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(54) IMPROVEMENTS IN APPARATUS FOR GASIFICATION OF LIQUIDS

(71) I, JOHN JAMES TODD, a British Subject of 11 Overbrook, West Horsley, Surrey and formerly of 17, Blythwood Drive, Parkside, Frimley, Camberley, Surrey, England, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to improvements in apparatus for gasification of liquids and more particularly is concerned with a device for the gasification of liquid media wherein said device in operation is totally immersed.

According to the present invention there is provided a device for the gasification of a liquid in which the device is immersed which comprises a hollow ring shaped member having inlet means for introduction of gas therein and an inwardly facing surface of which defines a central passageway for said liquid wherein only the said inwardly facing surface of said ring member is apertured to permit in operation of said device passage of gas from within said member into the liquid in said passageway in the form of bubbles and wherein at least one of the inwardly facing non-apertured surfaces of the ring member is extended such that the lateral cross-section of the extended passageway defined thereby is progressively increased in a direction away from the ring member.

Preferably in operation the device is immersed in a liquid such that the longitudinal axis of the central passageway defined by the body of the ring member has a substantially vertical direction and gas bubbles on passing through the apertured surface of the ring member into the liquid in the passageway rise through the liquid to the upper surface thereof inducing a flow of liquid upwardly through the pass-

ageway. The induced liquid flow passing the apertures in the surface of the ring member exerts a shearing effect on gas bubbles leaving the ring member through said apertures, thereby producing small gas bubbles for gasification of the liquid and thereby producing a higher rate of gasification of the liquid for any given applied gas pressure than hitherto possible by conventional gasification devices.

The surface of the ring member defining the central passageway may have an aperture in the form of a slit that is a continuous aperture or a plurality of slits either in continuous or discontinuous form, or the apertures may be a series of holes or slits either randomly located on the surface of the ring member or in circumferential rows or in any combination of these arrangements. The apertures may also comprise any combination of slits or holes. For example, the apertured surface may comprise at least one row of circumferentially disposed holes and at least one continuous slit. Further the apertured surface may comprise at least two rows of circumferentially disposed holes with at least one continuous slit between each row or it may comprise at least two rows of continuous slits with at least one row of circumferentially disposed holes located between each slit.

Where the apertured surface comprises rows of holes or slits it is preferable that when the device is immersed in liquid with the centrally defined passageway substantially vertical the holes or slits in the uppermost row are smaller in size than those in the row immediately beneath the said row. This arrangement ensures that bubbles of gas are emitted from substantially all the apertures into the liquid thereby ensuring maximum gasification rate. If it were not made easier for gas bubbles to escape from the lower apertures

by increasing the size thereof relative to the aperture size in the upper rows, gas bubbles would only escape from the uppermost rows of apertures that is, by following a route offering the least pressure resistance.

The body of the ring member may be circular in section and the resulting form of the member may be toroidal or any other suitable form for example elliptical. The body of the ring member may be non-circular in cross-section for example elliptical or may be of any regular or irregular cross-sectional shape.

Either or both of the non-apertured surfaces of the ring member adjacent said apertured surface may be extended in a direction so as to increase the length of the centrally enclosed passageway, but with the extended surface or surfaces thereof being so shaped that the cross-sectional area of the enclosed passageway is progressively increased. In the case where the extended non-apertured surface comprises the lower surface of the ring member, when the ring member is positioned such that the longitudinal axis of the passageway is substantially vertical, it will be seen that the shape of said extended surface of the ring member provides a progressively restricting passageway that is, a throttle, to flow of liquid therethrough when the device is in operation. This extended surfacing or fairing of the ring member induces increased liquid flow rate past the apertured surface of the ring member thereby increasing shearing of bubbles escaping therefrom.

The device in accordance with the invention may more conveniently be adapted for gasification of liquids by adjustably locating the ring member in an open-ended tube such that the longitudinal axis of the passageway enclosed by the ring member is substantially parallel to the longitudinal axis of the tube. The tube may then be fixedly located in a body of liquid to be gasified and the ring member can then be located at any desired position in the tube dependent upon the pressure of the gas supply or the rate of the gasification required or both of these factors. The gasification device may conveniently be similarly but fixedly located in a short length of open-ended tube, the ends of which tube are adapted for connection to similar open ended tubing lengths in an end-to-end fashion thereby enabling any depth of liquid to be gasified by connecting sufficient number of open-ended tubes together with the tube section containing the ring member of the invention located at a desired section position of the tube sections. The aforesaid tube sections having a ring member located therein may also be connected in an end-to-end fashion

with one or more tube sections having ring members located therein thereby creating a multiple gasification system.

Said tube members having ring members located therein may be adapted for immersion in a body of liquid by normal suspension methods but they may also be adapted to be immersed in a free standing position in a body of liquid to be gasified. Such latter adaptation may comprise a base portion for the tube members including a housing having apertured walls defining a central passageway for liquid flow therethrough, the housing being either detachably or fixedly secured to the lower end of the said tube member such that the central passageway of said housing becomes an extension of the central passageway of the tube member and the ring member located therein. The base portion is sufficiently massive in form both in size and weight to provide a firm foundation for the tube member permitting the whole assembly to be located in a free standing position on the floor of a vessel or container in which the liquid to be gasified is housed.

It may be found desirable to provide means for partially obstructing liquid flow when during operation of said device gasified liquid has passed through the central passageway defined by the hollow ring member when located in an open ended tube. The partially obstructing means preferably comprises an inverted cone-shaped member adjustably positioned in the tube above said ring member such that the inverted apex of the cone is located substantially centrally of the tube and therefore is the first part of the obstructing member to present itself to liquid flowing upwardly in the tube during operation of the device. The gasified liquid stream on meeting the obstructing member is thereby caused to follow an annular flow pattern directed towards the periphery of the tube.

A device for the gasification of liquid media in accordance with the invention will now be described by way of example only and with reference to the accompanying drawings in which:—

Figure 1 is a vertical section of a gasification device,

Figure 2 is a vertical schematic section of a gasification device,

Figure 3 is a section on the line AA of Figure 2,

Figure 4 is a longitudinal section of another gasification device,

Figure 5 is a vertical section of a base portion for a gasification device in accordance with the invention,

Figure 6 is a longitudinal section of a further gasification device.

The gasification device shown in Figures 130

1, 2 and 3 comprises a hollow ring shaped member 1 having gas inlet means 2 connected thereto and an inwardly facing surface 3 of the ring member 1 having apertures 4 therein. The inwardly facing surface 3 of the ring member 1 defines a central passageway 5 for liquid medium in which the device is in operation immersed. In operation gas leaves the ring member 1 through the apertures 4 in surface 3 forming bubbles which rise through the liquid in the direction given by arrows 6. The upward movement of bubbles through the liquid medium causes an upward movement of liquid medium in the direction given by arrows 7 through the central passageway 5 and this upward movement of liquid so induced upon flow past the apertures 4 brings about a reduction by shearing of the size of gas bubbles as they leave the apertures 4 to pass into the liquid.

The gasification device shown in Figure 4 comprises a ring shaped member 8 having apertures 4 located in an open ended tube 9 with a lower part 10 of the ring member 8 forming an extension to passageway 5 for passage of liquid medium therethrough. The extension 10 acts as a throttle to the upward liquid flow during operation of the gasification device and induces further shearing of gas bubbles on passage of gas from within member 8 into the liquid in passageway 5. A pipe 11 attached to the upper part of ring member 8 provides an inlet for gas from an external supply (not shown) into member 8. The ring member 8 may be fixedly located (fixing means not shown) in the tube 9 or it may be freely slidable within tube 9 for location of the member 8 at any desired position therein.

Figure 5 shows a base portion 12 suitable for supporting an open-ended tube 9 containing a gasification device in accordance with the invention by locating the lower end of tube 9 into a recess 14 of a wall member 13 of the base 12. The wall members 13 of the base 12 have apertures 15 through which liquid medium in which the gasification device is in operation immersed can pass into a central passageway 16 defined by wall members 13 which passageway 16 communicates directly with passageway 5 in the tube 9.

Figure 6 shows an open ended tube 9 having a ring member 8 located therein which member 8 has an extended part 10 and apertures 4 formed in member 8. A flow restricting member 17 is located in the tube 9 such that an apex part 18 presents itself to the upward flow of liquid during operation of the device causing the flow of gasified liquid to follow an outer annular path in the tube 9 thereby in-

ducing increased rate of flow and turbulence of gasified liquid and thus enhancing the gas bubble shearing effect.

The base portion shown in Figure 5 serves to eliminate or substantially reduce an initial tendency for the lower end of the tube to be displaced horizontally by the liquid to be gasified when the device as shown in Figure 5 and Figure 6 is in use. Such tendency may arise from direct forces from or eddy currents in the liquid or indirectly over a longer period from the production of standing waves in the liquid either in the tube or in a container for the body of liquid. The base portion advantageously rests on the base of a container for the body of liquid when the device is in use to maintain the lower end of the tube fixed in relation to the container.

The base portion makes it possible to use any material of lower density than that of the base portion in the manufacture of the tube provided that the base portion is of sufficient density, thickness and length. Thus, for example, when the base portion is of concrete and is of approximately equal or greater length and of greater thickness than the tube and is provided with a longer extending reinforcing portion of concrete of greater thickness than the remainder of the base part, the tube may be a plastics pipe, for example, of material which is in itself flexible. For example, such a concrete base portion may be in the form of a pipe of length from 2 to 3 feet, the reinforcing portion left thereof acting as a conventional weight for the tube with the tube being in the form of a plastics pipe whose length may be as much as about 3 feet.

The gasification device may be installed in a vessel where it may be used to gasify, for example, aerate, liquid contained in the vessel. The vessel may, for instance, be a sewage treatment vessel and the tube sections containing the gasification device may be of such a length that when stood upright on the base of the vessel they are fully submerged and the tubes may be held in position by the weight of the base portion.

The gas pressure required when an external generator for gas pressure supply is started up is more than that required thereafter, presumably because of a decrease in density of the material flowing in the tube once a water/gas mixture is established in the tube. Accordingly, the generator may be operated at a lower pressure shortly after it has been started. Alternatively, the ring member may be initially positioned fairly high up in the tube and then dropped to a position much lower down in the tube. A further possibil-

ity would be to introduce the gas initially higher up the tube. Any suitable combination of these approaches could be adopted to take advantage of the fact that a lower pressure is required after the start-up. It may be advantageous to use a generator which pumps gas at a single pressure, but the position of entry of the gas and/or position of ring member is varied.

- 10 The present invention further comprehends a device for the gasification of liquid media which comprises an apertured hollow ring shaped member as hereinbefore described having a central passageway extension comprising an extension of the lower non-apertured surface thereof, when the ring member is immersed in a liquid such that the longitudinal axis of said passageway is substantially vertical, and gas inlet means for connecting an external gas supply to the ring member comprising a rigid pipe which serves also to locate and suspend the ring member near to the bottom of a vessel containing liquid to be gasified, but sufficiently clear of said surface to allow in operation movement of liquid along the bottom and upwardly through the central passageway defined by said device. The ring member may also have a central passageway extension comprising an extension of the upper surface thereof projecting either in a direction such that the lateral cross section of the passageway remains substantially constant or in a direction such that said lateral cross section progressively increases away from said ring member. Two or more such devices may be connected together in a substantially horizontal plane that is in a side by side relationship by rigid inter-connecting pipes which serve also to supply gas from an external gas supply to the said devices.

- 45 Within the scope of the present invention there is also provided a liquid treatment apparatus comprising a vessel for containing liquid to be treated and one or more of the present gasification devices. In this case, the apparatus will also be provided with one or more gasification means accordingly for introducing gas into the device or devices.

WHAT I CLAIM IS:—

- 55 1. A device for the gasification of a liquid in which the device is immersed which comprises a hollow ring shaped member having inlet means for introduction of gas thereinto and an inwardly facing surface of which defines a central passageway for said liquid in which only the said inwardly facing surface of said ring member is apertured to permit in operation of said device passage of gas from within said member into the liquid in said passageway in the form of bubbles

and wherein at least one of the inwardly facing non-apertured surfaces of the ring members extended such that the lateral cross section of the extended passageway defined thereby is progressively increased in a direction away from the ring member.

2. A device as claimed in Claim 1 wherein said extended inwardly facing non-apertured surface of the ring member comprises the lower non-apertured surface thereof.

3. A device as claimed in Claim 1 wherein said extended inwardly facing non-apertured surface of the ring member comprises the upper non-apertured surface thereof.

4. A device as claimed in Claim 1 wherein both upper and lower inwardly facing non-apertured surfaces of the ring member are extended in a direction such that the lateral cross section of the extended central passageway defined thereby progressively increases in a direction away from the ring member.

5. A device as claimed in anyone of Claims 1-4 wherein the apertured surface of the ring member comprises a surface having one or more continuous apertures therein the or each aperture being in the form substantially of a slit.

6. A device as claimed in anyone of Claims 1-4 wherein the apertured surface of the ring member comprises a surface having one or more holes therein.

7. A device as claimed in Claim 6 wherein the holes are located at intervals on one or more circumferential lines along said surface.

8. A device as claimed in Claim 7 in which the apertured surface comprises holes located at intervals on each of a plurality of circumferential lines on said surface and wherein the size of holes in any one line is less than that of the holes in the line immediately below the said line when the ring member is in operation located in a liquid for gasification thereof such that the longitudinal axis of the central passageway is substantially vertical.

9. A device as claimed in any one of Claims 5-7 wherein the apertured surface of the ring member comprises at least one row of circumferentially disposed holes and at least one continuous slit aperture.

10. A device as claimed in any one of Claims 5-8 wherein the apertured surface of the ring member comprises more than one row of circumferentially disposed holes with at least one continuous slit aperture located between each row.

11. A device as claimed in any one of Claims 5-7 wherein the apertured surface of the ring member comprises more than one continuous slit aperture with at least one row of circumferentially disposed holes

13
ity would be to introduce the gas initially higher up the tube. Any suitable combination of these approaches could be adopted to take advantage of the fact that a lower pressure is required after the start-up. It may be advantageous to use a generator which pumps gas at a single pressure, but the position of entry of the gas and/or position of ring member is varied.

10 The present invention further comprehends a device for the gasification of liquid media which comprises an apertured hollow ring shaped member as hereinbefore described having a central passageway extension comprising an extension of the lower non-apertured surface thereof, when the ring member is immersed in a liquid such that the longitudinal axis of said passageway is substantially vertical, and gas inlet means for connecting an external gas supply to the ring member comprising a rigid pipe which serves also to locate and suspend the ring member near to the bottom of a vessel containing liquid to be gasified, but sufficiently clear of said surface to allow in operation movement of liquid along the bottom and upwardly through the central passageway defined by said device. The ring member may also have a central passageway extension comprising an extension of the upper surface thereof projecting either in a direction such that the lateral cross section of the passageway remains substantially constant or in a direction such that said lateral cross section progressively increases away from said ring member. Two or more such devices may be connected together in a substantially horizontal plane that is in a side by side relationship by rigid inter-connecting pipes which serve also to supply gas from an external gas supply to the said devices.

Within the scope of the present invention there is also provided a liquid treatment apparatus comprising a vessel for containing liquid to be treated and one or more of the present gasification devices. In this case, the apparatus will also be provided with one or more gasification means accordingly for introducing gas into the device or devices.

WHAT I CLAIM IS:—

1. A device for the gasification of a liquid in which the device is immersed which comprises a hollow ring shaped member having inlet means for introduction of gas therinto and an inwardly facing surface of which defines a central passageway for said liquid in which only the said inwardly facing surface of said ring member is apertured to permit in operation of said device passage of gas from within said member into the liquid in said passageway in the form of bubbles

and wherein at least one of the inwardly facing non-apertured surfaces of the ring members extended such that the lateral cross section of the extended passageway defined thereby is progressively increased in a direction away from the ring member.

2. A device as claimed in Claim 1 wherein said extended inwardly facing non-apertured surface of the ring member comprises the lower non-apertured surface thereof.

3. A device as claimed in Claim 1 wherein said extended inwardly facing non-apertured surface of the ring member comprises the upper non-apertured surface thereof.

4. A device as claimed in Claim 1 wherein both upper and lower inwardly facing non-apertured surfaces of the ring member are extended in a direction such that the lateral cross section of the extended central passageway defined thereby progressively increases in a direction away from the ring member.

5. A device as claimed in anyone of Claims 1-4 wherein the apertured surface of the ring member comprises a surface having one or more continuous apertures therein the or each aperture being in the form substantially of a slit.

6. A device as claimed in anyone of Claims 1-4 wherein the apertured surface of the ring member comprises a surface having one or more holes therein.

7. A device as claimed in Claim 6 wherein the holes are located at intervals on one or more circumferential lines along said surface.

8. A device as claimed in Claim 7 in which the apertured surface comprises holes located at intervals on each of a plurality of circumferential lines on said surface and wherein the size of holes in any one line is less than that of the holes in the line immediately below the said line when the ring member is in operation located in a liquid for gasification thereof such that the longitudinal axis of the central passageway is substantially vertical.

9. A device as claimed in any one of Claims 5-7 wherein the apertured surface of the ring member comprises at least one row of circumferentially disposed holes and at least one continuous slit aperture.

10. A device as claimed in any one of Claims 5-8 wherein the apertured surface of the ring member comprises more than one row of circumferentially disposed holes with at least one continuous slit aperture located between each row.

11. A device as claimed in any one of Claims 5-7 wherein the apertured surface of the ring member comprises more than one continuous slit aperture with at least one row of circumferentially disposed holes



located between each slit.

12. A device as claimed in any one of Claims 1-11 wherein said ring member is adjustably positioned in an open-ended tube member such that the longitudinal direction of the passageway enclosed by the ring member is substantially parallel to the longitudinal axial direction of the tube member, to facilitate when the tube member in operation is immersed in a liquid to be gasified in the positioning of the ring member at a desired depth in the liquid.

13. A device as claimed in any one of Claims 1-11 wherein said ring member is fixedly located in an open-ended tube member such that the longitudinal axial direction of the passageway enclosed by the ring member is substantially parallel to the longitudinal axial direction of the tube member.

14. A device as claimed in Claims 12 and 13 wherein either end of said tube member is adapted to be connectable in an end to end fashion to other open-ended tube members not having a ring member located therein to enable said gasification device more conveniently to be used at any desired depth in a liquid.

15. A device as claimed in Claims 12 and 13 wherein either end of said tube member is adapted to be connectable in an end to end fashion to other open ended tube members having a ring member located therein.

16. A device as claimed in Claims 12 35 and 13 wherein said tube member is provided with a base portion comprising a housing having apertured walls defining a central passageway for liquid flow there-through said housing being either detachably or fixedly secured to said tube member such that the central passageway of said housing becomes an extension of the central passageway of said tube member and the ring member located therein. 50

17. An apparatus for the treatment of liquids comprising two or more devices as claimed in any one of Claims 1-16 wherein said devices are spaced apart each from the other in a horizontal plane with rigid spacing members connecting said devices and each having a gas inlet pipe for connecting each of said devices with an external gas supply. 55

18. An apparatus as claimed in Claim 17 where one gas inlet pipe connects two or more of said devices with an external gas supply and the rigid spacing members connecting said two or more devices comprise gas supply pipes for connecting said one gas inlet pipe to said two or more devices. 60

19. A device for the gasification of liquids substantially as herein disclosed and described with reference to the accompanying drawings. 70

J. J. TODD.



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