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(54) Title: A LIQUID-LIQUID FILTER ARRANGEMENT

(57) Abstract: The invention relates to a liquid-liquid filter arrangement and associated method suitable for use in separating liquid contaminants from aqueous/organic sensitive, bulk liquid storage facilities without first coalescing or emulsifying the liquid contaminants in at least a portion of the bulk liquid before separating the liquid contaminants from the bulk liquid. The filter arrangement including a static density separator vessel, comprising an upper organic liquid portion, and a lower aqueous liquid portion, a contaminated aqueous-organic bulk liquid inlet, a separated aqueous liquid outlet, and an organic liquid outlet, the contaminated aqueous-organic bulk liquid inlet being configured and dimensioned to introduce the contaminated aqueous-organic bulk liquid into the static density separator vessel in a predetermined manner to enable any existing aqueous-organic liquid emulsion sufficient residence time within the vessel to separate prior to discharging the separated, aqueous liquid and the organic liquid from their respective outlets. The filter arrangement and method is suitable for use in separating either aqueous liquid contaminants from bulk fuel or organic liquid contaminants from bulk aqueous liquid.

A LIQUID-LIQUID FILTER ARRANGEMENT

Field of the Invention

The invention relates to a liquid-liquid filter arrangement suitable for use in aqueous/organic liquid-sensitive, bulk liquid storage facilities to separate unwanted aqueous phase, liquid contaminants from bulk organic phase liquid, such as water from bulk liquid fuel storage facilities, or to separate unwanted organic phase, liquid contaminants from bulk aqueous phase liquid, such as from bulk potable water storage facilities, and to corresponding methods for such separation.

Background to the Invention

The contamination of aqueous/organic sensitive, bulk liquid storage facilities such as liquid fuel storage facilities and/or potable water storage facilities is an ever present concern at such facilities.

More particularly but not exclusively, the contamination of fossil and synthetic liquid fuels in bulk storage facilities by aqueous phase liquid contaminants, such as water, causes extensive losses in many industries worldwide, including the petroleum, transport, mining, marine and electricity generation sectors, where operational failure in equipment such as generators constitute a common problem.

Known equipment for removing liquid contaminants in aqueous/organic sensitive liquid storage facilities such as fuel depots incudes a fuel/water separator, commonly utilizing filter media to separate the solid contaminants and centrifugal forces to separate the typically lighter fuel from the denser aqueous phase liquid contaminants. Finer aqueous phase liquid droplets are often treated with coalescing agents to create larger drops that are more susceptible to centrifugal forces or gravity to assist with the separation process. Known processes for removing aqueous liquid contaminants such as water from liquid fuel storage facilities include the use of stripper material wherein fine aqueous phase liquid molecules are not allowed to pass through the media but forced to drop out. The separated aqueous phase liquid contaminants are then drained off periodically by means of suitable waste disposal facilities.

Three of the more common problems with the known equipment, including filters, are irregular liquid contaminant removal, such as drainage, the relatively insufficient storage capacity for the separated liquid contaminants in the existing systems, causing an inability to cope with relatively large liquid flow or volumes, and the inability of the equipment to handle aqueous/organic emulsified contaminants. These problems typically allow contaminated bulk liquid to bypass or pass through the filter systems unhindered into downstream equipment, allowing the contaminants to cause operational breakdowns and other operation difficulties.

Object of the Invention

It is therefore an object of the invention to provide a novel liquid-liquid filter arrangement and associated method aimed at overcoming or at least reducing the above limitations of some of the existing filters and methods or at least to provide alternative arrangements therefor.

Summary of the Invention

According to a first aspect of the invention there is provided a liquid-liquid filter arrangement suitable for separating aqueous phase liquid contaminants from organic liquid fuel, the filter arrangement including a static density separator vessel, comprising an upper organic liquid portion, and a lower aqueous liquid portion, a contaminated organic liquid fuel inlet, a separated aqueous liquid contaminant outlet, and a contaminant-free, organic liquid fuel outlet.

The filter arrangement preferably separates the aqueous phase liquid contaminants from organic liquid fuel without first coalescing or emulsifying the aqueous phase liquid contaminants in at least a portion of the organic liquid fuel.

The contaminated organic liquid fuel inlet may be configured and dimensioned to introduce the contaminated organic liquid fuel into the static density separator vessel in a predetermined manner to enable the aqueous liquid-in-organic liquid emulsion sufficient residence time within the vessel to separate prior to discharging the separated, aqueous liquid contaminant and the contaminant-free, organic liquid fuel from their respective outlets. The contaminated organic liquid fuel inlet may consist of a central tube ending in a sieve for retaining any solid contaminants.

Introduction of the contaminated organic liquid fuel in predetermined manner may comprise adherence to predetermined operational variables selected from the group including introducing the contaminated bulk liquid under a substantially laminar flow regime and a specific flow rate into the vessel; and batch wise, semi-continuously or continuously; while maintaining the levels of the aqueous liquid and the organic liquid operatively within the corresponding aqueous liquid and organic liquid portions of the vessel, to enable sufficient separation of the aqueous and organic phases within the emulsion to separate prior to discharging the separated organic liquid and aqueous liquid from their respective outlets.

The filter arrangement may include a first, aqueous liquid sensor, for sensing the aqueous liquid, a second sensor, for sensing the aqueous liquid rising towards the upper organic liquid portion, and a third sensor, for sensing the organic liquid dropping towards the lower aqueous liquid portion.

The filter arrangement may have an aqueous liquid control valve, for controlling the flow of aqueous liquid from and/or into the aqueous portion, to retain the aqueous liquid operatively within the lower aqueous liquid portion, and thus the organic liquid operatively within the upper organic liquid portion respectively.

The sensors may consist of electronic density sensors, calibrated float or circuit sensors, the sensors being capable of sensing the gradually increasing or decreasing densities or circuit disturbances of the liquids being measured at the respective points to assess the rising of the relatively higher density, aqueous liquid towards the upper organic liquid portion, and the dropping of the relatively lower density, organic liquid towards the lower aqueous liquid portion.

The sensors are preferably calibrated to measure density variances between specific parameters according to the specific density ranges of the bulk fuel, potential contaminants and/or possible emulsions. The sensors may have controlled, low voltage supply to reduce the risk of an electric arc flash in the presence of the liquid fuel.

The filter arrangement may be operable batch wise, alternatively semi-continuously, alternatively, continuously, by controlling the flow rate of the contaminated organic liquid fuel into the static density separator vessel, and/or by controlling the aqueous liquid control valve,

and thereby the respective levels of the aqueous liquid and the organic liquid operatively within the corresponding portions within the vessel.

The filter arrangement may be provided with a suitable PC Board to control the variables, including the flow rates of the contaminated organic liquid fuel into the static density separator vessel and/or the aqueous liquid into and/or from the vessel, via the control valve, and thus the levels of the aqueous and the organic liquid levels within the vessel.

The filter arrangement preferably includes a suitably configured peristaltic pump for introducing the contaminated bulk liquid into the vessel under a substantially laminar flow regime and at the specific flow rate to minimize turbulence so as to avoid emulsifying the liquid contaminants into the bulk liquid before allowing separation of the aqueous and organic phases within the vessel.

The filter arrangement preferably includes a suitably configured, pre-liquid-liquid separation, particulate filter vessel, for removing at least some of any particulate solid contaminants from the bulk fuel.

According to a second aspect of the invention there is provided a method suitable for separating aqueous phase liquid contaminants from organic liquid fuel, the method including the step of:

Settling the contaminated organic liquid fuel in a static density separator vessel, having an upper organic liquid portion and a lower aqueous liquid portion, to enable any aqueous liquid-in-organic liquid emulsion sufficient residence time within the vessel to separate into a bottom, relatively higher density, aqueous phase liquid contaminants layer and a top, relatively lower density, substantially contaminant-free, organic liquid fuel layer;

Sensing the aqueous liquid contaminants layer rising towards the upper organic liquid portion;

Sensing the organic liquid fuel layer dropping towards the lower aqueous liquid portion;

Controlling the gradual increasing or decreasing densities of the liquids being measured at the respective points to assess the rising of the relatively higher density, aqueous liquid towards the upper organic liquid portion, and the dropping of the relatively lower density, organic liquid fuel towards the lower aqueous liquid portion;

Discharging separated, aqueous liquid contaminants from a suitable, relatively lower outlet; and

Discharging relatively contaminant-free, organic liquid fuel from a suitable, relatively higher outlet.

The step of discharging the separated, aqueous liquid contaminants and/or discharging the relatively contaminant-free, organic liquid fuel may be batch wise, alternatively semi-continuously, alternatively, continuously, by controlling the flow rate of the contaminated organic liquid fuel into the static density separator vessel, and/or by controlling the aqueous liquid control valve, thereby controlling the respective levels of the aqueous liquid and the organic liquid operatively within the corresponding portions within the vessel.

According to a third aspect of the invention there is provided a liquid-liquid filter arrangement suitable for separating organic phase liquid contaminants from an aqueous bulk liquid, the filter arrangement including a static density separator vessel, comprising an upper organic liquid portion and a lower aqueous liquid portion, a contaminated aqueous liquid inlet, a separated organic liquid contaminant outlet, and a separated, contaminant-free, aqueous liquid outlet.

The contaminated aqueous liquid inlet may be configured and dimensioned to introduce the contaminated aqueous liquid into the lower aqueous liquid portion of the static density separator vessel in a predetermined manner to enable the organic liquid-in-aqueous liquid emulsion sufficient residence time within the vessel to separate prior to discharging the separated, organic liquid contaminant and the contaminant-free, aqueous liquid from their respective outlets. The contaminated aqueous liquid inlet may consist of a central tube ending in a sieve for retaining any solid contaminants.

The filter arrangement may include a first, aqueous liquid sensor, for sensing the aqueous liquid rising towards the upper organic liquid portion, and a second, organic liquid sensor, for sensing the organic liquid dropping towards the lower aqueous liquid portion. The filter arrangement may have an aqueous liquid control valve, for controlling the flow of aqueous liquid from and/or into the aqueous portion, to retain the aqueous liquid operatively within the lower aqueous liquid portion and thus the organic liquid operatively within the upper organic liquid portion respectively.

The sensors may consist of electronic density sensors calibrated float or circuit sensors, capable of sensing the gradually increasing or decreasing densities of the liquids being

measured at the respective points to assess the rising of the relatively higher density, aqueous liquid towards the upper organic liquid portion, and the dropping of the relatively lower density, organic liquid towards the lower aqueous liquid portion. The sensors are preferably calibrated to measure density variances between specific parameters according to the specific density ranges of the bulk fuel, potential aqueous contaminants and/or possible emulsions.

The filter arrangement may be operable batch wise, alternatively semi-continuously, alternatively, continuously, by controlling the flow rate of the contaminated aqueous liquid into the static density separator vessel, and/or by controlling the aqueous liquid control valve, and thereby the respective levels of the aqueous liquid and the organic liquid operatively within the corresponding portions within the vessel.

The filter arrangement may be provided with a suitable PC Board to control the variables, including the flow rates of the contaminated aqueous liquid into the static density separator vessel and/or the aqueous liquid into and/or from the vessel, via the control valve, and thus the levels of the aqueous and the organic liquid levels within the vessel.

According to a fourth aspect of the invention there is provided a method suitable for separating organic phase liquid contaminants from aqueous bulk liquid, the method including the step of:

Settling the contaminated aqueous bulk liquid in a static density separator vessel, having an upper organic liquid portion and a lower aqueous liquid portion, to enable any organic liquid-in-aqueous liquid emulsion sufficient residence time within the vessel to separate into a bottom, relatively higher density, substantially contaminant-free, aqueous liquid layer and a top, relatively lower density, organic liquid contaminant layer;

Sensing the aqueous liquid layer rising towards the upper organic liquid portion;

Sensing the organic liquid layer dropping towards the lower aqueous liquid portion;

Controlling the gradual increasing or decreasing densities of the liquids being measured at the respective points to assess the rising of the relatively higher density, aqueous liquid towards the upper organic liquid portion, and the dropping of the relatively lower density, organic liquid towards the lower aqueous liquid portion;

Discharging separated, relatively contaminant-free aqueous liquid from a suitable, relatively lower outlet; and

Discharging separated, organic liquid contaminants from a suitable, relatively higher outlet.

The step of discharging the separated, relatively contaminant-free, aqueous liquid and/or of discharging the organic liquid contaminants may be batch wise, alternatively semi-continuously, alternatively, continuously, by controlling the flow rate of the contaminated aqueous liquid into the static density separator vessel, and/or by controlling the aqueous liquid control valve, thereby controlling the respective levels of the aqueous liquid and the organic liquid operatively within the corresponding portions within the vessel.

Detailed Description of the Invention

An embodiment of the invention shall now be described with reference to the accompanying drawings wherein:

Figure 1 is a diagrammatic cross-section of a static density separator vessel of a liquid-liquid filter arrangement in accordance with the invention; and

Figure 2 is a diagrammatic cross-section of the static density separator vessel illustrated in Figure 1 with a particulate filter vessel upstream of the static density separator vessel.

A filter arrangement 1 suitable for use in separating aqueous phase liquid contaminants from fossil and synthetic liquid fuel in bulk storage facilities in accordance with the invention and as reflected in Figure 1 includes a static density separator vessel 2, comprising an upper organic liquid portion 2a and a lower aqueous liquid portion 2b, a contaminated bulk liquid fuel inlet 3, a separated aqueous liquid contaminant outlet 4, and a contaminant-free, bulk liquid fuel outlet 5.

The contaminated bulk liquid fuel inlet 3 is configured and dimensioned to introduce the contaminated organic liquid fuel into the static density separator vessel 2 in a predetermined manner to enable the aqueous liquid-in-organic liquid emulsion sufficient residence time within the vessel to separate prior to discharging the separated, aqueous liquid contaminant and the contaminant-free, bulk liquid fuel from their respective outlets 4 and 5. The contaminated bulk liquid fuel inlet 3 consists of a central tube ending in a sieve 6 for retaining any solid contaminants (not shown). Alternatively, the sieve 6 could be substituted by a flow directional device (not shown).

Introduction in a predetermined manner consists of adherence to predetermined operational variables, such as introducing the contaminated bulk liquid into the vessel 2 under a substantially laminar flow regime and a specific flow rate, so as to minimize turbulence and hence avoid emulsifying the liquid contaminants into the bulk liquid before allowing separation of the aqueous and organic phases within the vessel, semi-continuously, while maintaining the levels of the aqueous liquid and the organic liquid operatively within the upper organic liquid portion 2a and the lower aqueous liquid portion 2b, of the vessel, to enable sufficient separation of the aqueous and organic phases within the emulsion to separate prior to discharging the separated liquid fuel and the aqueous liquid contaminants from their respective outlets 5 and 4.

The filter arrangement 1 includes a suitably configured peristaltic pump (not shown) for introducing the contaminated bulk liquid into the vessel under a substantially laminar flow regime.

The filter arrangement 1 further includes a first, aqueous liquid sensor 7b, for sensing the aqueous liquid, a second sensor 8, for sensing the aqueous liquid rising towards the upper organic liquid portion 2a, and a third sensor 7a, for sensing the organic liquid dropping towards the lower aqueous liquid portion 2b.

The filter arrangement 1 also has an aqueous liquid control valve 9, for controlling the flow of aqueous liquid from and/or into the aqueous portion 2a, to retain the aqueous liquid operatively within the lower aqueous liquid portion 2b and thus the organic liquid operatively within the upper organic liquid portion 2a respectively.

The sensors 7a & b and 8 consist of electronic density sensors, alternatively, calibrated float or circuit sensors, capable of sensing the gradually increasing or decreasing densities, alternatively, the circuit disturbances, of the liquids being measured at the respective sensors to assess the rising of the relatively higher density, aqueous liquid towards the upper organic liquid portion 2a, and the dropping of the relatively lower density, organic liquid towards the lower aqueous liquid portion 2b. The sensors 7a & b and 8 are calibrated to measure density variances between specific parameters according to the specific density ranges of the bulk fuel, potential aqueous contaminants and possible emulsions.

It is envisaged that the filter arrangement 1 can be operated batch wise, semi-continuously or continuously in accordance with the invention, by controlling the flow rate of the contaminated bulk liquid fuel into the static density separator vessel 2, and/or by controlling the aqueous liquid control valve 9, and thereby the respective levels of the aqueous liquid and the organic liquid operatively within the corresponding portions within the vessel.

The filter arrangement 1 is provided with a suitable PC Board 10 to control the variables, including the flow rates of the contaminated organic liquid fuel into the static density separator vessel 2 and/or the aqueous liquid into and/or from the vessel, via the control valve 9, and thus the levels of the aqueous and the organic liquid levels within the vessel.

The filter arrangement 1 is commissioned by priming the static density separator vessel 2 with a suitable aqueous liquid to a preselected level in the lower aqueous liquid portion 2b, and with a suitable organic liquid to a preselected level in the middle emulsion portion 2b or the upper aqueous portion 2a in accordance with the operation variables for the filter arrangement.

The filter arrangement 1 is typically fed with contaminated liquid fuel from bulk storage, via a pre-liquid-liquid separation, particulate filter vessel 11, as reflected in Figure 2. The particulate filter vessel 11 is provided with an internal co-centric cylindrical sieve 12, for retaining at least some of the particulate solid contaminants (not shown) in the fuel. The particulate filter vessel 11 has an upper organic liquid portion 11a and a lower aqueous liquid portion 11b, a materially particulate-free, organic liquid fuel outlet 13, located towards the upper portion of the vessel so as to enable pre-separation of aqueous liquid contaminants, and an aqueous liquid contaminants drain valve 14, for the draining of the pre-separated aqueous liquid contaminants.

It will be appreciated that many variations from the specific embodiments as described hereinabove are possible in detail, such as adapting the liquid-liquid filter arrangement and associated method for separating organic liquid contaminants from aqueous bulk liquid, or by incorporating specific safety and/or control features such as a fuel drainage control to prevent accidental fuel drainage or drainage of other bulk liquids, without departing from the scope and/or spirit of the inventions as claimed hereinafter.

Claims

1. A liquid-liquid filter arrangement suitable for use in separating liquid contaminants in aqueous/organic sensitive, bulk liquid storage facilities, such as aqueous contaminants in bulk fuel tanks, the filter arrangement including a static density separator vessel, comprising an upper organic liquid portion, and a lower aqueous liquid portion, a contaminated aqueous-organic bulk liquid inlet, a separated aqueous liquid outlet, and an organic liquid outlet, the contaminated aqueous-organic bulk liquid inlet being configured and dimensioned to introduce the contaminated aqueous-organic bulk liquid into the static density separator vessel in a predetermined manner to enable any existing aqueous-organic liquid emulsion sufficient residence time within the vessel to separate prior to discharging the separated, aqueous liquid and the organic liquid from their respective outlets.

2. The filter arrangement as claimed in claim 1 wherein the arrangement is adapted for separating aqueous phase liquid contaminants from bulk liquid fuel, characterised in that the contaminated aqueous-organic liquid inlet constitutes a contaminated liquid fuel inlet, the separated aqueous liquid outlet constitutes a separated aqueous liquid contaminant outlet, and the organic liquid outlet constitutes a contaminant-free, bulk liquid fuel outlet, and wherein the contaminated liquid fuel inlet is configured and dimensioned to introduce the contaminated liquid fuel into the static density separator vessel in a predetermined manner to enable the aqueous liquid-in-organic liquid emulsion sufficient residence time within the vessel to separate prior to discharging the separated, aqueous liquid contaminant and the contaminant-free, organic liquid fuel from their respective outlets.

3. The filter arrangement as claimed in claim 1 wherein the arrangement is adapted for separating organic phase liquid contaminants from bulk aqueous liquid, characterised in that the contaminated aqueous-organic bulk liquid inlet constitutes a contaminated bulk aqueous liquid inlet, the separated aqueous liquid outlet constitutes a contaminant-free, bulk aqueous liquid outlet, and the organic liquid outlet constitutes an organic liquid contaminant outlet, and wherein the contaminated bulk aqueous liquid inlet is configured and dimensioned to introduce the contaminated bulk aqueous liquid into the static density separator vessel in a predetermined manner to enable the organic liquid-in-

aqueous liquid emulsion sufficient residence time within the vessel to separate prior to discharging the separated, organic liquid contaminant and the contaminant-free, bulk aqueous liquid from their respective outlets.

4. The filter arrangement as claimed in claim 1 wherein the introduction of the contaminated bulk liquid under a predetermined manner comprises introduction under predetermined operational variables selected from the group including introducing the bulk fluid:

without intentionally emulsifying the liquid contaminants in at least a portion of the bulk liquid before separating the liquid contaminants from the bulk liquid;
under a substantially laminar flow regime and at a specific flow rate, so as to minimize emulsifying the liquid contaminants into the bulk liquid before allowing separation of the aqueous and organic phases in the vessel; and
at least semi-continuously;

while maintaining the levels of the aqueous liquid and the organic liquid operatively within the corresponding aqueous liquid and organic liquid portions of the vessel, to enable sufficient separation of the aqueous and organic phases within the emulsion to separate prior to discharging the separated organic liquid and aqueous liquid from their respective outlets.

5. The filter arrangement as claimed in claim 1 wherein the contaminated bulk liquid inlet comprises a central tube with a sieve at its opening for retaining any solid contaminants.

6. The filter arrangement as claimed in claim 1 wherein the arrangement is provided with a first, aqueous liquid sensor, for sensing the aqueous liquid, a second sensor, for sensing the aqueous liquid rising towards the upper organic liquid portion, and a third sensor, for sensing the organic liquid dropping towards the lower aqueous liquid portion.

7. The filter arrangement as claimed in claim 6 wherein the sensors are selected from electronic density sensors, calibrated float and circuit sensors, the sensors being capable of sensing the gradually increasing or decreasing densities of the liquids being measured at the respective points to assess the rising of the relatively higher density, aqueous liquid towards the upper organic liquid portion, and the dropping of the relatively lower density, organic liquid towards the lower aqueous liquid portion.

8. The filter arrangement as claimed in claim 2 or 3 characterised in being provided with a liquid contaminant control valve, for controlling the volume of liquid contaminant in its corresponding portion in the vessel, so as to retain the liquid contaminant operatively within its corresponding portion, and thus the bulk liquid operatively within the bulk liquid portion.

9. The filter arrangement as claimed in claims 1 to 8 wherein the arrangement is provided with a suitable PC board and associated control system for controlling preselected operational variables, selected from the group comprising the flow rate of the contaminated bulk liquid into the static density separator vessel and the levels of the aqueous and the organic liquid levels operatively within the aqueous liquid portion and the organic liquid portions respectively.

10. The filter arrangement as claimed in claim 6 wherein the sensors are calibrated to measure density variances between specific parameters according to the specific density ranges of the bulk liquid, potential contaminants and/or possible emulsions.

11. The filter arrangement as claimed in claims 6 to 10 wherein the sensors have controlled, low voltage supply to negate possible sparking in the presence of the liquid fuel and are electrolysis resistant.

12. The filter arrangement as claimed in claim 1 having a suitably configured peristaltic pump for introducing the contaminated bulk liquid into the vessel under the substantially laminar flow regime and at the specific flow rate.

13. The filter arrangement as claimed in claim 1 having a suitably configured, pre-liquid-liquid separation, particulate filter vessel, for removing at least some of any particulate solid contaminants from the bulk fuel.

14. A method suitable for separating liquid contaminants in aqueous/organic sensitive, bulk liquid storage facilities, the method including the steps of:

Introducing the contaminated aqueous/organic bulk liquid in a predetermined manner into a static density separator vessel, having an upper organic liquid portion and a lower aqueous liquid portion, to enable any aqueous/organic liquid emulsion sufficient residence time within the vessel to separate into a bottom,

relatively higher density, aqueous phase liquid layer and a top, relatively lower density, organic liquid layer;

sensing the aqueous liquid layer rising towards the upper organic liquid portion;

sensing the organic liquid layer dropping towards the lower aqueous liquid portion;

controlling the gradual increasing or decreasing densities of the liquids being measured at the respective points to assess the rising of the relatively higher density, aqueous liquid towards the upper organic liquid portion, and the dropping of the relatively lower density, organic liquid fuel towards the lower aqueous liquid portion;

discharging suitably separated, aqueous liquid from a suitable, relatively lower outlet; and

discharging suitably separated organic liquid from a suitable, relatively higher outlet.

15. The method as claimed in claim 14 wherein the predetermined manner includes the steps of introducing the contaminated bulk liquid:

without first emulsifying the liquid contaminants in at least a portion of the bulk liquid before separating the liquid contaminants from the bulk liquid;

under a substantially laminar flow regime, at a specific flow rate, at least semi-continuously;

maintaining the levels of the aqueous liquid and the organic liquid operatively within the corresponding aqueous liquid and organic liquid portions of the vessel; and

allowing any aqueous/organic liquid emulsion sufficient residence time within the vessel to separate into a bottom, relatively higher density, aqueous phase liquid layer and a top, relatively lower density, organic liquid layer;

prior to discharging the separated organic liquid and aqueous liquid from their respective outlets.

16. The method as claimed in claim 14 or 15 wherein the liquid contaminant is an aqueous phase liquid and wherein the bulk liquid is bulk liquid fuel, the method including the step of controlling the volume of liquid aqueous contaminant in its corresponding portion in the vessel, thereby retaining the aqueous liquid contaminant operatively within the

aqueous liquid portion and the bulk fuel operatively within the organic liquid portion within the vessel.

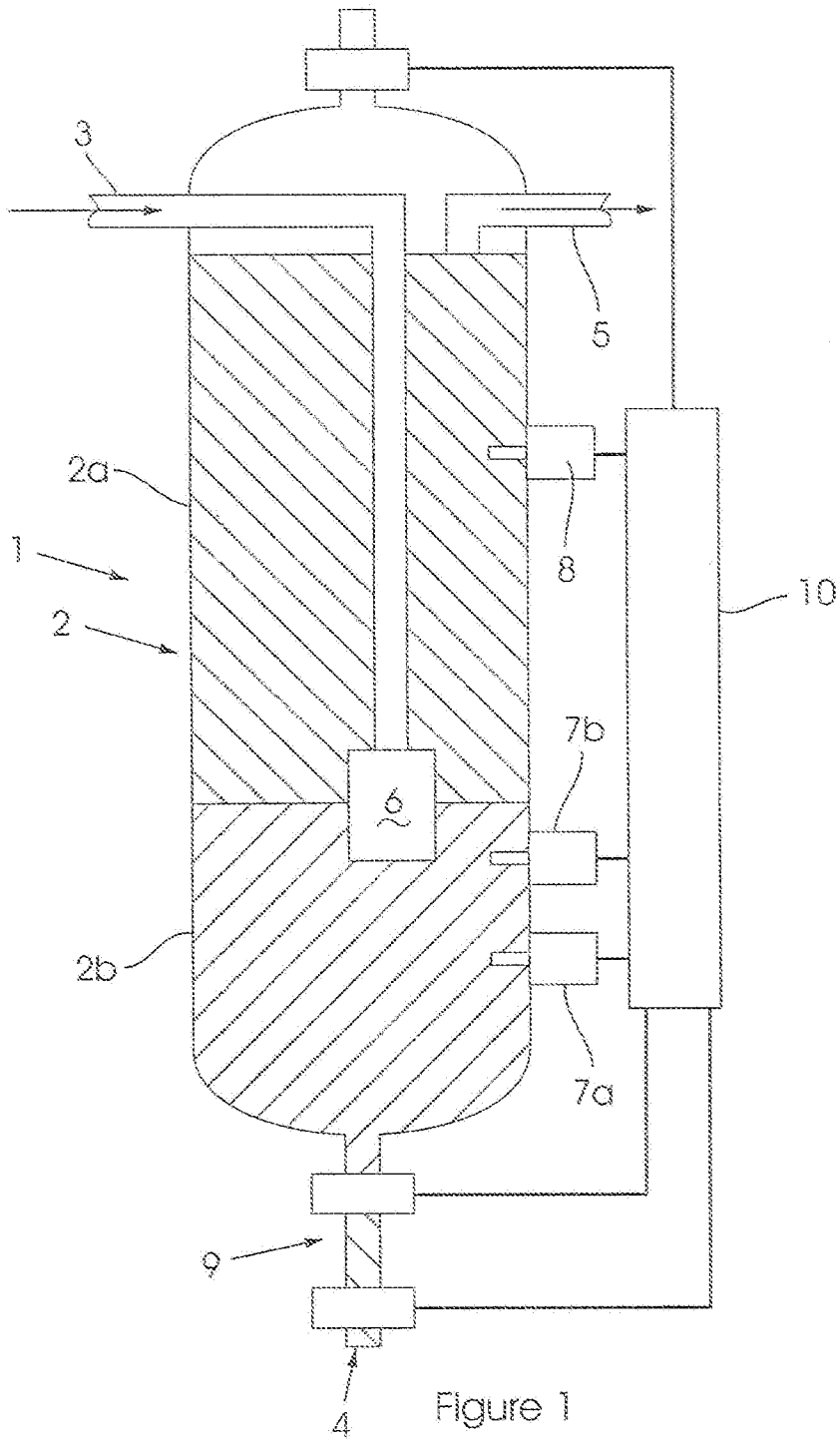

Figure 1

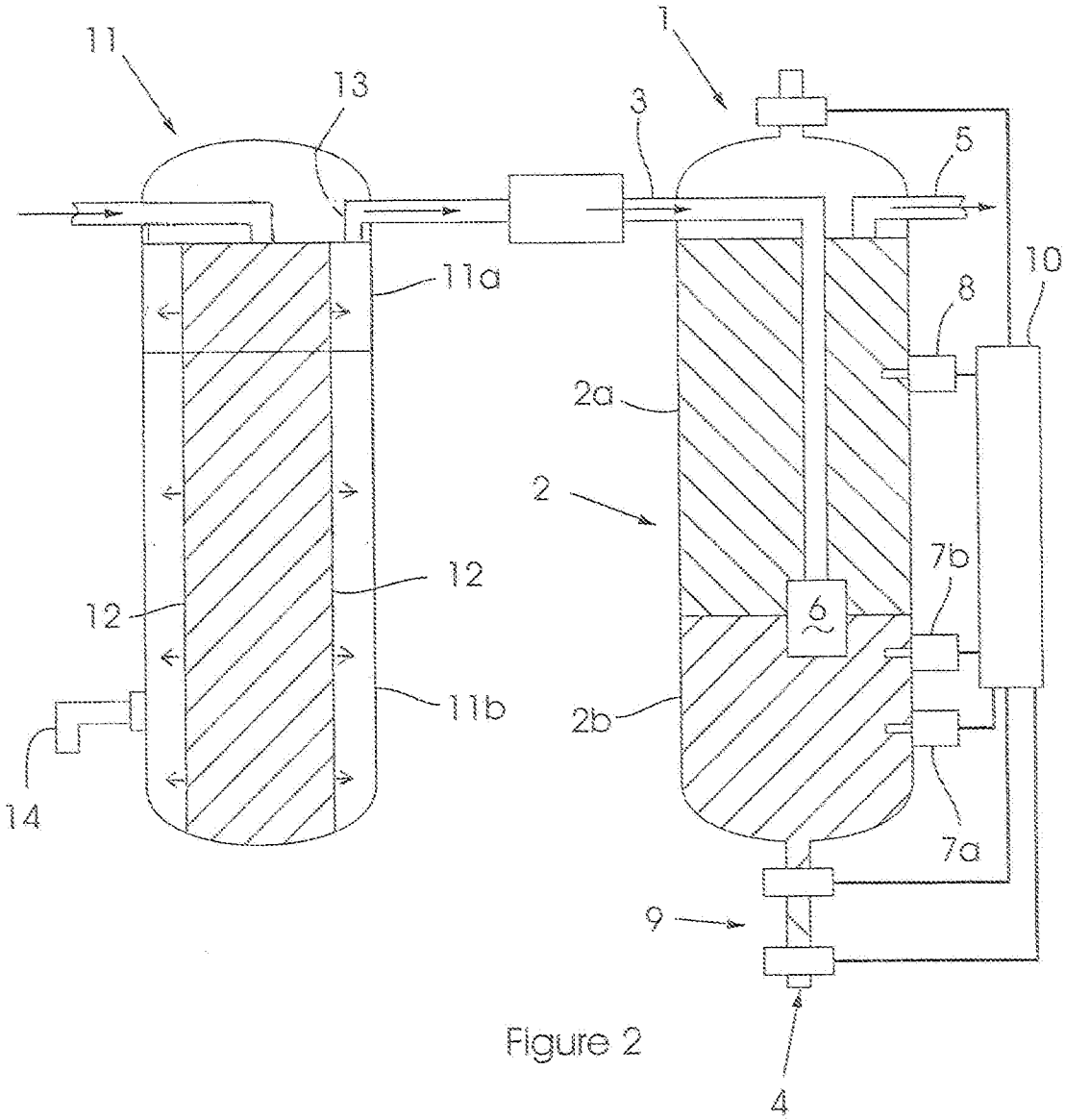

Figure 2