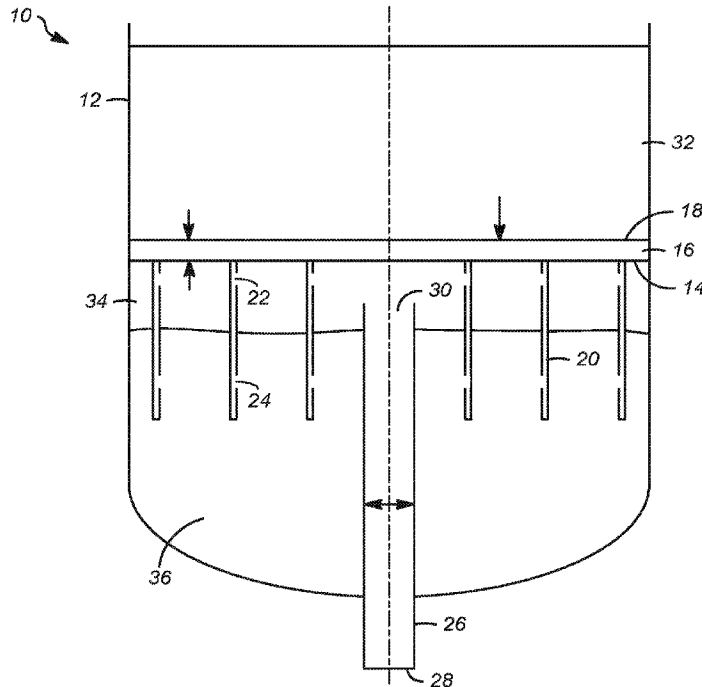




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(57) **Abrégé/Abstract:**

The present invention relates to an apparatus for vapor-liquid distribution. More specifically, the present invention relates to a vapor-liquid distribution device that may be used in an ionic liquid co-current vapor and liquid up-flow reactor designed to distribute vapor uniformly across the reactor cross section through restriction orifices on distributors located across the distribution tray.

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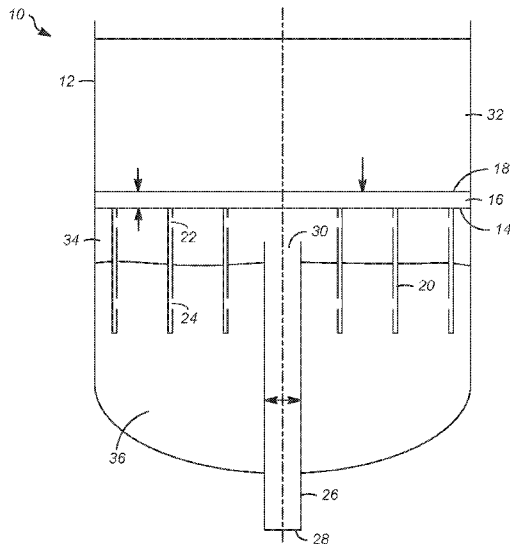


FIG. 1

(57) Abstract: The present invention relates to an apparatus for vapor-liquid distribution. More specifically, the present invention relates to a vapor-liquid distribution device that may be used in an ionic liquid co-current vapor and liquid up-flow reactor designed to distribute vapor uniformly across the reactor cross section through restriction orifices on distributors located across the distribution tray.



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APPARATUS FOR VAPOR-LIQUID DISTRIBUTION

[0001] Continue to [0002].

FIELD

5 [0002] The present invention relates to an apparatus for vapor-liquid distribution. More specifically, the present invention relates to a vapor-liquid distribution device that may be used in an ionic liquid co-current vapor and liquid up-flow reactor designed to distribute vapor uniformly across the reactor cross section through restriction orifices on distributors located across the distribution tray.

10 BACKGROUND

[0003] In the co-current vapor-liquid upflow reactors, liquid is the continuous phase and vapor dispersed phase. It is critical to distribute vapor uniformly across the reactor cross section, which is achieved by building a vapor chamber under a distribution tray so that vapor can be distributed through restriction orifices on distributors located across the distribution tray. Good tray performance requires there to be a stable gas-liquid interface below the tray. When the gas-liquid feed stream is injected into the bottom of reactor, gas bubbles travel upwards and disrupt the gas-liquid interface, which negatively impacts gas distribution in the tray.

SUMMARY

20 [0004] The present invention is a vapor-liquid distribution tray that may be used in an ionic liquid co-current vapor and liquid up-flow reactor designed to distribute vapor uniformly across the reactor cross section through restriction orifices on distributors located across the distribution tray.

[0005] A first embodiment of the invention is an apparatus for vapor-liquid distribution, 25 comprising a tubular housing; a cylindrical riser having an inlet and an outlet which is affixed

to the bottom opening of the tubular housing; a distribution plate affixed to the inside of the tubular housing; a plurality of liquid chimneys affixed to the bottom of the distribution plate wherein each liquid chimney includes a first horizontal opening and a second horizontal opening.

5 [0006] A second embodiment of the invention is an apparatus for vapor-liquid distribution, comprising; a tubular housing; a cylindrical riser having one inlet and one outlet which is affixed to the bottom opening of the tubular housing; a distribution plate affixed to the inside of the tubular housing; at least 36 liquid chimneys affixed to the bottom of the distribution plate in an even distribution wherein each liquid chimney includes a first
10 horizontal opening and a second horizontal opening.

[0007] A third embodiment of the invention is an apparatus for vapor-liquid distribution, comprising; a tubular housing located in an ionic liquid co-current vapor and liquid up-flow reactor designed to distribute vapor uniformly across the reactor cross section, wherein the tubular housing includes a vapor space and a liquid space wherein the vapor space is located
15 above the liquid space; a cylindrical riser having one inlet and one outlet which is affixed to the bottom opening of the tubular housing; a distribution plate affixed to the inside of the tubular housing; a plurality of liquid chimneys affixed to the bottom of the distribution plate in an even distribution wherein each liquid chimney includes a first circular horizontal opening and a second slotted horizontal opening, wherein the first circular horizontal opening
20 of the liquid is located in the vapor space and the second slotted horizontal opening is located in the liquid space, wherein 50% of the liquid chimneys are located in the vapor space and 50% of the liquid chimneys are located in the liquid space.

[0008] In the foregoing, all temperatures are set forth in degrees Celsius and, all parts and percentages are by weight, unless otherwise indicated. Other objects, advantages and
25 applications of the present invention will become apparent to those skilled in the art from the following detailed description and drawing. Additional objects, advantages and novel features of the examples will be set forth in part in the description which follows, and in part will become apparent to those skilled in the art upon examination of the following description and the accompanying drawing or may be learned by production or operation of the
30 examples. The objects and advantages of the concepts may be realized and attained by means of the methodologies, instrumentalities and combinations particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWING

[0009] FIG.1 illustrates a vapor-liquid distribution device that may be used in an ionic liquid co-current vapor and liquid up-flow reactor.

DETAILED DESCRIPTION

5 [0010] The following detailed description is merely exemplary in nature and is not intended to limit the application and uses of the embodiment described. Furthermore, there is no intention to be bound by any theory presented in the preceding background or the following detailed description.

[0011] The description of the apparatus of this invention is presented with reference to 10 the attached FIG. 1. FIG. 1 is a simplified diagram of the preferred embodiment of this invention and is not intended as an undue limitation on the generally broad scope of the description provided herein and the appended claims. Certain hardware such as valves, pumps, compressors, heat exchangers, instrumentation and controls, have been omitted as not essential to a clear understanding of the invention. The use and application of this hardware is 15 well within the skill of the art.

[0012] The various embodiments described herein relate to a vapor-liquid distribution tray. As shown in FIG. 1, an apparatus 10 comprises of a tubular housing 12 comprising having a riser 26 and a distribution plate 14. Inside of the housing there is a vapor space 34 and a liquid space 36. The riser enters the bottom portion of the tubular housing 12 and 20 extends upwards towards the distribution plate 14. The riser may be cylindrical and includes a bottom opening 28 and a top opening 30. The riser 26 provides a combination of vapor and liquid to the vapor space 34. In the example shown in FIG.1, the riser 26 has one bottom opening 28 and one top opening 30. However, it is contemplated that in other embodiments there may be multiple top openings 30. For example, there may be 2 or more top openings 30 25 that may disperse the distribution of vapor and liquid into the vapor space 34.

[0013] The distribution plate 14 is a horizontal plate affixed to the inside of the housing 12 that includes a plurality of liquid chimneys 20 that are coupled to the distribution plate 14 and located at various locations around the underneath of the distribution plate 14. The liquid chimneys 20 are connected to the bottom of the distribution plate 14 and extend downward 30 into the liquid space 36. In the example shown in FIG. 1, the top half of the liquid chimneys

20 are in the vapor space 34 and the bottom half of the liquid chimneys are in the liquid space 36. However, it is contemplated that in other embodiments, the liquid chimneys 20 may be proportioned differently. For example, 30% of the liquid chimneys 20 may be located in the vapor space 34 and the other 70% of the liquid chimneys 20 may be located in the liquid space 36.

5 [0014] In the example shown in FIG. 1, there are 36 liquid chimneys 20 affixed to the bottom of the distribution plate 14. However, it is contemplated that any amount of liquid chimneys 20 may be affixed to the bottom of the distribution plate 14. For example, there will always be at least 2 liquid chimneys located around the distribution plate 14.

10 [0015] In the example shown in FIG. 1, the liquid chimneys are cylindrical and hollow in the inside, shaped like a tube. This allows the vapor located in the vapor space 34 and the liquid space 36 to enter the liquid chimneys 20 and rise up into the space above the distribution tray 14. Each liquid chimney 20 includes at least 2 openings. In the example shown in FIG. 1, each liquid chimney 20 includes a first opening 22 and a second opening 24.

15 The first opening 22 is exposed to the vapor space 34 and the second opening 24 is exposed to the liquid space 36. The first opening 22 may be circular, so it is shaped like a hole, or it may be shaped like a slot or a triangle. The second opening 24 may be circular, so it is shaped like a hole, or it may be shaped like a slot or a triangle. It is also contemplated that the second opening 24 may be located at the very bottom of the liquid chimney 20 so it is slotted from

20 the bottom of the liquid chimney 20 upwards, so as to facilitate the flow of the vapor into the liquid chimney 20. As discussed above, the example illustrated in FIG. 1 pictures each liquid chimney having 2 openings each. However, it is contemplated that each liquid chimney may have more than 2 holes. For example, each liquid chimney may have 5 holes each, and each hole may be a different shape. For example, if the liquid chimney has 5 holes, 2 of the holes

25 may be circular openings, and the other 3 holes may be vertical slots. It is also contemplated that each individual liquid chimney may have its own unique combination of openings and shapes of openings.

[0016] The space above the distribution plate 14 is a free liquid space 16 which is in between the distribution plate 14 and a support grid 18. The section 32 above the support grid

30 18 is the section 32 which includes porous ceramic material that captures solids and other contaminants and may aid in gas distribution.

[0017] While the invention has been described with what are presently considered the preferred embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but it is intended to cover various modifications and equivalent arrangements included within the scope of the appended claims.

5

SPECIFIC EMBODIMENTS

[0018] While the following is described in conjunction with specific embodiments, it will be understood that this description is intended to illustrate and not limit the scope of the preceding description and the appended claims.

[0019] A first embodiment of the invention is an apparatus for vapor-liquid distribution, comprising a tubular housing; a cylindrical riser having an inlet and an outlet which is affixed to the bottom opening of the tubular housing; a distribution plate affixed to the inside of the tubular housing; a plurality of liquid chimneys affixed to the bottom of the distribution plate wherein each liquid chimney includes a first horizontal opening and a second horizontal opening. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph, wherein there are 2 to 100 liquid chimneys affixed to the bottom of the distribution plate. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph, wherein there are 36 liquid chimneys affixed to the bottom of the distribution plate. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph, wherein the tubular housing includes a vapor space and a liquid space wherein the vapor space is located above the liquid space. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph, wherein the first horizontal opening of the liquid is located in the vapor space and the second horizontal opening is located in the liquid space. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph, wherein 50% of the liquid chimneys are located in the vapor space and 50% of the liquid chimneys are located in the liquid space. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph, wherein the liquid chimney horizontal openings are circular. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first

embodiment in this paragraph, wherein the liquid chimney horizontal openings are slotted. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph, wherein the first horizontal openings in the liquid chimneys are circular and the second horizontal openings in the liquid chimneys are slotted. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph, further comprising a second outlet on the cylindrical riser.

[0020] A second embodiment of the invention is an apparatus for vapor-liquid distribution, comprising; a tubular housing; a cylindrical riser having one inlet and one outlet which is affixed to the bottom opening of the tubular housing; a distribution plate affixed to the inside of the tubular housing; at least 36 liquid chimneys affixed to the bottom of the distribution plate in an even distribution wherein each liquid chimney includes a first horizontal opening and a second horizontal opening. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph, wherein the tubular housing includes a vapor space and a liquid space wherein the vapor space is located above the liquid space. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph, wherein the first horizontal opening of the liquid is located in the vapor space and the second horizontal opening is located in the liquid space. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph, wherein 50% of the liquid chimneys are located in the vapor space and 50% of the liquid chimneys are located in the liquid space. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph, wherein the liquid chimney horizontal openings are circular. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph, wherein the liquid chimney horizontal openings are slotted. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph, wherein the first horizontal openings in the liquid chimneys are circular and the second horizontal openings in the liquid chimneys are slotted. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph, further comprising a second outlet on the cylindrical riser.

[0021] A third embodiment of the invention is an apparatus for vapor-liquid distribution, comprising; a tubular housing located in an ionic liquid co-current vapor and liquid up-flow reactor designed to distribute vapor uniformly across the reactor cross section, wherein the tubular housing includes a vapor space and a liquid space wherein the vapor space is located
5 above the liquid space; a cylindrical riser having one inlet and one outlet which is affixed to the bottom opening of the tubular housing; a distribution plate affixed to the inside of the tubular housing; a plurality of liquid chimneys affixed to the bottom of the distribution plate in an even distribution wherein each liquid chimney includes a first circular horizontal opening and a second slotted horizontal opening, wherein the first circular horizontal opening
10 of the liquid is located in the vapor space and the second slotted horizontal opening is located in the liquid space, wherein 50% of the liquid chimneys are located in the vapor space and 50% of the liquid chimneys are located in the liquid space.

[0022] Without further elaboration, it is believed that using the preceding description that one skilled in the art can utilize the present invention to its fullest extent and easily ascertain
15 the essential characteristics of this invention, without departing from the spirit and scope thereof, to make various changes and modifications of the invention and to adapt it to various usages and conditions. The preceding preferred specific embodiments are, therefore, to be construed as merely illustrative, and not limiting the remainder of the disclosure in any way whatsoever, and that it is intended to cover various modifications and equivalent
20 arrangements included within the scope of the appended claims. In the foregoing, all temperatures are set forth in degrees Celsius and, all parts and percentages are by weight, unless otherwise indicated.

CLAIMS:

1. An apparatus for gas-liquid distribution, comprising:
a tubular housing;
a cylindrical riser having an inlet and an outlet which is affixed to a bottom opening
of the tubular housing;
a distribution plate affixed to the inside of the tubular housing; and
a plurality of chimneys affixed to the bottom of the distribution plate wherein each
chimney comprises a first horizontal opening and a second horizontal opening.
2. The apparatus of claim 1, wherein there are 4 to 500 chimneys affixed to the
bottom of the distribution plate.
3. The apparatus of claim 1, wherein there are 36 chimneys affixed to the bottom of
the distribution plate.
4. The apparatus of claim 1, wherein the tubular housing comprises a gas space and a
liquid space wherein the gas space is located above the liquid space.
5. The apparatus of claim 4, wherein the cylindrical riser outlet is located in the gas
space.
6. The apparatus of claim 5, wherein the first horizontal opening of the chimney is
located in the gas space and the second horizontal opening is located in the liquid space.
7. The apparatus of claim 5, wherein both of the first and the second horizontal
openings of the chimney are located in the gas space.
8. The apparatus of claim 5, wherein 30% of the chimneys is located in the gas space
and the rest of the chimneys is located in the liquid space.
9. The apparatus of claim 5, wherein 70% of the chimneys is located in the gas space
and the rest in the liquid space.
10. The apparatus of claim 1, wherein the first horizontal openings in the chimneys
are circular and the second horizontal openings in the chimneys are slotted.

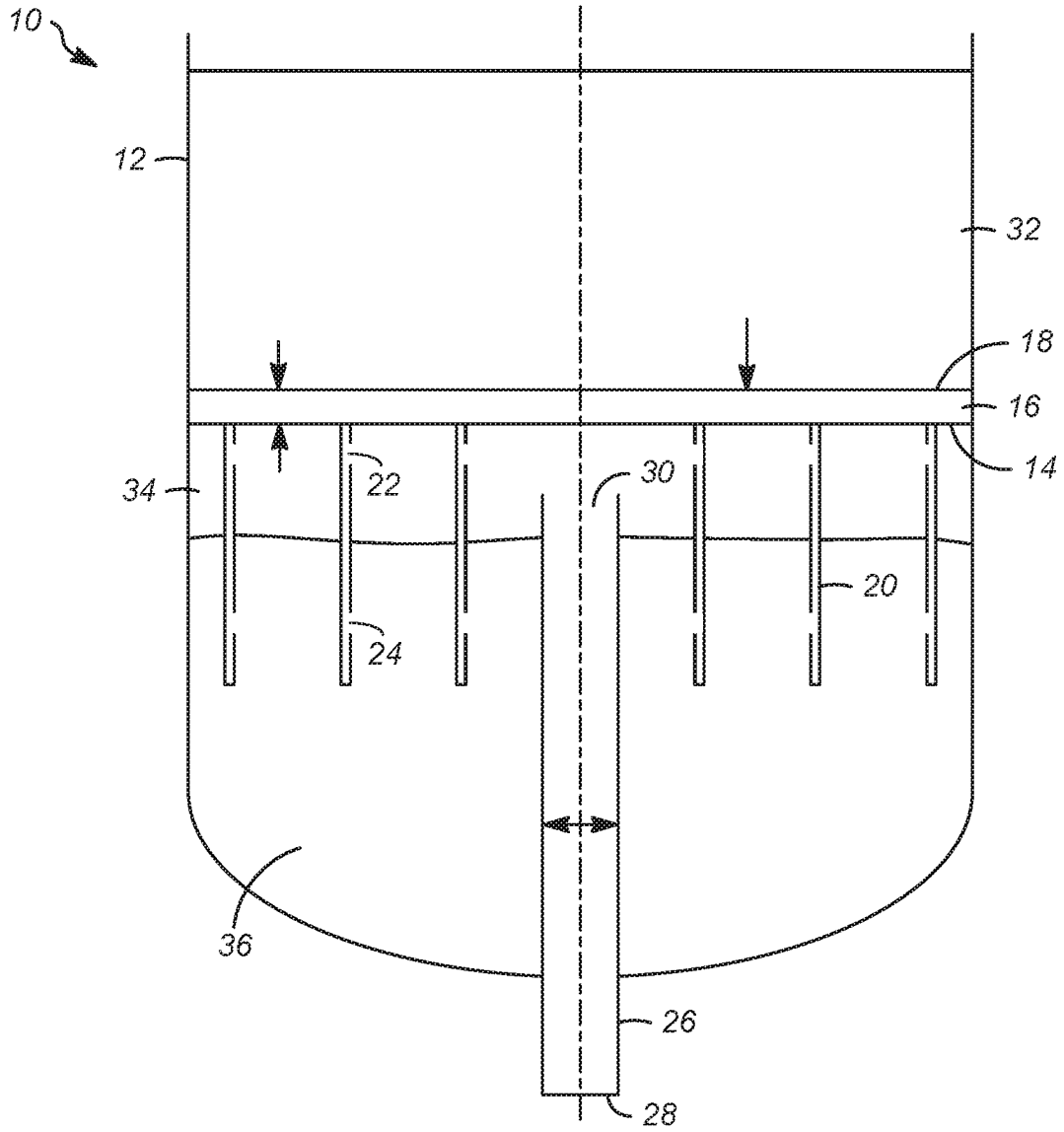


FIG. 1

