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(54) Title: STORAGE TANK FOR ICE-SLURRY

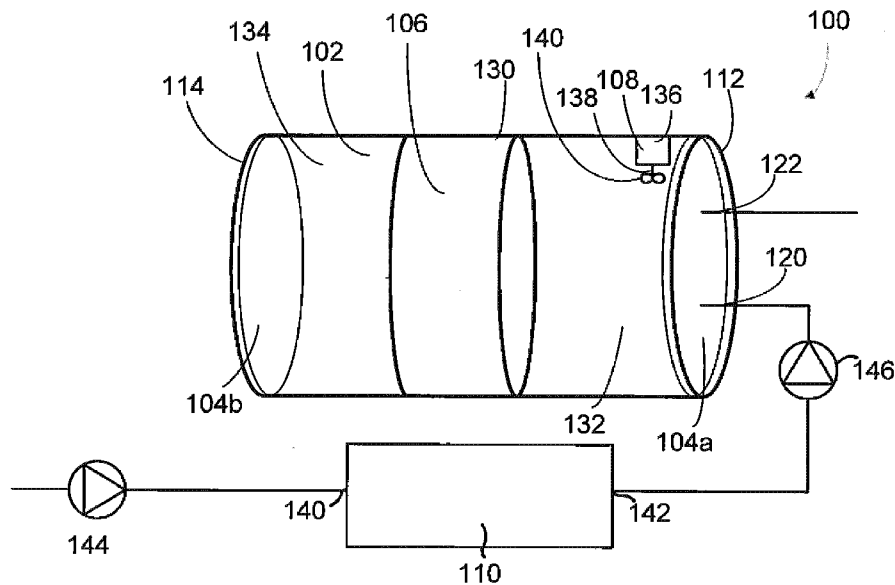


FIG. 1

(57) Abstract: A storage tank comprises: a body having opposite open ends; end plates removably connected to the opposite open ends of the body, one of the end plates comprising an inlet and an outlet; and a piston floatably mounted within the body. The piston is movable towards the end plate having the inlet and the outlet during discharge of ice-slurry contained within the storage tank via the outlet.



Declarations under Rule 4.17:

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STORAGE TANK FOR ICE-SLURRY

Cross Reference to Related Application

5 [0001] This application claims the benefit of U.S. Provisional Application No. 62/778580
filed on December 12, 2018, the entire contents of which are incorporated herein by
reference.

Field

10 [0002] The subject disclosure relates to storage tanks and in particular, to a storage tank
for ice-slurry.

Background

15 [0003] Ice-slurry is known in the art and is a phase changing material made up of ice
crystals formed and suspended within a liquid or solution such as water or brine. Ice-slurry
can be used for a number of applications such as for freezing temperature sensitive products
like foodstuffs (fish, etc.). Ice-slurry can also be used for ice pigging, which is a process in
which ice-slurry is pumped through a pipe to remove sediment and other unwanted deposits
within the pipe.

20 [0004] The storage of ice-slurry is difficult as ice crystals may separate from the liquid or
solution of the ice-slurry. As such, it is difficult to store and maintain ice-slurry having a
particular ice fraction (the ratio of ice crystals to liquid or solution).

[0005] While attempts have been made to provide adequate storage for ice-slurry,
improvements in the storage of ice-slurry are desired. It is therefore an object at least to
provide a novel storage tank for ice-slurry.

25

Summary

[0006] It should be appreciated that this summary is provided to introduce a selection of
concepts in a simplified form that are further described below in the Detailed Description of
Embodiments. This summary is not intended to be used to limit the scope of the claimed
30 subject matter.

[0007] Accordingly, in one aspect there is provided a storage tank comprising: a body
having opposite open ends; end plates removably connected to the opposite open ends of
the body, one of the end plates comprising an inlet and an outlet; and a piston floatably
mounted within the body, the piston being movable towards the end plate having the inlet
35 and the outlet during discharge of ice-slurry contained within the storage tank via the outlet.

[0008] In one or more embodiments, the piston divides the storage tank into isolated first
and second compartments, with the first compartment being delineated by the piston and the

end plate having the inlet and the outlet, and with the second compartment being delineated by piston and the other end plate.

[0009] In one or more embodiments, a seal extends about a periphery of the piston, with the seal being in contact with an interior surface of the body.

5 [0010] In one or more embodiments, at least one agitator is mounted within the body and is configured to mix ice-slurry contained within the storage tank. In other embodiments, a plurality of agitators may be mounted within the body at spaced locations.

[0011] In one or more embodiments, the at least one agitator may be mounted within the first compartment of the storage tank and configured to mix ice-slurry contained therein. The
10 at least one agitator may be positioned adjacent the outlet. Alternatively, a plurality of agitators may be mounted within the first compartment of the storage tank at spaced locations. For example, one agitator may be positioned adjacent the outlet and another agitator may be positioned adjacent the inlet.

[0012] In one or more embodiments, the outlet is positioned at a location above the inlet.

15 [0013] In one or more embodiments, the storage tank is pressurized.

[0014] In one or more embodiments, the other end plate comprises an inlet to permit the ingress of a pressurizing medium into the second compartment of the storage tank. The pressurizing medium may, for example, be water or air.

20 [0015] In one or more embodiments, the piston is semi-permeable to permit the flow of liquid or solution therethrough.

Brief Description of the Drawings

[0016] Embodiments will now be described more fully with reference to the accompanying drawings in which:

25 [0017] Figure 1 is a schematic view of a storage tank for ice-slurry and an ice-making machine for generating ice-slurry;

[0018] Figure 2 is a schematic view of the storage tank and the ice-making machine of Figure 1 prior to filling of the storage tank with ice-slurry;

30 [0019] Figure 3 is a schematic view of the storage tank and the ice-making machine of Figure 1 during filling of the storage tank with ice-slurry;

[0020] Figure 4 is a schematic view of the storage tank of Figure 1 during storage of ice-slurry;

[0021] Figure 5 is a schematic view of the storage tank of Figure 1 during draining of ice-slurry; and

35 [0022] Figure 6 is a schematic view of another embodiment of a storage tank for ice-slurry, an ice-making machine for generating ice-slurry, and a pressurizing source for pressurizing the storage tank.

Detailed Description of Embodiments

[0023] The foregoing summary, as well as the following detailed description of certain examples will be better understood when read in conjunction with the appended drawings. As used herein, an element or feature introduced in the singular and preceded by the word "a" or "an" should be understood as not necessarily excluding the plural of the elements or features. Further, references to "one example" or "one embodiment" are not intended to be interpreted as excluding the existence of additional examples or embodiments that also incorporate the described elements or features. Moreover, unless explicitly stated to the contrary, examples or embodiments "comprising" or "having" or "including" an element or feature or a plurality of elements or features having a particular property may include additional elements or features not having that property. Also, it will be appreciated that the terms "comprises", "has", "includes" means "including but not limited to" and the terms "comprising", "having" and "including" have equivalent meanings.

[0024] As used herein, the term "and/or" can include any and all combinations of one or more of the associated listed elements or features.

[0025] It will be understood that when an element or feature is referred to as being "on", "attached" to, "connected" to, "coupled" with, "contacting", etc. another element or feature, that element or feature can be directly on, attached to, connected to, coupled with or contacting the other element or feature or intervening elements may also be present. In contrast, when an element or feature is referred to as being, for example, "directly on", "directly attached" to, "directly connected" to, "directly coupled" with or "directly contacting" another element of feature, there are no intervening elements or features present.

[0026] It will be understood that spatially relative terms, such as "under", "below", "lower", "over", "above", "upper", "front", "back" and the like, may be used herein for ease of description to describe the relationship of an element or feature to another element or feature as illustrated in the figures. The spatially relative terms can however, encompass different orientations in use or operation in addition to the orientation depicted in the figures.

[0027] In the following, a storage tank for ice-slurry is described and comprises a body having opposite open ends, end plates removably connected to the opposite open ends of the body, one of the end plates comprising an inlet and an outlet; and a piston floatably mounted within the body, the piston being movable towards the end plate having the inlet and the outlet during discharge of ice-slurry contained within the storage tank via the outlet.

[0028] Turning now to Figure 1, a storage tank for ice-slurry is shown and is generally identified by reference numeral 100. The storage tank comprises a body 102, end plates 104a, 104b at opposite ends of the body 102, a piston 106 within the body 102 and an agitator 108 within the body 102. As will be described, the storage tank 100 is configured to store ice-slurry received from an external ice-making machine 110.

[0029] In this embodiment, the body 102 is generally cylindrical in shape and comprises opposite open ends 112, 114. The body 102 is made of stainless steel or other suitable structural material.

[0030] The end plates 104a, 104b are removably connected to the opposite open ends 5 112, 114 of the body 102. Although not shown, a seal such as for example an O-ring is used to ensure the end plates 104a, 104b seal the opposite open ends 112, 114 of the body 102. End plate 104a comprises an inlet 120, and an outlet 122. The inlet 120 is configured to permit the ingress of ice-slurry into the storage tank 100. The outlet 122 is configured to permit the egress of ice-slurry out of the storage tank 100. In this embodiment, the outlet 10 122 is positioned above the inlet 120.

[0031] The piston 106 is floatably mounted within the body 102. The piston 106 comprises a seal 130, which in this embodiment is a ring formed of rubber or other suitable material. The seal 130 extends about the periphery of the piston 106. The piston 106 is dimensioned such that the seal 130 is in contact with the interior surface of the body 102. 15 As a result, the piston 106 divides the interior of the storage tank 100 into two compartments 132, 134. The first compartment 132 is delineated by the piston 106 and the end plate 104a and the second compartment 134 is delineated by the piston 106 and the end plate 104b. In this embodiment, the piston 106 isolates the first compartment 132 from the second compartment 134 and as such, ice-slurry or components thereof are not exchanged 20 therebetween. As will be described, the size or volume of the first and second compartments 132, 134 are adjusted when the piston 106 moves longitudinally within the body 102.

[0032] The agitator 108 is positioned within the first compartment 132 adjacent the outlet 122. The agitator 108 comprises a motor 136, a shaft 138 and an impeller 140. The motor 25 136 is configured to rotate the shaft 138 and the impeller 140. A master controller (not shown) is used to selectively turn the motor 136 on and off. The agitator 108 is used to agitate ice-slurry contained within the first compartment 132 of the storage tank 100 to avoid separation of ice-slurry contained within the first compartment 132 of the storage tank 100 into ice crystals and liquid or solution.

[0033] In this embodiment, the storage tank 100 is configured to store ice-slurry received 30 from the external ice-making machine 110. In this embodiment, the ice-making machine 110 is of the type described in U.S. Patent Nos. 5,884,501 and 6,056,046, the relevant portions of which are incorporated herein by reference. Generally, the ice-making machine 110 comprises an ice generator tube having a cylindrical internal heat exchange surface. A 35 blade assembly is disposed within the ice generator tube and includes a plurality of blades in contact with the heat exchange surface. The blade assembly is mounted on a shaft driven by a motor via a transmission. Refrigerant circulates through refrigerant circuits in proximity to the heat exchange surface. Brine solution, which in this embodiment is sea-water, is

pumped using pump 144 into the ice-making machine 110 via inlet 140 and is directed towards the heat exchange surface therein. While this occurs, refrigerant circulates through the refrigerant circuits to cool the heat exchange surface. As the refrigerant flows through the refrigerant circuits, the refrigerant absorbs heat through the heat exchange surface and boils. The brine solution in contact with the heat exchange surface is thus supercooled.

[0034] To avoid deposition of ice on the heat exchange surface, which would inhibit heat transfer to the refrigerant and thereby reduce the efficiency of the ice-making machine 110, the blade assembly is rotated by the motor at a rate that is fast enough to allow the blades to remove the supercooled brine solution from the heat exchange surface prior to crystallization of ice crystals on the heat exchange surface. The supercooled brine solution therefore crystallizes in the body of brine solution within the ice generator tube allowing the brine solution to act as a secondary refrigerant in the formation of fine ice crystals throughout the brine solution. The supercooled brine solution including the ice crystals exits the ice-making machine 110 as ice-slurry via outlet 142.

[0035] Ice-slurry exiting the ice-making machine 110 via outlet 142 is pumped into the storage tank 100 via the inlet 120 using pump 146. Initially, when little or no ice-slurry is contained within the storage tank 100, the piston 106 is positioned adjacent the end plate 104a as shown in Figure 2. As ice-slurry enters the storage tank 100 and begins to fill the first compartment 132, the piston 106 moves in the direction of arrow A towards the end plate 104b thereby increasing the size or volume of the first compartment 132 and decreasing the size or volume of the second compartment 134, as shown in Figure 3. As a result, the amount of ice-slurry that can be stored in the first compartment 132 increases. Once the desired amount of ice-slurry has been pumped into the storage tank 100, the ice-making machine 110 is turned off and the ice-making machine 110 and pump 146 are disconnected from the inlet 120. A cap (not shown) is then placed on the inlet 120 to close it off as shown in Figure 4.

[0036] When ice-slurry is required, ice-slurry can be pumped out of the storage tank 100 via the outlet 122. As ice-slurry is pumped out of the storage tank 100, the air pressure within the storage tank 100 causes the piston 106 to move in the direction of arrow B towards the end plate 104a, thereby decreasing the size or volume of the first compartment 132 and increasing the size or volume of the second compartment 134, as shown in Figure 5.

[0037] Throughout operation, the agitator 108 may be selectively switched on to agitate ice-slurry contained in the first compartment 132 of the storage tank 100 to inhibit ice crystal and liquid or solution separation.

[0038] The ice-slurry held in the storage tank 100 may be used for a number of applications such as for example ice pigging, chilling temperature sensitive products etc.

[0039] Another embodiment of a storage tank 100' is shown in Figure 6. In this embodiment, like reference numerals will be used to indicate like components with a "" added for clarity. As can be seen, storage tank 100' is similar to that of storage tank 100, with the following exception. In this embodiment, the end plate 104b' comprises an inlet 124. The inlet 124 is connectable to a pressurizing source 200 via a pump 202. The pressurizing source 200 is configured to deliver a pressurizing medium to the second compartment 134' of the storage tank. In this embodiment, the pressurizing source 200 is a pressurized air source that delivers air to the second compartment 134' of the storage tank 100' via the pump 202 and inlet 124. When connected, pressurized air from the pressurized air source 200 may be pumped into the second compartment 134' of the storage tank 100' to help move the piston 106' in the direction of arrow B toward end plate 104a', further helping ice-slurry removal from the first compartment 132' of the storage tank 100' via outlet 122'.

[0040] In another embodiment, rather than pumping pressurized air into the storage tank 100', water may be pumped into the second compartment 134' of the storage tank 100' via inlet 124 to help move the piston 106' in the direction of arrow B towards the end plate 104a'. The water may be pumped back out of the second compartment 134' of the storage tank 100' and may be fed into the ice-making machine 110' during ice-slurry creation.

[0041] Although in embodiments the storage tank is described as comprising an agitator positioned adjacent the outlet, those skilled in the art will appreciate that alternatives are available. For example, in another embodiment, the agitator may be positioned adjacent the inlet. In another embodiment, multiple agitators, such as for example two agitators, may be used. In this example, a first agitator may be placed adjacent the inlet and a second agitator may be placed adjacent the outlet. The agitators may be controlled separately or simultaneously, as desired.

[0042] Although in embodiments the piston is described as dividing the storage tank into two isolated compartments, in another embodiment the piston may be semi-permeable. In this embodiment, the body of the piston may comprise a screen dimensioned to permit the passage of liquid or solution such as water or brine but prevent the passage of solid particles such as ice crystals. In this example, water may be injected into the second compartment of the storage tank and may pass through the piston into the first compartment of the storage tank to decrease the ice-fraction of the ice-slurry within the first compartment of the storage tank. Similarly, water may be drained from the first compartment into the second compartment to increase the ice-fraction of the ice-slurry within the first compartment of the storage tank.

[0043] Although embodiments have been described above with reference to the accompanying drawings, those of skill in the art will appreciate that variations and modifications may be made without departing from the scope thereof as defined by the appended claims.

What is claimed is:

1. A storage tank comprising:
a body having opposite open ends;
end plates removably connected to the opposite open ends of the body, one of the end plates comprising an inlet and an outlet; and
a piston floatably mounted within the body, the piston being movable towards the end plate having the inlet and the outlet during discharge of ice-slurry contained within the storage tank via the outlet.
2. The storage tank of claim 1, wherein the piston divides the storage tank into isolated first and second compartments, the first compartment being delineated by the piston and the end plate having the inlet and the outlet, and the second compartment being delineated by the piston and the other end plate.
3. The storage tank of claim 1 or 2, further comprising a seal extending about a periphery of the piston, the seal being in contact with an interior surface of the body.
4. The storage tank of any one of claims 1 to 3, further comprising:
at least one agitator mounted within the body and configured to mix ice-slurry contained within the storage tank.
5. The storage tank of claim 4, comprising a plurality of agitators mounted within the body at spaced locations.
6. The storage tank of claim 2, comprising:
at least one agitator mounted within the first compartment of the storage tank and configured to mix ice-slurry contained within the first compartment of the storage tank.
7. The storage tank of claim 6, wherein the at least one agitator is positioned adjacent the outlet.
8. The storage tank of claim 6, comprising a plurality of agitators mounted within the first compartment of the storage tank at spaced locations.
9. The storage tank of claim 8, wherein one agitator is positioned adjacent the outlet and wherein another agitator is positioned adjacent the inlet.

10. The storage tank of any one of claims 1 to 9, wherein the outlet is positioned at a location above the inlet.
11. The storage tank of any one of claims 1 to 10, wherein the storage tank is pressurized.
12. The storage tank of any one of claims 2 and 6 to 9, wherein the other end plate comprises an inlet to permit the ingress of a pressurizing medium into the second compartment of the storage tank.
13. The storage tank of claim 12, wherein the pressurizing medium is water or air.
14. The storage tank of claim 1, wherein the piston is semi-permeable to permit the flow of liquid or solution therethrough.

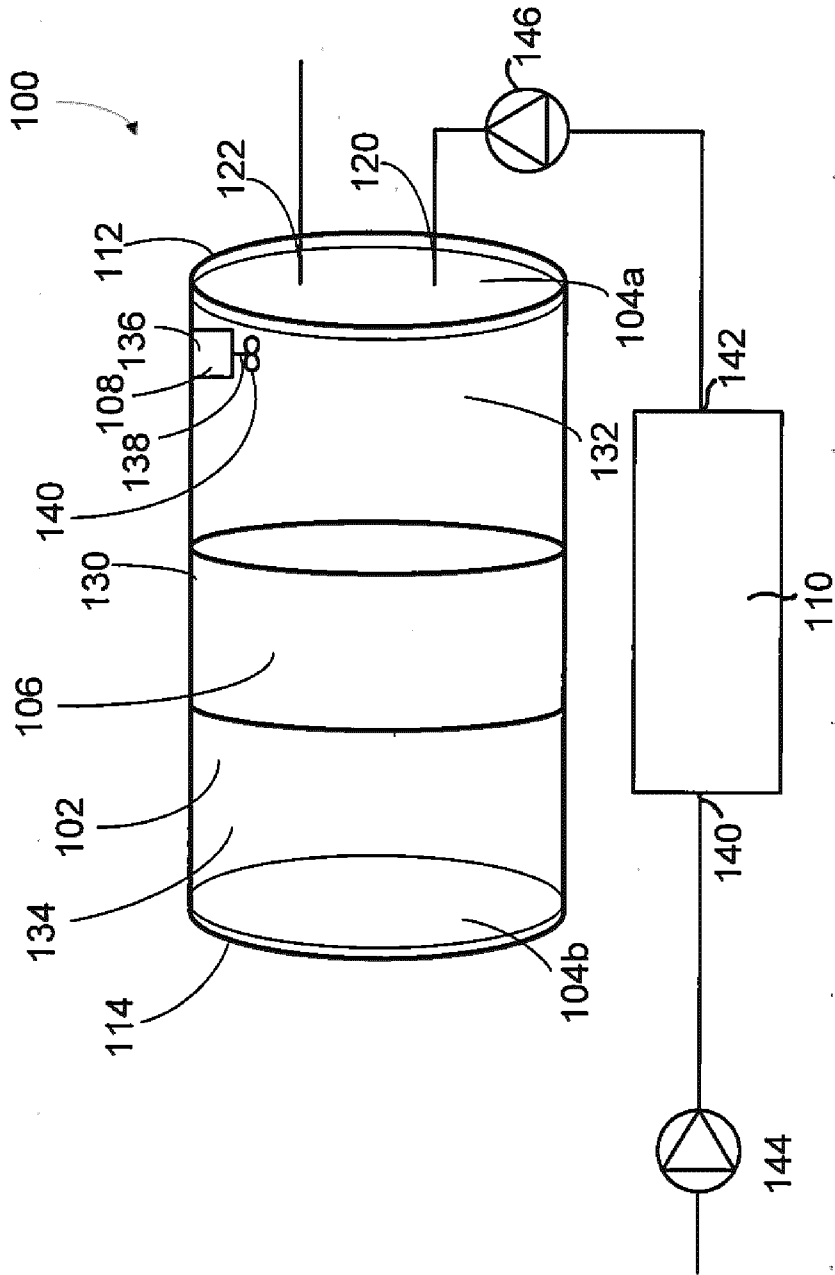


FIG. 1

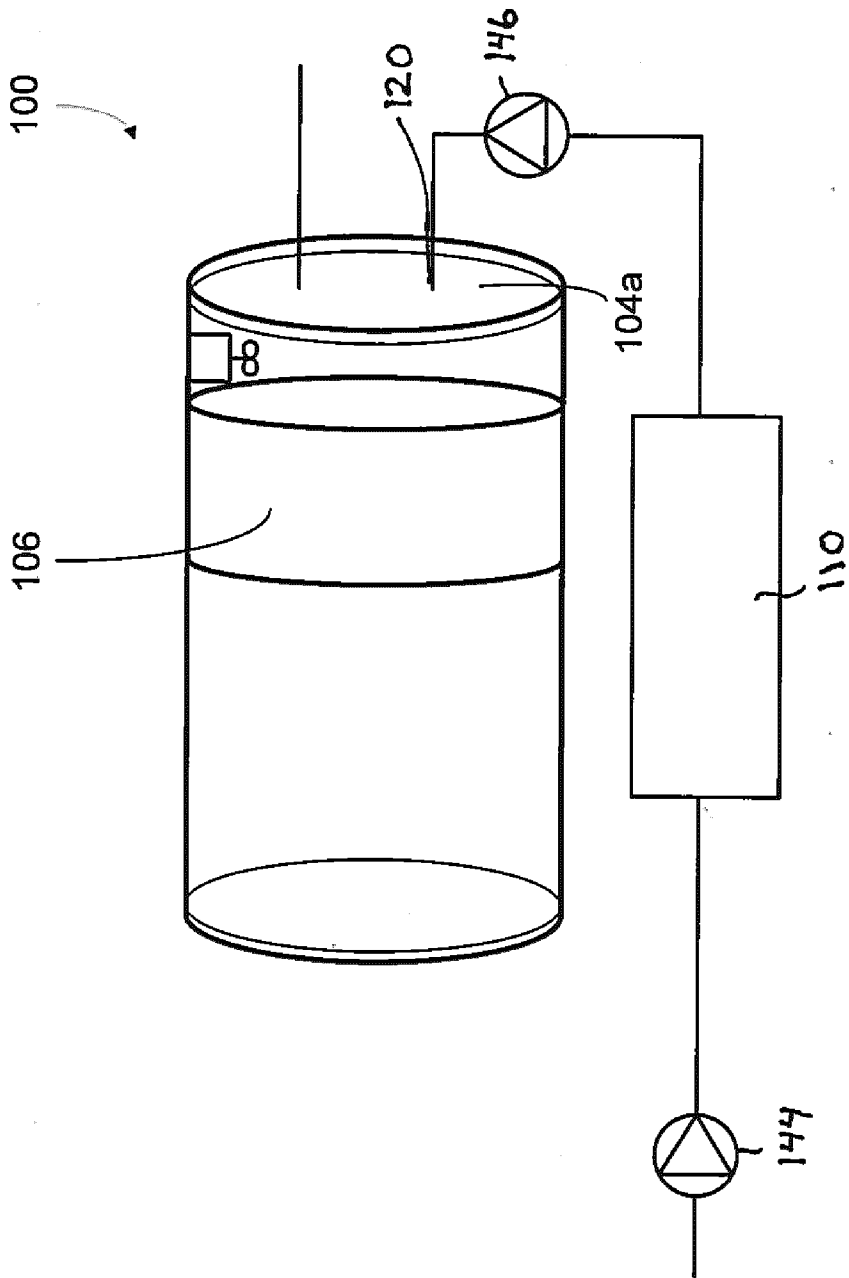


FIG. 2

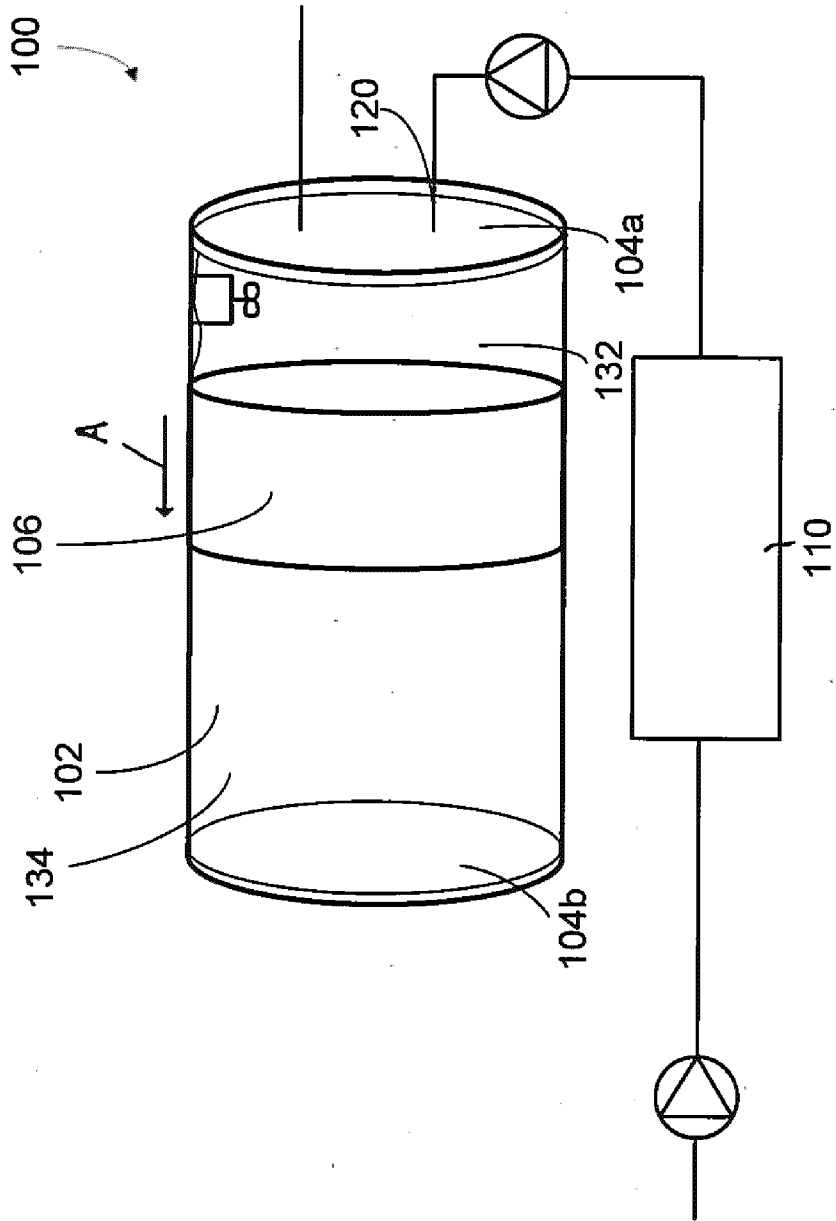


FIG. 3

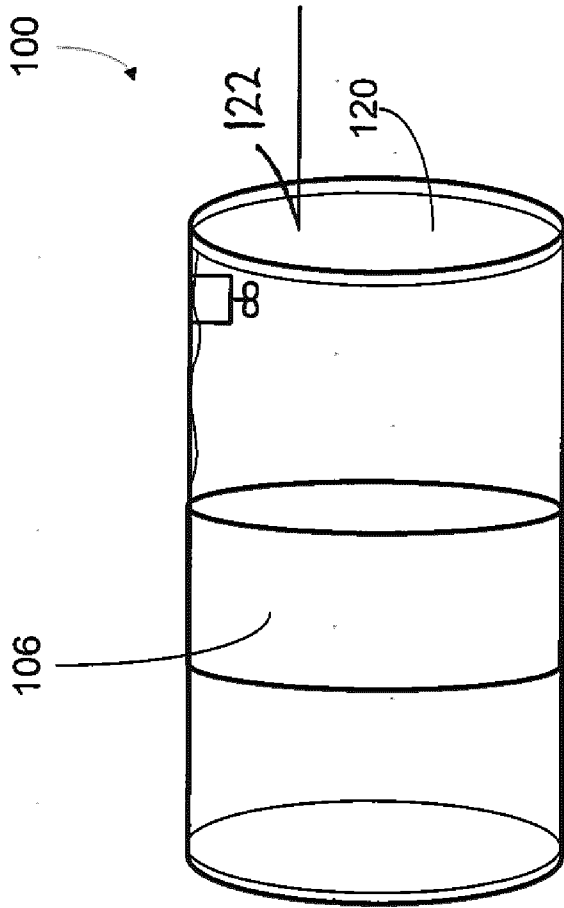


FIG. 4

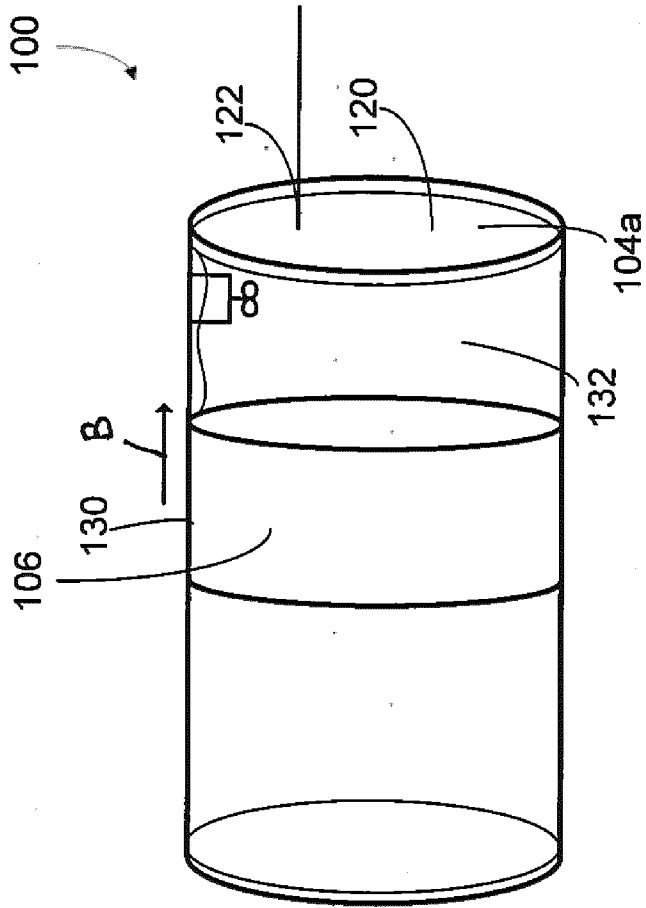


FIG. 5

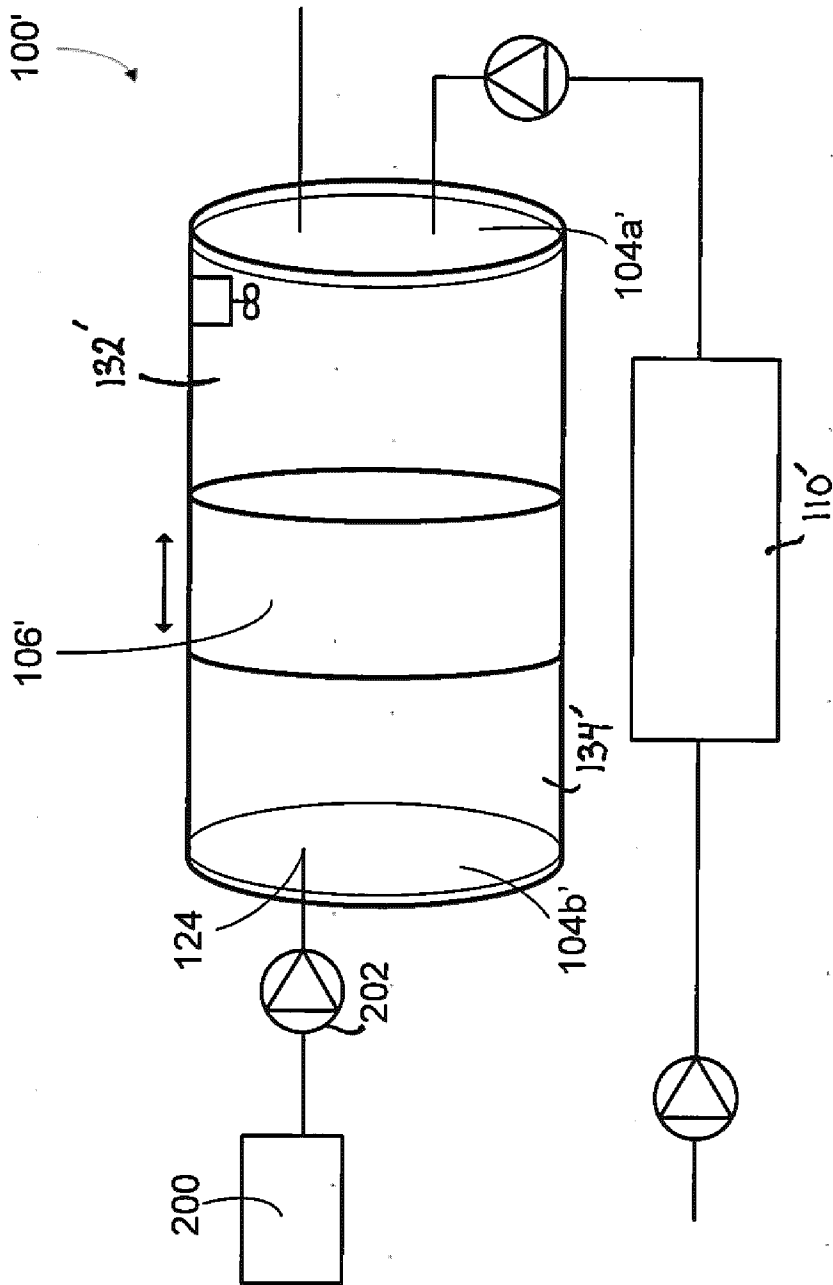


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER
 IPC: **B65D 83/76** (2006.01), **B65D 83/64** (2006.01), **B65D 85/00** (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 IPC(2006.01): B65D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)

Questel-Orbit (FamPat), Canadian Patents Database
 (Keywords: first, second, piston, divid*, ice, slurry, storage, tank)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US5035733A, (GOLDSTEIN, V.) 30 July 1991 (30-07-1991) *Fig. 1-3; col. 1, 2*	1-14
A	KR101135987B1, (EE, H. et al.) 17 April 2012 (17-04-2012) *Fig. 1-6*	1-14
A	CN110425782A, (HE, Y. et al.) 08 November 2019 (08-11-2019) *Fig. 1; claim 1-4*	1-14

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents:	“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
“A” document defining the general state of the art which is not considered to be of particular relevance	“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
“D” document cited by the applicant in the international application	“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
“E” earlier application or patent but published on or after the international filing date	“&” document member of the same patent family
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Date of the actual completion of the international search
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2019/051801

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
US5035733A	30 July 1991 (30-07-1991)	US5035733A	30 July 1991 (30-07-1991)
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