus, the fluid sanitizing device of the present invention is considerably lighter, and smaller. Further, the fluid sanitizing device does not generate loud noises or may not generate any noise at all. In addition, the fluid sanitizing device is able to sanitize fluid at a faster flow rate and more effectively than conventional apparatus. Therefore, the fluid sanitizing device of the present invention is able to sanitize fluid therethrough fast and provide fluid that is sanitized to be safe for consumption or use.

[0087] A skilled person would appreciate that the features described in one example may not be restricted to that example and may be combined with any one of the other examples.

[0088] The present invention relates to a fluid sanitizing device and a method of sanitizing a fluid generally as herein described, with reference to and/or illustrated in the accompanying drawings.

Claim

1. A fluid sanitizing device comprising,
 - a chamber adapted to channel a fluid therethrough in a longitudinal direction, the chamber comprising a tubular chamber wall extending in the longitudinal direction from a proximal end to a distal end of the chamber opposite the proximal end, an inlet at the proximal end for fluid flow into the chamber and an outlet at the distal end of the chamber for fluid flow out of the chamber, wherein the fluid enters the chamber via the inlet at a speed,
 - a sanitizing light emitter disposed within the chamber, wherein the sanitizing light emitter is adapted to emit a sanitizing light to sanitize the fluid through the chamber,
 - wherein the chamber is adapted to reduce the speed of the fluid flowing from the inlet to the outlet.
2. The fluid sanitizing device according to claim 1, wherein the inlet comprises an inlet opening area through which the fluid flows into chamber, the outlet comprises an outlet opening area through which the fluid flows out of the chamber, and the chamber comprises a cross-sectional area through which the fluid flows through, wherein the cross-sectional area is larger than the inlet opening area and the outlet opening area.
3. The fluid sanitizing device according to claim 1 to 2, further comprising a disruptor disposed at the proximal end and adapted to disrupt at least a portion of the fluid flowing into the chamber from the inlet.
4. The fluid sanitizing device according to claim 3, wherein the disruptor comprises a rotatable element adapted to be rotated to cause the fluid flowing into the chamber to flow turbulently.
5. The fluid sanitizing device according to claim 3, wherein the disruptor comprises a deflector adapted to deflect the fluid flow in a direction away from the longitudinal direction and towards the chamber wall.

6. The fluid sanitizing device according to any one of claims 1 to 5, wherein the sanitizing light emitter is disposed at the outlet.
7. The fluid sanitizing device according to claim 5, wherein the deflector is disposed at a middle portion between the proximal end and the distal end and the deflector extends across the middle portion and spaced from the chamber wall, forming a gap between the deflector and the chamber wall and adjacent the chamber wall, wherein the sanitizing light emitter is disposed at the gap, and wherein the fluid is directed to flow via the gap.
8. The fluid sanitizing device according to any one of claims 1 to 7, wherein the chamber comprises a length along and a width across the longitudinal direction, wherein the width is longer than the length.
9. The fluid sanitizing device according to any one of claims 1 to 8, wherein the outlet is disposed adjacent the chamber wall.
10. The fluid sanitizing device according to claim 9, wherein the device comprises a pair of outlets disposed adjacent and at opposite sides of the chamber wall.
11. The fluid sanitizing device according to any one of claims 1 to 10, further comprising a plurality of panels disposed within the chamber and adapted to alter the direction of the fluid flow as the fluid flows from the inlet to the outlet.
12. The fluid sanitizing device according to claim 11, wherein the plurality of panels are adapted to direct the fluid to flow in a zig-zag direction.
13. The fluid sanitizing device according to claim 1, wherein the inlet is adapted to direct the fluid flow in a direction tangential to the chamber wall, wherein the fluid flow into the chamber via the inlet is circulated spirally from the proximal end to the distal end.
14. The fluid sanitizing device according to claim 13, wherein the chamber further comprises a tube disposed in the centre of the chamber and extends from the proximal end to

the distal end, the tube comprises a near end at the proximal end of the chamber and a far end at the distal end of the chamber, wherein the tube is adapted to guide the fluid to flow spirally in the chamber.

15. The fluid sanitizing device according to claim 13 or 14, wherein the sanitizing light emitter is disposed at the proximal end of the chamber.

16. The fluid sanitizing device according to any one of claims 13 to 14, wherein the outlet of the chamber is disposed at the far end of the tube and the tube extends out of the chamber at the proximal end, wherein the fluid is directed out of the chamber through the tube.

17. The fluid sanitizing device according to claim 16, wherein the far end is wider than the near end.

18. The fluid sanitizing device according to claim 16, wherein the near end is wider than the far end.

19. The fluid sanitizing device according to any one of claims 16 to 18, wherein the sanitizing light emitter is disposed at the distal end of the chamber and adapted to emit sanitizing light onto the fluid flowing through the outlet.

20. The fluid sanitizing device according to any one of claims 1 to 18, further comprising a plurality of optical cables in optical communication with the sanitizing light emitter and adapted to transmit the sanitizing light from the sanitizing light emitter to at least one of the proximal end, the distal end, and a middle portion between the proximal end and the distal end.

21. A method of sanitizing a fluid, the method comprising,
 channelling the fluid through a chamber in a longitudinal direction from an inlet at a proximal end to an outlet at a distal end opposite the proximal end, wherein the fluid enters the chamber via the inlet at a speed,
 sanitizing the fluid through the chamber, and
 reducing the speed of the fluid flowing from the inlet to the outlet.

22. The method according to claim 21, wherein reducing the speed of the fluid flow comprises disrupting at least a portion of the fluid flowing into the chamber from the inlet.
23. The method according to claim 22, wherein disrupting the at least a portion of the fluid flow includes causing the fluid flowing into the chamber to flow turbulently.
24. The method according to claim 21, wherein reducing the speed of the fluid flow includes deflecting the fluid flow in a direction away from the longitudinal direction and towards a chamber wall of the chamber.
25. The method according to claim 24, wherein the fluid is directed to flow via a gap adjacent the chamber wall.
26. The method according to any one of claims 21 to 24, wherein the fluid is directed to flow in a zig-zag direction.
27. The method according to claim 21, wherein reducing the speed of the fluid flow comprises directing the fluid flow in a direction tangential to the chamber wall, wherein the fluid flow into the chamber via the inlet is circulated spirally from the proximal end to the distal end.
28. The method according to claim 27, further comprising directing the fluid out of the chamber through a tube disposed in the centre of the chamber, wherein the tube extends from the distal end to the proximal end and out of the chamber at the proximal end.
29. The method according to any one of claims 21 to 28, further comprising transmitting the sanitizing light from the sanitizing light emitter to at least one of the proximal end, the distal end, and a middle portion between the proximal end and the distal end.