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[Continued on next page]

(54) **Title**: METHOD TO SEPARATE THE COMPONENTS IN THESE GAS LIQUIDS, VAPOURS OR GAS, AND DEVICE FOR IMPLEMENTING SAID METHOD

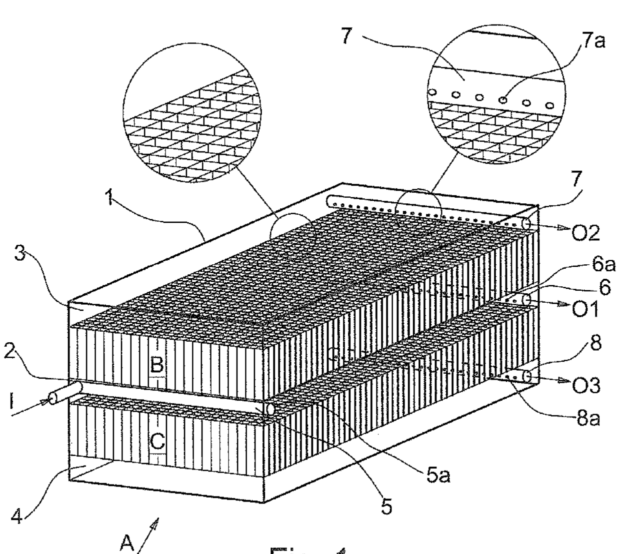

Fig. 1

(57) **Abstract**: This invention relates to a method and to a device for the implementation of said method, to separate the components that are inside mixtures of liquids, gases and vapors, resorting to gravimetric principles and with (pervasive and distributed) contrast to transverse motions, producing much higher efficiency indexes, also thanks to the dynamics of three-dimensional reverse return. The method is of the type which provides for the execution of the following steps: • creation of a horizontal flow of said fluid mixtures, wherein said fractions are arranged on different levels as a function of their density; • taking said fractions through taking means positioned on each of said levels; the separation of said fractions being obtained by the only effect of gravity and of the hydrostatic thrust which derives therefrom and it is characterized by the use of means fitted to delimit the areas in which the flow is exclusively vertical and not disturbed by said horizontal flow, in such a way as to promote said separation, because not disturbed by turbulence and transverse motions, said vertical movements generating additional horizontal formed by fluids of different density. The device (A) is of the type which includes: • means fitted to create a horizontal flow of said fluid mixtures, in such a way that said fractions are arranged on different levels as a function of their density; • taking means positioned on each of said levels, fitted to individually take said fractions; wherein the separation of said fractions is obtained by the only effect of gravity and of the hydrostatic thrust which derives therefrom and it is characterized in that it comprises a first and a second block (B, C), each one of which comprises a plurality of vertical channels, fitted to delimit the zones in which the flow is exclusively vertical and not disturbed by said horizontal flow, said blocks (A, B) being inserted in a container, so as to locate: • a first gap (2), between said blocks (B, C); • a second gap (3), positioned above said first block (B); - a third gap (4) located below

[Continued on next page]

WO 2016/092577 A1

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

said second block (C); being provided: • input means (5, 5a), positioned in correspondence with a first end of said first gap (2); • taking means (6, 6a), (7,7a), (8, 8a) positioned in correspondence with a second end of said first, second and third gaps (2, 3, 4); when all the volume comprised in said container (1) is filled with said mixture of fluids of different density, said fluids being: • run into said container (1) through said input means (5, 5a); • taken from said container (1) through said taking means (6, 6a), (7,7a), (8, 8a), said taking being differentiated in function of the different density of the fluid.

METHOD TO SEPARATE THE COMPONENTS IN THESE GAS LIQUIDS, VAPOURS OR GAS, AND DEVICE FOR IMPLEMENTING SAID METHOD

DESCRIPTION

This invention relates to a method and to a device for the implementation of said method, to separate the components that are inside mixtures of liquids, gases and vapors, resorting to gravimetric principles and with (pervasive and distributed) contrast to transverse motions, producing much higher efficiency indexes, also thanks to the dynamics of three-dimensional reverse return.

It is strongly felt the need to have systems to separate gaseous or liquids mixtures in various industrial processes, particularly functional for the environmental reclamation. The existing technologies employ various principles of chemistry and of technical physics through articulated installation structures, also resorting to high pressures and with specific filters, quite high economic resources and spaces. Examples: municipal wastewater treatment plants, anaerobic digestion plants, microalgae cultivations plants. The problem also occurs in extractive processes from fossil sources, for example mixtures of bituminous shale and mixtures of gases from oils, less and less pure, accessing to less valuable resources and to greater depths. In particular, it has been examined the section of the existing biogas plants, that require technologies of "upgrading" of gaseous mixtures produced by the anaerobic digestion of organic masses: wastewaters, wet, grass cuttings and agro-food waste. It is needed a greater separation of the produced components (CO_2, CH_4, H_2S), from which it is possible to isolate biomethane of a high quality and possibly to capture the CO_2 whose value is increased, rather than inlet into the environment (emitted by internal combustion machinery that by anaerobic digestion, that inert would flow together with the first, or issued by usual techniques of upgrading).

In summary, in the current state it is not possible to separate the components of a mixture while it is flowing, except if you use filters or centrifuge techniques which act by fractionating the flow in time, with high costs and often not sustainable, both in economic and environmental terms.

In particular, it is not possible to operate the separation of the components that constitutes a fluid in movement, that use gravimetric principles, that normally require under the state of rest to give time to act to the stratification (for example water and oil).

The purpose of the this invention is to propose a method and a device to implement said method, respectively conform to the claims 1 and 3, for the gravimetric separation of mixtures of fluids, liquid or gaseous, said mixtures being composed of fractions of different densities.

The method is of the type which provides for the execution of the following steps:

- creation of a horizontal flow of said fluid mixtures, wherein said fractions are arranged on different levels as a function of their density;
- taking said fractions through taking means positioned on each of said levels;

the separation of said fractions being obtained by the only effect of gravity and of the hydrostatic thrust which derives therefrom and it is characterized by the use of means fitted to delimit the areas in which the flow is exclusively vertical and not disturbed by said horizontal flow, in such a way as to promote said separation, because not disturbed by turbulence and transverse motions, said vertical movements generating additional horizontal formed by fluids of different density.

The device is of the type which includes:

- means fitted to create a horizontal flow of said fluid mixtures, in such a way that said fractions are arranged on different levels as a function of their density;
- taking means positioned on each of said levels, fitted to individually take said fractions;

wherein the separation of said fractions is obtained by the only effect of gravity and of the hydrostatic thrust which derives therefrom and it is characterized in that it comprises a first and a second block, each one of which comprises a plurality of vertical channels, fitted to delimit the zones in which the flow is exclusively vertical and not disturbed by said horizontal flow, said blocks being inserted in a container, so as to locate:

- a first gap, between said blocks;
- a second gap, positioned above said first block;
- a third gap located below said second block;

being provided:

- input means, positioned in correspondence with a first end of said first gap;
- taking means, positioned in correspondence with a second end of said first, second and third gaps;

when all the volume comprised in said container is filled with said mixture of fluids of different density, said fluids being:

- run into said container through said input means;
- taken from said container through said taking means, said taking being differentiated in function of the different density of the fluid.

Other characteristics, such as for example the possibility of multiple separations of components present in a mixture will be the subject of the dependent claims.

The use of a device according to the invention allows for example to separate the components of bituminous shale in the extractive industry, more and more operating at greater depths with products that are less and less pure.

The invention will be now described for illustrative and not limitative purpose, according to a preferred embodiment and with reference to the attached figures, wherein:

- Figure 1 shows the device according to the invention;
- Figure 2 shows the diagram of the operation of the device according to the invention.

With reference to fig. 1, with (A) it is indicated a device gravimetric separator according to the invention.

Said device (A) comprises a first (B) and a second (C) block, each of which comprises a plurality of vertical channels. Said blocks (B) and (C) are inserted in a container (1), indicated by the lines of great thickness and are positioned inside said container (1) so as to locate the following three gaps:

- a first gap (2), between said blocks (B) and (C);
- a second gap (3), positioned above said first block (B);
- a third gap (4), placed below said second block (C).

At the two ends of the first gap (2) are positioned a first inlet pipe (5) and a first outlet pipe (6). According to a preferred embodiment, said first pipe (5) and second pipe (6) are cylindrical and, on each of them, a plurality of holes are made, respectively (5a) and (6a) aligned along a generatrix of said cylinders.

In the second gap (3) and in the third gap (4), in correspondence with said first outlet pipe (6), are positioned respectively a second outlet pipe (7) and a third outlet pipe (8). Also in this case, on each one of said outlet pipes (7) and (8) a plurality of holes is made, respectively (7a) and (8a) aligned along a generatrix of said cylinders.

The flow of the mixture that must be treated, indicated by the arrow (I) enters into the first pipe (5), from which it exits through the holes (5a) and it invades the whole volume enclosed by the container (1). Under the thrust of the entering flow, the mixture exits from the three outlet pipes (6), (7) and (8), passing through the holes (6a), (7a) and (8a) respectively.

The mixture that must be treated flows through the first gap (2), moving toward the first outlet pipe (6). By establishing a laminar flow regime. The fraction of the mixture having a lower density will be inclined to rise towards the first block (B), entering in the vertical channels, where it will find the state of rest to leave the gravity act, and here it will run into the second gap (3). At the same time, the fraction of the mixture having higher density will be inclined to descend towards the second block (C), entering in the vertical channels, where it will find the state of rest to leave the gravity act, and here it will run into the third gap (4). Finally, the fraction of the mixture having an average density will remain in the first gap (2).

As a consequence, it will be possible to gather three fractions of the mixture from the three outlet pipes (6), (7) and (8), the flows of said three fractions being represented by arrows (O1), (O2) and (O3), respectively for the fraction of medium density, of low density and high density.

By observing the arrow (I), which indicates the flow entering the device (A), and the arrows (O1), (O2) and (O3), which indicate the outgoing flows, you note that the conditions of reverse return are made. The movement in the inlet pipe (5) and in the outlet pipes (6, 7, 8) extends in a direction perpendicular to the direction of the streams in the gaps (2, 3, 4), while the movement in the vertical channels of the blocks (B, C) is simultaneously perpendicular both to the flow in the gaps (2, 3, 4), and to the flow in the pipes of the inlet (5) and outlet (6, 7, 8). In this way it is realized the reverse return in three-dimensional option. In practice the mixture to be separated is run into a side of the laminar flow that develops in the gaps and taken in correspondence of the opposite side of said laminar flow.

By inserting in the separator (A) according to the invention a mixture comprising protein and oleic fractions, the various fractions will have the following behavior:

• the oleic fraction having a lower density, will gather at the top in the second gap (3), and therefore it will be taken from the second outlet pipe (7);

• the protein fraction, having higher density, will gather at the bottom in the third gap (4), and therefore it be drawn from the third outlet pipe (8);

• the remaining fraction, consisting mostly of water, will remain in the first gap (2), and can be taken from the first outlet pipe (6).

According to a preferred embodiment (not shown), in the container (1) a number of blocks (B, C, etc.) greater than two are positioned, in such a way as to identify a number of gaps greater than three, said arrangement allowing to make splits, greater than three fractions, of the components present in a mixture, obviously of different density among them.

The invention has been described for illustrative and not limitative purposes, according to some preferred embodiments. The person skilled in the art could devise numerous other embodiments, all falling within the scope of protection of the enclosed claims.

CLAIMS

1. Method for the gravimetric separation of mixtures of fluids, liquid or gaseous, said mixtures being composed by fractions of different densities, of the type which provides for the execution of the following steps:
    - creation of a horizontal flow of said fluid mixtures, wherein said fractions are arranged on different levels as a function of their density;
    - taking said fractions through taking means positioned on each of said levels;

   the separation of said fractions being obtained by the only effect of gravity and of the hydrostatic thrust which derives therefrom and it is characterized by the use of means fitted to delimit the areas in which the flow is exclusively vertical and not disturbed by said horizontal flow, in such a way as to promote said separation, because not disturbed by turbulence and transverse motions, said vertical movements generating additional horizontal flows formed by fluids of different density.
2. Method for the gravimetric separation of mixtures of fluids, according to claim 1, characterized in that said means, fitted to define the zones in which the flow is exclusively vertical, comprise a plurality of vertical pipes, arranged above and below said horizontal flow of said fluid mixtures wherein said fractions of lower density and higher density flow due to the effect of gravity and of the hydrostatic thrust that results from.
3. Method for the gravimetric separation of mixtures of fluids, according to claim 1, characterized in that the mixture to be separated is run into in correspondence of a side of said horizontal flows and taken in correspondence of the opposite side of said horizontal flows.
4. Device (A) for the gravimetric separation of mixtures of fluids, liquid or gaseous, said mixtures being composed by fractions of different densities, of the type which includes:
    - means fitted to create a horizontal flow of said fluid mixtures, in such a way that said fractions are arranged on different levels as a

function of their density;

- taking means positioned on each of said levels, fitted to individually take said fractions;

wherein the separation of said fractions is obtained by the only effect of gravity and of the hydrostatic thrust which derives therefrom, characterized in that it comprises a first block (B) and a second block (C), each one of which comprises a plurality of vertical channels, fitted to delimit zones in which the flow is exclusively vertical and not disturbed by said horizontal flow, said blocks (B) and (C) being inserted in a container (1), so as to locate:

- a first gap (2), between said blocks (B) and (C);
- a second gap (3), positioned above said first block (B);
- a third gap (4), placed below said second block (C);

being provided:

- input means (5, 5a), positioned in correspondence with a first end of said first gap (2);
- taking means (6, 6a), (7, 7a), (8, 8a) positioned in correspondence with a second end of said first (2), second (3) and third (4) gap, respectively;

when all the the volume comprised in said container (1) is filled by said mixture of fluids of different density, said fluids being:

- run into in said container (1), through said inlet means (5, 5a);
- taken from said container (1), through said taking means (6, 6a), (7, 7a), (8, 8a), said taking being differentiated in function of the different density of the fluid.

5. Device (A), for the gravimetric separation of mixtures of fluids, according to claim 4, characterized in that said input means comprise an inlet pipe (5), of cylindrical or similar shape, on which a plurality of holes (5a) is made, aligned along a generatrix.
6. Device (A), for the gravimetric separation of mixtures of fluids, according to claim 4, characterized in that said taking means comprise outlet pipes

(6, 7, 8), of cylindrical or similar shape, on which are made a plurality of holes (6a, 7a, 8a) aligned along a generatrix of said outlet pipes (6, 7, 8), respectively.

7. Device (A), for the gravimetric separation of mixtures of fluids, according to claims from 4 to 6, characterized in that said introduction means are fitted to introduce the mixture to be separated in correspondence of a side of said flows that develop in the gaps (2, 3, 4) and said taking means are fitted to pick up the fractions of said mixture to be separated at the opposite side of said flows that develop in the gaps (2, 3, 4).

8. Device (A), for the gravimetric separation of mixtures of fluids, according to at least one of claims from 4 to 7, characterized in that in said container (1) are positioned a number of blocks (B, C, etc.) greater than two, in such a way as to identify a number of gaps greater than three, said arrangement allowing to make splits greater than three fractions of different density among them, of components present in said mixture.

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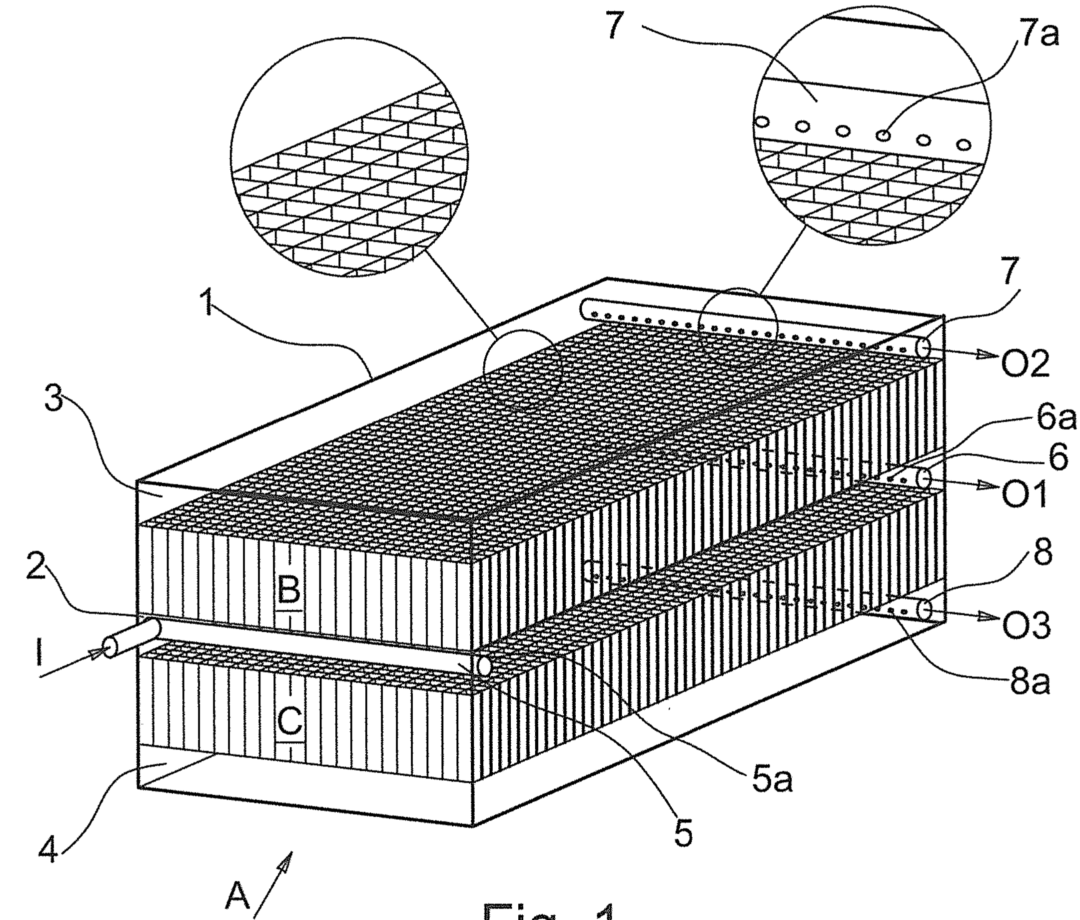

Fig. 1

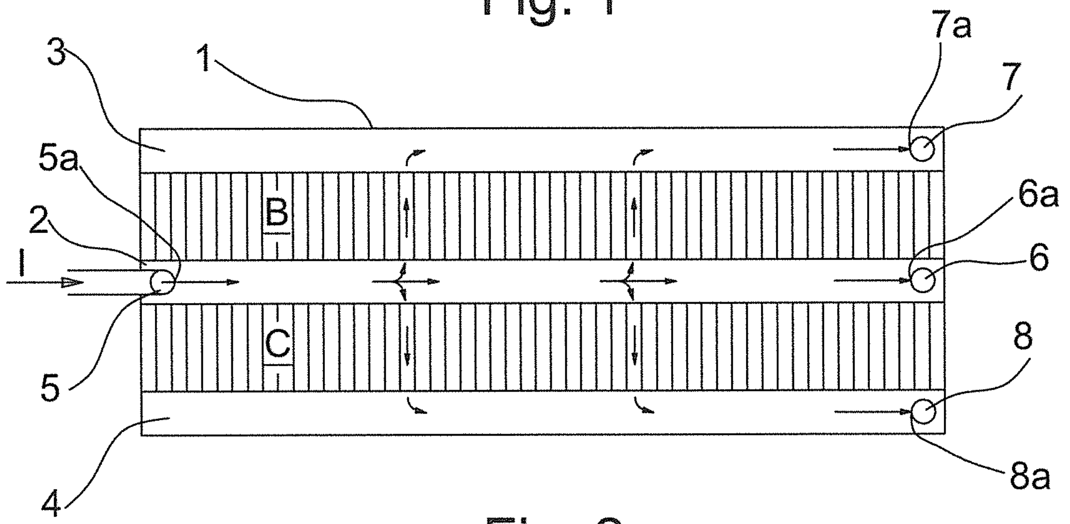

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2015/000297

A. CLASSIFICATION OF SUBJECT MATTER
INV. B01D17/02 B01D17/04 B01D19/00
ADD.

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)
B01D

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

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

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 620 194 A1 (SEPARATECH CANADA INC [CA]) 1 February 2006 (2006-02-01) abstract; figures page 5, line 3 - line 28 page 6, line 35 - line 57 -----	1-8
A	US 2006/175251 A1 (ROBERTS R L [US]) 10 August 2006 (2006-08-10) abstract; figures page 2, paragraph 29 - page 3, paragraph 30 -----	1-8
A	DE 28 12 731 A1 (SPERRY RAND LTD) 5 October 1978 (1978-10-05) abstract; figures page 4, paragraph first page 5, paragraph first ----- -/--	1-8

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 April 2016	28/04/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Lapeyrère, Jean

1

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	FR 2 704 447 A1 (OMNIUM TRAITEMENT VALORISA [FR]) 4 November 1994 (1994-11-04) abstract; figures page 10, line 9 - line 26 -----	1-8

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IT2015/000297

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
EP 1620194	A1	01-02-2006	AT	355879	T	15-03-2007
			AU	2003213938	A1	25-10-2004
			BR	0318226	A	04-04-2006
			CA	2517415	A1	14-10-2004
			EP	1620194	A1	01-02-2006
			MX	PA05010601	A	09-03-2006
			US	2006231510	A1	19-10-2006
			WO	2004087286	A1	14-10-2004
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DE 2812731	A1	05-10-1978	NONE			
FR 2704447	A1	04-11-1994	NONE			

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Demande internationale publiée par l'Organisation Mondiale de la Propriété sous le numéro:

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Roberts (43) **Pub. Date: Aug. 10, 2006**

(54) **SYSTEM FOR SETTLING SOLIDS OR OTHER IMPURITIES FROM WATER OR WASTEWATER AND ASSOCIATED METHODS**

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Alexandria, VA 22314 (US)

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(22) Filed: **Feb. 4, 2005**

Publication Classification

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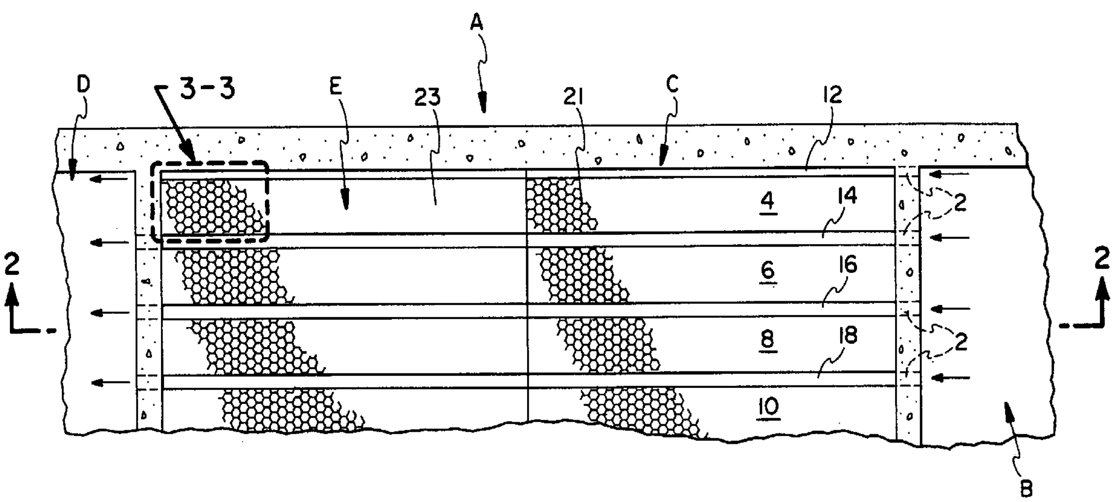
B01D 21/02 (2006.01)

(52) **U.S. Cl.** **210/519**; 210/521

(57) **ABSTRACT**

A system for settling solids or other impurities from water or wastewater. The system includes a containment vessel for containing fluid. The containment vessel has an inlet for receiving an influent and an outlet through which an effluent is discharged. At least a first group of tube settlers is disposed in the containment vessel. The first group of tube settlers has a top, a bottom and a plurality of tubes for receiving influent and discharging effluent. A distribution channel is provided for distributing influent evenly through the first group of tube settlers to enhance the settling of solids and other impurities from water or wastewater.



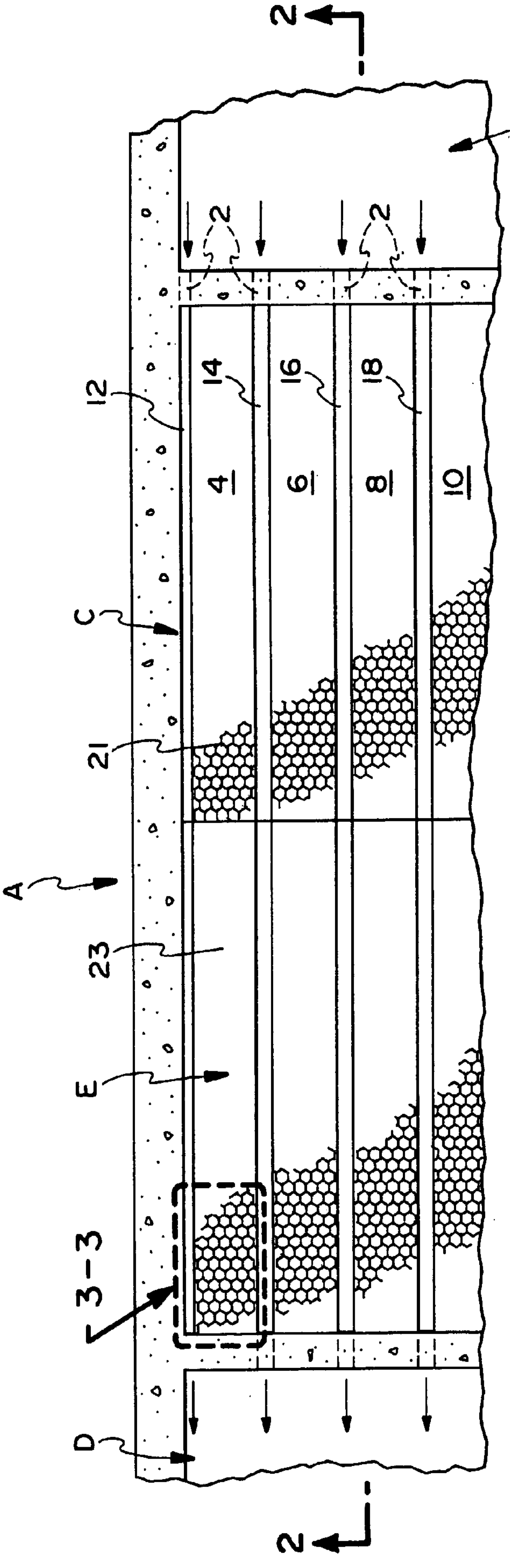


FIG. 1

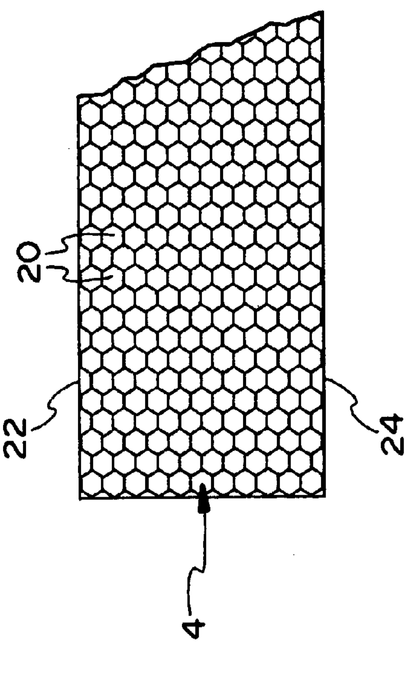


FIG. 3

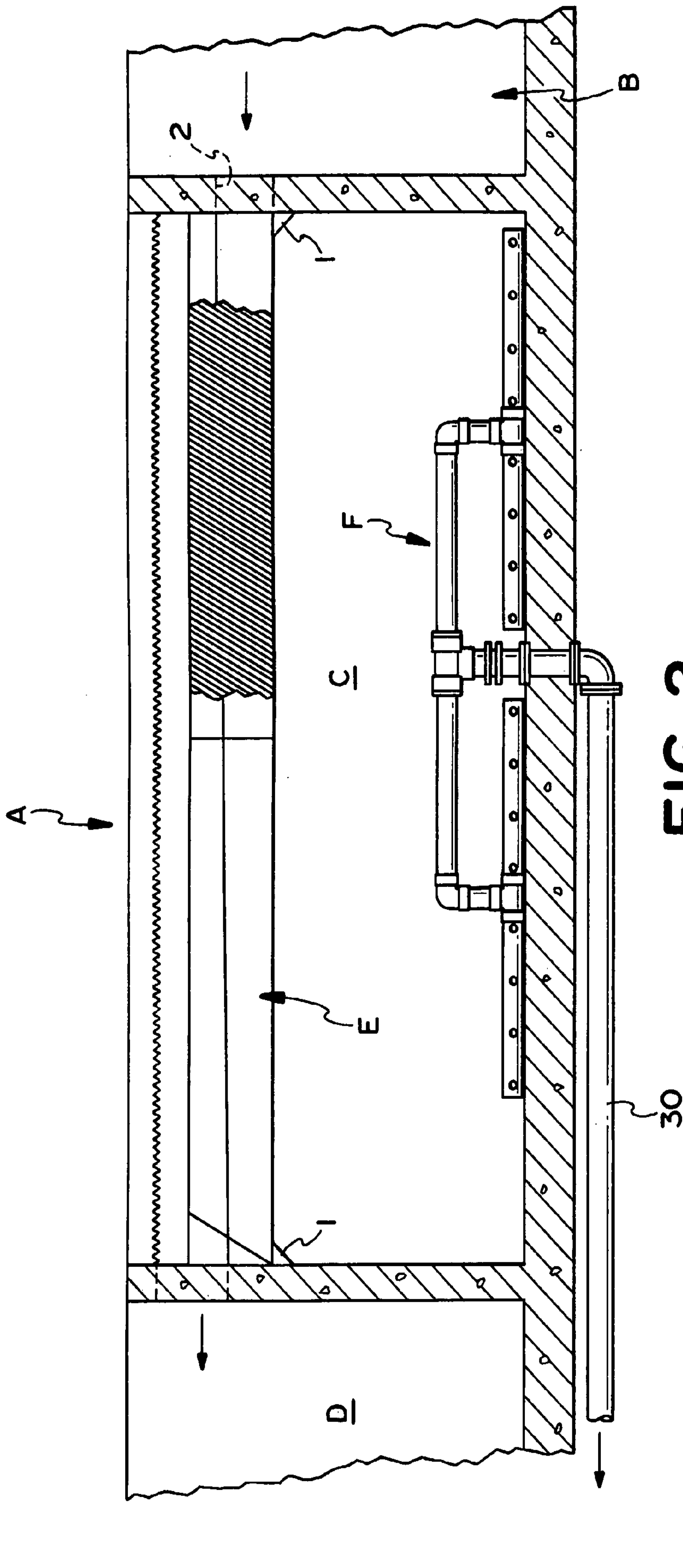


FIG. 2

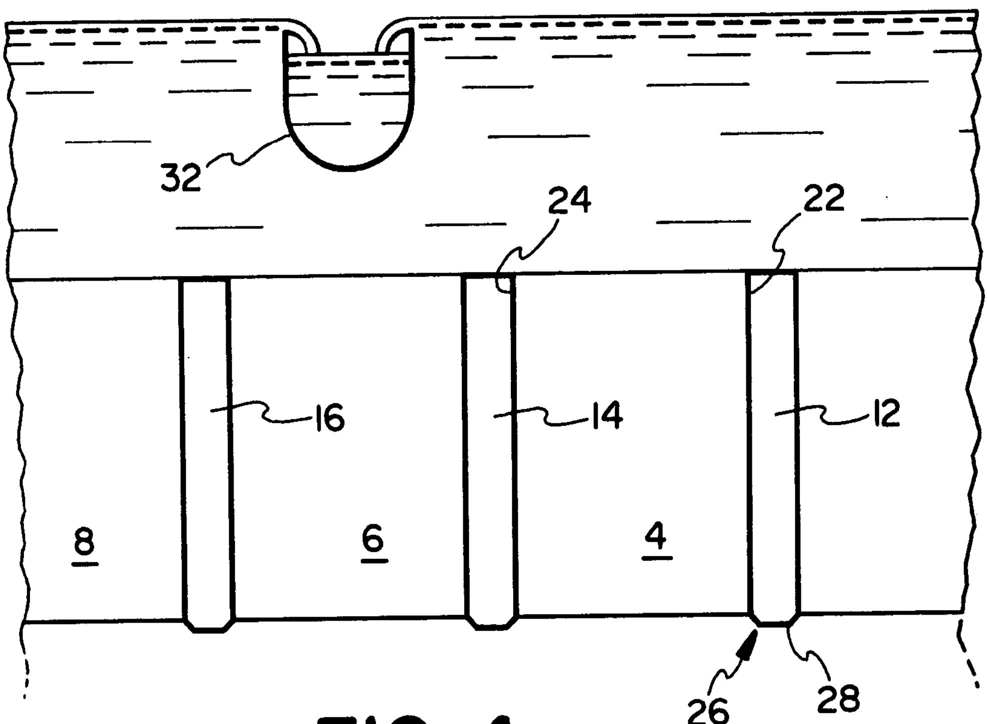


FIG. 4

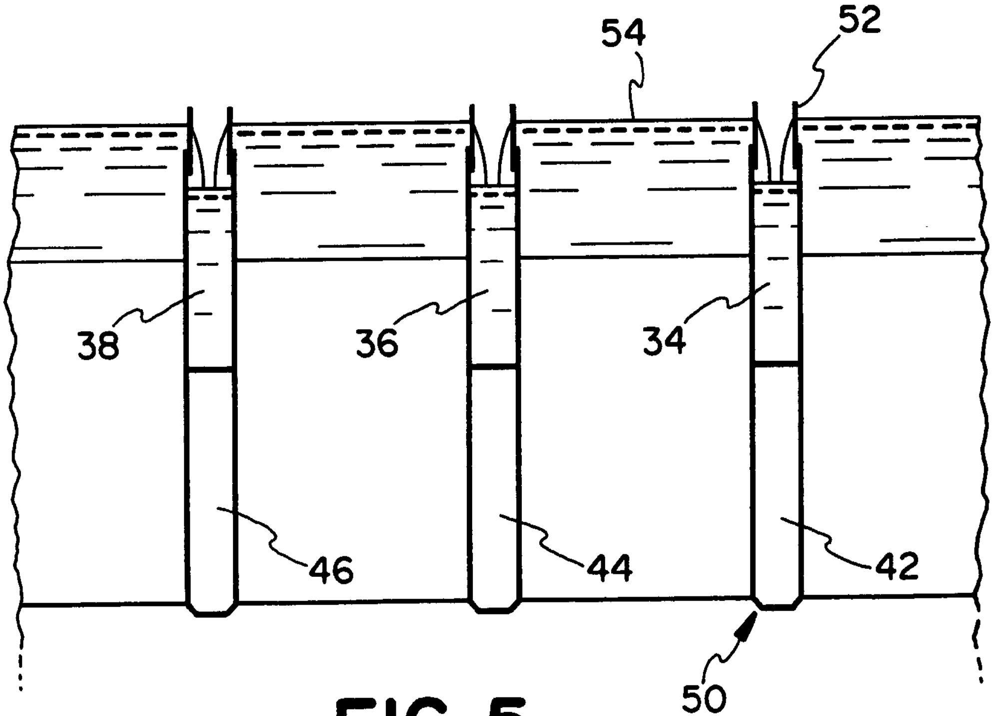


FIG. 5

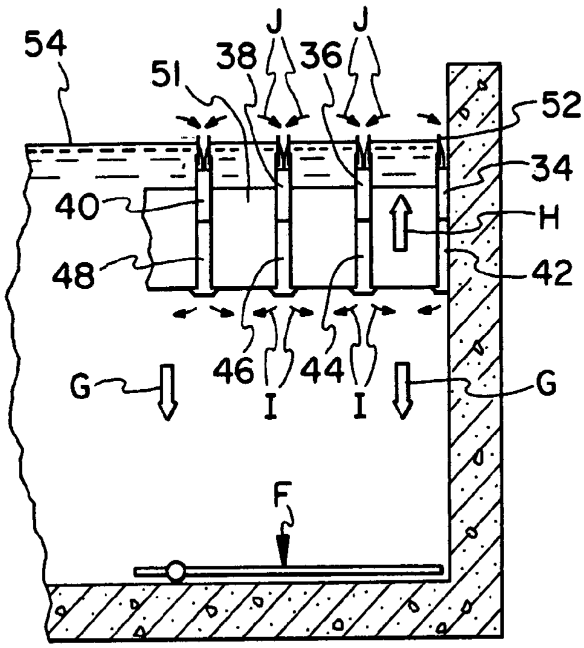


FIG. 6

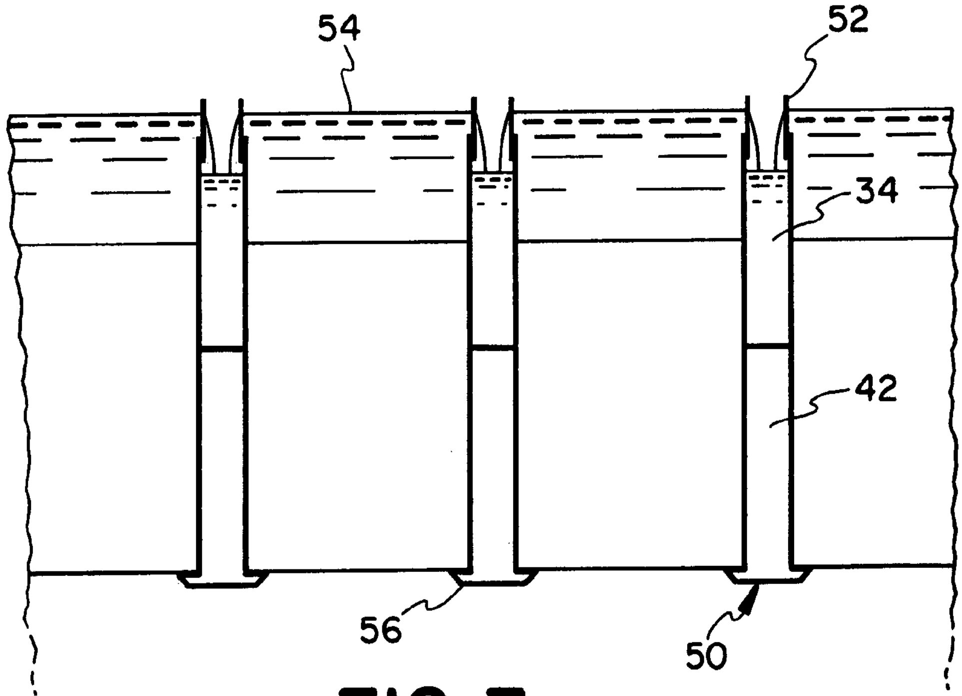


FIG. 7

SYSTEM FOR SETTLING SOLIDS OR OTHER IMPURITIES FROM WATER OR WASTEWATER AND ASSOCIATED METHODS

FIELD OF THE INVENTION

[0001] The present invention is directed to a system for settling solids or other impurities from water and/or wastewater that includes tube settlers as a component of the system. In other words, tube settlers are an essential component of the present invention.

BACKGROUND OF THE INVENTION

[0002] It has previously been known to remove impurities from water and/or wastewater with systems utilizing tube settlers. Tube settlers are most commonly used in bundle configurations. Tube settlers typically measure approximately two feet wide and thirty inches high. Tube settlers are typically oriented on a sixty degree slope to provide the tubes with a developed length of approximately three feet. The length of the bundles of tube settlers range from approximately four feet to fifteen feet. Runs longer than fifteen feet are achieved by orienting multiple bundles in an end-to-end manner. The end-to-end configuration of multiple bundles of tube settlers can provide the tube settler system with an overall length in excess of one hundred feet. Tube settlers are typically formed from PVC or ABS. Tube settlers may be employed in the construction of new systems or in the rehabilitation of existing water and/or wastewater treatment plants.

[0003] One of the major deficiencies in previously known tube settlers has been the occurrence of short-circuiting, i.e., the influent flow and effluent flow is not uniformly distributed along the length of the tube settler. Maldistribution results in localized high velocity fluid flow through the tube settlers resulting in significantly reduced settling efficiency. This highly undesirable condition is aggravated when the tubes become clogged with floc resulting in even greater maldistribution of fluid through the tube settlers.

[0004] It has previously been proposed to use large distributors below the tube settlers in an effort to avoid maldistribution of fluid through the tube settlers. These distributors are commonly made using large diameter pipes having drilled orifices. These large distributors are expensive. Further, these large distributors occupy considerable space below the tube settlers decreasing the waste collection volume of the vessel in which the tube settlers are located. Similarly, previously developed tube settler systems have employed large collectors to collect the effluent exiting the tube settlers. These effluent collectors include submerged orifices, V-notched weirs or other forms of fluid flow control in an effort to provide even flow above the tube settlers.

OBJECTS AND SUMMARY OF THE INVENTION

[0005] An object of the preferred embodiment of the present invention is to provide a novel and unobvious system for settling solids or other impurities from water or wastewater.

[0006] Another object of a preferred embodiment of the present invention is to provide a system for settling solids or other impurities from water or wastewater that overcomes one or more disadvantages of previously known settling systems.

[0007] A further object of a preferred embodiment of the present invention is to provide a system for settling solids or other impurities from water or wastewater that achieves superior distribution of fluid flow through one or more bundles of tube settlers.

[0008] Yet still another object of the present invention is to provide a system for settling solids or other impurities from water or wastewater that eliminates the need for large and/or costly distribution devices below one or more bundles of tube settlers.

[0009] A still further object of the present invention is to provide a system for settling solids or other impurities from water or wastewater that eliminates the need for large and/or costly collection devices above one or more bundles of tube settlers

[0010] It must be understood that no one embodiment of the present invention need include all of the aforementioned objects of the present invention. Rather, a given embodiment may include one or none of the aforementioned objects. Accordingly, these objects are not to be used to limit the scope of the claims of the present invention.

[0011] In summary, one preferred embodiment of the present invention is directed to a system for settling solids or other impurities from water or wastewater. The system includes a containment vessel for containing fluid. The containment vessel has an inlet for receiving an influent and an outlet through which an effluent is discharged. At least a first group of tube settlers are disposed in the containment vessel. The first group of tube settlers has a top, a bottom, a first end and a second end. The first group of tube settlers further has a plurality of tubes for receiving influent and discharging effluent. The system further includes a distribution member for distributing influent evenly through the first group of tube settlers. At least a first portion of the distribution member is disposed between the top of the first group of tube settlers and the bottom of the first group of tube settlers.

[0012] Another preferred embodiment of the present invention is directed to a system for settling solids or other impurities from water or wastewater. The system includes a containment vessel for containing fluid. The containment vessel has an inlet for receiving an influent and an outlet through which an effluent is discharged. At least first and second groups of tube settlers are disposed in the containment vessel. The first and second groups of tube settlers each have a top and a bottom. Each of the first and second groups of tube settlers further have a plurality of tubes for receiving influent and discharging effluent. A distribution channel is provided for distributing influent evenly through the first and second groups of tube settlers. The distribution channel has a first sidewall, a second sidewall and a bottom. The distribution channel further has a plurality of orifices through which the influent flows. The distribution channel is disposed relative to the first group of tube settlers such that at least a portion of the distribution channel extends between the top of the first group of tube settlers and the bottom of the first group of tube settlers.

[0013] A further embodiment of the present invention is directed to a system for settling solids or other impurities from water or wastewater. The system includes a containment vessel for containing fluid. The containment vessel has an inlet for receiving an influent and an outlet through which an effluent is discharged. At least first and second groups of tube settlers are disposed in the containment vessel. The first and second groups of tube settlers each have a top and a bottom. Each of the first and second groups of tube settlers further have a plurality of tubes for receiving influent and discharging effluent. A distribution member is provided for distributing influent evenly through the first and second groups of tube settlers. A collection member is provided for collecting effluent from the first and second groups of tube settlers. The distribution member and the collection member share a common wall.

[0014] Still a further preferred embodiment of the present invention is directed a system for settling solids or other impurities from water or wastewater. The system includes a containment vessel for containing fluid. The containment vessel has an inlet for receiving an influent and an outlet through which an effluent is discharged. At least first and second groups of tube settlers are disposed in the containment vessel. The first and second groups of tube settlers each have a top and a bottom. Each of the first and second groups of tube settlers further have a plurality of tubes for receiving influent and discharging effluent. A distribution member is provided for distributing influent evenly through the first and second groups of tube settlers. The distribution member has a plurality of orifices posited below the bottom of the first group of tube settlers and the bottom of the second group of tube settlers. At least a portion of the distribution member is one piece with at least a portion of the first group of tube settlers and at least a portion of the distribution member is one piece with at least a portion of the second group of tube settlers.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] **FIG. 1** is a fragmentary plan view of a system formed in accordance with a preferred embodiment of the present invention.

[0016] **FIG. 2** is a fragmentary cross-sectional view taken along the lines **2-2** in **FIG. 1**.

[0017] **FIG. 3** is an enlarged plan view of a portion of the tube settlers illustrated in **FIG. 3** by dashed lines referenced as **3-3**.

[0018] **FIG. 4** is a fragmentary sectional view of the embodiment illustrated in **FIG. 1** with various features omitted.

[0019] **FIG. 5** is a fragmentary sectional view of a second preferred embodiment of the present invention with various features omitted.

[0020] **FIG. 6** is a fragmentary sectional view of the embodiment illustrated in **FIG. 5** showing the fluid flow path as well as additional features not shown in **FIG. 5**.

[0021] **FIG. 7** is a fragmentary sectional view of a third preferred embodiment of the present invention with various features omitted.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

[0022] The most preferred forms of the invention will now be described with reference to **FIGS. 1-7**. The appended claims are not limited to the most preferred forms and no term used herein is to be given a meaning other than its ordinary meaning unless accompanied by a statement that the term "as used herein is defined as follows".

FIGS. 1 Through 3

[0023] Referring to FIGS. **1** to **4**, a portion of a system A for settling solids or other impurities from water or wastewater is illustrated in one of many possible configurations. The omitted details of system A and their interrelationship with the illustrated portions will be readily appreciated by one of ordinary skill in the art.

[0024] System A includes a flocculator B, containment and settling vessel or basin C and an effluent discharge vessel or basin D. The outer walls of the flocculator B, vessel C and vessel D may be formed of concrete or any other suitable material.

[0025] Any conventional flocculator can be used as the flocculator B. Since the construction and operation of flocculators are well known to those of ordinary skill in the art, flocculator B will not be described in detail. However, it is noted that the process of flocculation occurring in flocculator B results in the agglomeration of impurities in the influent allowing the impurities to be readily settled out as the fluid passes through the containment and settling vessel C. As used herein influent is defined as fluid that has not passed through the tube settlers. Effluent as used herein is defined as fluid that has passed through the tube settlers. Influent from the flocculator B enters the containment and settling vessel C through inlets **2** shown in **FIGS. 1 and 2**.

[0026] The containment and settling vessel C includes a tube settler module E and a sludge collection system F. Support members **1** support the tuber settler module E above the sludge collection system F. The sludge collection system F may be of any conventional construction. However, it is preferred that the SPYDER® sludge collection system be used to remove the sludge from vessel C. The SPYDER® sludge collection system is disclosed in U.S. Pat. Nos. 6,045,709 and 6,354,328 which are incorporated herein by reference in their entirety.

[0027] The tube settler module E includes one or more tube settler groups. While four tube settler groups **4**, **6**, **8** and **10** are shown in **FIG. 1**, it will be readily appreciated that the number of groups may be varied as desired. The tube settler module E further includes one or more influent channels. While four influent channels **12**, **14**, **16** and **18** are shown in **FIG. 1**, it will be readily appreciated that the number of influent channels may be varied as desired.

[0028] Each group of tube settlers includes at least one bundle of tubes. Preferably, the tube bundles have a honeycomb type construction. However, it will be readily appreciated that the configuration of the tube bundles may vary. As seen in **FIG. 1**, each tube settler group includes two tube bundles **21** and **23** oriented in an end-to-end manner. Referring to **FIG. 3**, each tube bundle includes a plurality of tubes **20**. Each of the tubes **20** is preferably oriented on a sixty degree slope.

[0029] Each tube bundle also includes sidewalls. For example, the tube bundle illustrated in **FIG. 3** includes sidewalls **22** and **24**. Preferably, the sidewalls of the tube bundles form the walls of the corresponding influent channels, i.e., the sidewalls of the tube bundles and the sidewalls of the corresponding influent channels are formed from one-piece.

[0030] The influent channels **12**, **14**, **16** and **18** run the length of the corresponding tube settler groups **4**, **6**, **8** and **10**. Referring to **FIG. 4**, a plurality of orifices **26** are formed in the lower section **28** of each of the influent channels **12**, **14**, **16** and **18**. The orifices **26** are positioned below the lowermost portion of the corresponding tube settlers groups. The orifices **26** are further formed along the length of the influent channel. In this manner, the influent is directed below the tube settler groups along the entire length of the corresponding tube settler group. The lower section **28** of the influent channels may be a separate piece from the sidewalls of the influent channels. In this instance, the lower section **28** may be secured in a fluid tight manner to the sidewalls of the influent channel using any conventional means. Alternatively, the lower section may be formed as one-piece with the sidewalls of the influent channels.

[0031] As seen in **FIG. 4**, a major portion of the influent channels extends between the top of the tube settler groups and the bottom of the tube settler group. However, it is essential that a minor portion of the influent channels extend below the bottom of the corresponding tube settler groups to ensure the influent is directed below the bottom of the corresponding tube settler group.

[0032] As the fluid travels below the groups of tube settlers upwardly through the individual tubes, solids and other impurities in the fluid settle to the bottom of the vessel C where they are removed by the sludge collection system F and transported to a desired location via piping **30**.

[0033] The containment and settling vessel C also includes a collection launderer **32** as seen in **FIG. 4** for collecting the effluent discharged from the tube settler groups.

FIGS. **5** and **6**

[0034] Another preferred embodiment will now be described in connection with **FIGS. 5 and 6**. In this embodiment, the collection launderer **32** has been replaced with effluent collection channels **34**, **36**, **38** and **40** mounted directly above influent distribution channels **42**, **44**, **46** and **48**. The effluent channels extend above the top **51** of the corresponding group of tube settlers. Preferably, the sidewalls of the effluent collection channels **34**, **36**, **38** and **40** are formed as one-piece with the corresponding sidewalls of the influent distribution channels **42**, **44**, **46** and **48**. Orifices **50** are formed in the influent distribution channels below the bottom of the tube settler groups to ensure that the fluid is directed below the lowermost portion of the tube settler groups. Preferably, the effluent collection channels **42**, **44**, **46** and **48** are provided with v-notch flow control weirs **52**. In this manner, the flow of the effluent **54** into the collection channels can be controlled. However, it will be readily appreciated that any suitable flow control device can be used.

[0035] It is noted that the sludge collection system F of this second preferred embodiment is the same as the first preferred embodiment depicted in **FIGS. 1 through 4**. Accordingly, it has the same reference character.

[0036] Referring to **FIG. 6**, arrow G represents the direction that solids and other impurities travel. Arrow H represents the direction that fluid flows through the tubes of the tube settler groups. Arrows I represent the directions that fluid flows out of the influent distribution channels.

FIG. **7**

[0037] A further preferred embodiment will now be described in connection with **FIG. 7**. This embodiment is the same as the embodiment depicted in **FIGS. 5 and 6** with the sole exception noted below. Accordingly, like elements are given the same reference numerals. The influent channels in this embodiment differ from early embodiments in that support members **56** extending outwardly from each side of the influent channels to support the tube settler groups. These support members eliminate the need for intermediate supports along the length of the tube settler groups.

[0038] While this invention has been described as having a preferred design, it is understood that the preferred design can be further modified or adapted following in general the principles of the invention and including but not limited to such departures from the present invention as come within the known or customary practice in the art to which the invention pertains. The claims are not limited to the preferred embodiment.

We claim:

1. A system for settling solids or other impurities from water or wastewater, said system including:

(a) a containment vessel for containing fluid, said containment vessel having an inlet for receiving an influent and an outlet through which an effluent is discharged;

(b) at least a first group of tube settlers disposed in said containment vessel, said first group of tube settlers having a top, a bottom, a first end and a second end, said first group of tube settlers further having a plurality of tubes for receiving influent and discharging effluent; and,

(c) a distribution member for distributing influent evenly through said first group of tube settlers, at least a first portion of said distribution member being disposed between said top of said first group of tube settlers and said bottom of said first group of tube settlers.

2. A system as set forth in claim 1, wherein:

(a) said distribution member is a distribution channel having a first sidewall, a second sidewall, a bottom and a plurality of orifices through which the influent flows.

3. A system as set forth in claim 2, wherein:

(a) said plurality of orifices are disposed below said bottom of said first group of tube settlers.

4. A system as set forth in claim 1, wherein:

(a) at least a portion of said inlet of said containment vessel extends above said bottom of said first group of tube settlers.

5. A system as set forth in claim 4, wherein:

(a) said distribution member is formed from a nonmetallic material.

6. A system as set forth in claim 1, further including:

(a) a sludge collection system positioned in said containment vessel, said first group of tube settlers being positioned above said sludge collection system; and,

(b) a flocculator upstream of said containment vessel.

7. A system as set forth in claim 1, further including:

(a) a collection member, said collection member and said distribution member having a common wall.

8. A system as set forth in claim 7, further including:

(a) a second group of tube settlers disposed in said containment vessel, said second group of tube settlers having a top, a bottom, a first end and a second end, said second group of tube settlers further having a plurality of tubes for receiving influent and discharging effluent; and,

(b) at least a portion of said collection member and at least a portion of said distribution member extend between said top of said first group of tube settlers and said bottom of said first group of tube settlers.

9. A system as set forth in claim 1, wherein:

(a) at least a major portion of said collection member extends between said top of said first group of tube settlers and said bottom of said first group of tube settlers.

10. A system for settling solids or other impurities from water or wastewater, said system including:

(a) a containment vessel for containing fluid, said containment vessel having an inlet for receiving an influent and an outlet through which an effluent is discharged;

(b) at least first and second groups of tube settlers disposed in said containment vessel, said first and second groups of tube settlers each having a top and a bottom, each of said first and second groups of tube settlers further having a plurality of tubes for receiving influent and discharging effluent; and,

(c) a distribution channel for distributing influent evenly through said first and second groups of tube settlers, said distribution channel having a first sidewall, a second sidewall and a bottom, said distribution channel further having a plurality of orifices through which the influent flows, said distribution channel being disposed relative to said first group of tube settlers such that at least a portion of said distribution channel extends between said top of said first group of tube settlers and said bottom of said first group of tube settlers.

11. A system as set forth in claim 10, wherein:

(a) said top of said first group of tube settlers is disposed at substantially the same height as said top of said second group of tube settlers and said bottom of said first group of tube settlers is disposed at substantially the same height as said bottom of said second group of tube settlers.

12. A system as set forth in claim 10, wherein:

(a) said distribution channel includes means for supporting said first and second groups of tube settlers.

13. A system as set forth in claim 10, wherein:

(a) said first group of tube settlers are disposed adjacent said first sidewall of said distribution channel and said second group of tube settlers are disposed adjacent said second sidewall of said distribution channel.

14. A system as set forth in claim 10, wherein:

(a) at least a major portion of said distribution channel extends between said top of said first group of tube settlers and said bottom of said first group of tube settlers.

15. A system for settling solids or other impurities from water or wastewater, said system including:

(a) a containment vessel for containing fluid, said containment vessel having an inlet for receiving an influent and an outlet through which an effluent is discharged;

(b) at least first and second groups of tube settlers disposed in said containment vessel, said first and second groups of tube settlers each having a top and a bottom, each of said first and second groups of tube settlers further having a plurality of tubes for receiving influent and discharging effluent;

(c) a distribution member for distributing influent evenly through said first and second groups of tube settlers;

(d) a collection member for collecting effluent from said first and second groups of tube settlers; and,

(e) said distribution member and said collection member share a common wall.

16. A system as set forth in claim 15, wherein:

(a) said distribution member is a distribution channel having a first sidewall, a second sidewall, a bottom and a plurality of orifices through which the influent flows.

17. A system as set forth in claim 16, wherein:

(a) said collection member is a collection channel having a first sidewall, a second sidewall, a bottom.

18. A system as set forth in claim 17, wherein:

(a) said first sidewall of said collection channel and said first sidewall of said distribution channel are one piece.

19. A system as set forth in claim 18, wherein:

(a) said second sidewall of said collection channel and said second sidewall of said distribution channel are one piece.

20. A system as set forth in claim 19, wherein:

(a) said collection channel includes a fluid flow control member.

21. A system for settling solids or other impurities from water or wastewater, said system including:

(a) a containment vessel for containing fluid, said containment vessel having an inlet for receiving an influent and an outlet through which an effluent is discharged;

(b) at least first and second groups of tube settlers disposed in said containment vessel, said first and second groups of tube settlers each having a top and a bottom, each of said first and second groups of tube settlers further having a plurality of tubes for receiving influent and discharging effluent; and,

(c) a distribution member for distributing influent evenly through said first and second groups of tube settlers, said distribution member having a plurality of orifices posited below said bottom of said first group of tube settlers and said bottom of said second group of tube settlers, at least a portion of said distribution member is one piece with at least a portion of said first group of tube settlers and at least a portion of said distribution member is one piece with at least a portion of said second group of tube settlers.

* * * * *

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(54) Bezeichnung: Einrichtung zur Beseitigung von Verschmutzungen aus Flüssigkeiten

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Patentansprüche

1. Einrichtung zur Beseitigung von Verschmutzungen aus einer Flüssigkeit, gekennzeichnet durch einen Behälter mit einem flachen Boden (1) und einer im wesentlichen den Boden des Behälters bedeckenden Anordnung von vertikalen Zellen (3), die an ihrer Oberseite offen und an ihrer Unterseite geschlossen sind und die ausreichend schmal und hoch sind, um zu verhindern, daß zirkulierende Strömungen in dem Behälter den Bodenbereich der Zellen erreichen, wobei die Zellen vom Behälterboden abnehmbar sind, um am Boden der Zellen befindliches Sediment zu beseitigen.

2. Einrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Zellen (3) aneinander angrenzend angeordnet sind und einen quadratischen, hexagonalen oder anderen mehreckigen Querschnitt aufweisen und mindestens etwa viermal bis sechsmal so tief wie ihre durchschnittliche Querabmessung sind.

3. Einrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Zellen (3) an ihrer Oberseite scharfkantig ausgeführt sind.

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4. Einrichtung nach Anspruch 1, dadurch gekennzeichnet daß die Zellen (3) aus einer beidseitig offenen Zellenstruktur bestehen, die an der Unterseite durch eine Schicht oder Lage (4) aus elastischem Material abgedichtet sind.

5. Einrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Zellenanordnung (3) als Ganzes, oder aus einzelnen Abschnitten bestehend, aus dem Behälter herausnehmbar ist.

6. Einrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Zellenanordnung (3) aus einem oder mehreren Kunststofformteilen nach Art einer Matte besteht.

7. Einrichtung nach Anspruch 6, dadurch gekennzeichnet, daß die Zellenanordnung (3) aus einem Kunststofformteil besteht, bei dem die Unterseiten der Zellen geschlossen sind.

8. Einrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Zellenanordnung (3) aus durch Haftschweißung miteinander verbundenen, jeweils etwa dem halben Zellenquerschnitt entsprechend verformten Blechen besteht.

9. Einrichtung nach Anspruch 1, dadurch gekennzeichnet, daß unterhalb der Zellenanordnung (3) eine Lage oder Platte (5) vorgesehen ist, die aus magnetisiertem Material besteht oder magnetisiertes Material eingeformt enthält.

10. Einrichtung nach Anspruch 1, dadurch gekennzeichnet, daß in den unteren Abschnitt der aus Kunststoff bestehenden Zellenanordnung (3) magnetisiertes Material eingeformt ist.

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11. Einrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Zellenanordnung (3) in eine verdickte Bodenwand des Behälters eingeformt und nach unten durch eine Verschlußplatte abgedichtet ist.

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Einrichtung zur Beseitigung von Verschmutzungen aus Flüssigkeiten

Die Erfindung bezieht sich auf die Beseitigung von Verschmutzungen aus Flüssigkeiten. Ziel der Erfindung ist die Schaffung einer Einrichtung, mit der Feststoffe oder Tropfen von größerer Dichte als die der Flüssigkeit veranlaßt werden, sich aus der Flüssigkeit abzuscheiden, um dann entfernt werden zu können, ohne die Flüssigkeit erneut zu verunreinigen.

Obwohl die Erfindung nachfolgend unter besonderer Bezugnahme auf das Arbeitsmedium von Hydrauliksystemen beschrieben wird, ist sie jedoch gleichermaßen bei zahlreichen anderen Flüssigkeiten einschließlich Wasser für Haushalts- oder Industriezwecke anwendbar und auch für fermentierte Flüssigkeiten, in denen Hefezellen und andere Organismen als Sediment enthalten sind.

Eine Einrichtung zur Verringerung und/oder Beseitigung der Verschmutzung einer Flüssigkeit gemäß der Erfindung

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umfaßt einen Behälter mit einem flachen Boden, einer Anordnung von vertikalen Zellen, die im wesentlichen den Boden des Behälters bedecken, an ihrer Oberseite offen und an ihrer Unterseite geschlossen sind und ausreichend schmal bzw. eng und ausreichend tief sind, um zu verhindern, daß zirkulierende Strömungen in dem Behälter die Bodenbereiche der Zellen erreichen, wobei die Zellen abnehmbar sind oder geöffnet werden können, um am Boden der Zellen befindliches Sediment zu beseitigen.

Die Zellen können einen quadratischen oder hexagonalen Querschnitt aufweisen und sollten wenigstens viermal, vorzugsweise wenigstens sechsmal so tief bzw. hoch wie ihre durchschnittliche Querabmessung sein. Vorzugsweise sind die Zellwände an der Oberseite scharfkantig, um waagerechte oder nahezu waagerechte Oberflächen zu vermeiden, auf denen sich Sedimente ansammeln könnten, ohne sich in die Zellen hinein abzusetzen. Günstige Breitenabmessungen der Zellen ergeben sich als Kompromiß zwischen einer erhöhten Wirksamkeit, indem man einerseits die Zellen e-nger macht, und andererseits aus der Notwendigkeit der Vermeidung des Einfangens von Luft, wenn die Zellen zu Anfang gefüllt werden. Für die meisten, mit Ausnahme von sehr viskosen, Flüssigkeiten ist eine Querabmessung von ungefähr 4 mm (d.h. zwischen 3 mm und 5 mm) zweckmäßig, um diese unerwünschte Wirkung zu vermeiden. Wenn jedoch die Zellen mit der Arbeitsflüssigkeit schon vorgefüllt werden können, lassen sich auch engere Zellen als mit den oben genannten Werten anwenden und ein günstiger Wirkungsgrad für den Absetzvorgang erreichen.

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Obwohl die Zellen grundsätzlich in eine verdickte Bodenwand des Behälters eingeformt und durch Verwendung eines unteren Verschlußteils abgedichtet werden können, besteht eine einfache, billige und bevorzugte Herstellungstechnik darin, die Anordnung von Zellen als Matte auszuformen, bzw. in eine Matte einzubeziehen, die dann in den Behälter eingelegt wird und den Behälterboden im wesentlichen vollständig abdeckt.

Diese Matte kann einstückig hergestellt werden oder auch aus mehreren Abschnitten bestehen. Die Matte kann aus einem Kunststoff-Formteil bestehen, wobei die Zellen an ihrem Boden geschlossen sind, oder die Zellen werden beispielsweise durch Haftschweißung und Aufweitung einer Streifenanordnung hergestellt oder durch eine Extrusionsformung, wobei dann die Zellen am Boden offen sind und ein Vers-chluß dadurch erfolgt, daß man die Matte auf eine Unterlage aus nachgiebigem Material aufsetzt, z.B. auf eine Bahn oder eine Lage aus Neopren oder auf eine aus geschäumtem Kunststoff mit geschlossener Zellenstruktur bestehende Materiallage. Falls die Verschmutzungsstoffe auch magnetische Partikel enthalten, so läßt sich das Zurückhalten der sedimentierten Partikel dadurch verbessern, daß man eine Lage oder ein Blech aus magnetischem Material verwendet und die Partikel an den Zellenböden zurückhält, worauf weiter unten noch eingegangen ist.

Die Erfindung eignet sich u.B. besonders für Hydrauliksysteme zu Stell- oder Steuerzwecken, die gewöhnlich einen Vorratstank aufweisen, aus dem eine Pumpe das hydraulische Medium ansaugt und es unter Druck in das System hineinfördert, aus dem es gegebenenfalls zum Vorratsbehälter zurückläuft. Während des Betriebes sammeln

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sich im hydraulischen Medium Schmutzstoffe an, die teilweise aus Körnern oder Bruchstücken von Abriebsmaterial bestehen wie Silica (Siliciumoxyd), aus Metallteilchen, die durch Abrieb an den Ventilen, Pumpen und Motoren des Hydrauliksystems entstehen, und aus kleinsten Wassertröpfchen aufgrund von Kondensation. Sehr häufig ist ein solches Hydrauliksystem nur während der täglichen Arbeitsstunden in Betrieb und wird über Nacht abgeschaltet, so daß während dieser Zeit die Verschmutzungspartikel, die im allgemeinen eine größere Dichte als diejenige des hydraulischen Mediums besitzen, sich am Boden des Vorratsbehälters absetzen werden. Bei den bisher bekannten Hydrauliksystemen wird das hydraulische Medium nach dem morgendlichen Einschalten innerhalb des Vorratsbehälters stark bewegt und durchmischt, so daß der größte Anteil des Sediments zurück in den Kreislauf gelangt. Obwohl derartige Systeme normalerweise mit Filtern versehen sind, haben die Filter niemals eine vollständige absolute Leistungsfähigkeit. Falls darüberhinaus die Filter aus Wegwerfelementen bestehen, sind sie teuer und erfordern Arbeiten zur Überprüfung und zur Wartung beim Vorgang des Auswechselns; wenn die Filter aus reinigungsfähigen Elementen bestehen, sind sie noch aufwendiger und erfordern eine besondere Anlage, z.B. in Form von Ultraschallbädern, in der sie sachgemäß gereinigt werden können. Durch Anwendung der erfindungsgemäßen Einrichtung wird der größte Teil der Verschmutzung der hydraulischen Flüssigkeit beseitigt, der sonst die Filter erreichen würde, so daß die Lebensdauer der Filter verlängert wird und die sich aus der Filterwartung ergebenden Kosten und Abschaltzeiten reduziert werden.

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Die Erfindung ist nachfolgend anhand eines Ausführungsbeispiels unter Bezugnahme auf die Zeichnung näher erläutert, wobei die Zeichnung eine perspektivische Teilansicht eines Abschnittes im Bereich der Bodenkante eines Vorratsbehälters für hydraulische Flüssigkeit zeigt, bei dem die erfindungsgemäße Absetzeinrichtung angewendet ist.

Entsprechend der Zeichnung bildet eine Bodenplatte 1 zusammen mit einer senkrechten Seitenwand 2 den unteren Bereich längs einer Seitenkante eines Vorratsbehälters für hydraulische Flüssigkeit in einem hydraulischen Antriebssystem. Der Vorratsbehälter besitzt eine rechteckige Form und wird an seiner nicht gezeigten Oberseite durch einen abnehmbaren Deckel zur Staubabdichtung abgeschlossen.

Auf dem Boden des Vorratsbehälters befindet sich eine bienenwabenähnliche Anordnung aus hexagonalen Zellen 3, die nahezu die gesamte Bodenfläche des Behälters bedeckt und die aus dünnen haftverschweißten Metallblechen besteht und auf die erforderliche Form aufgeweitet worden ist. Diese Zellenanordnung liegt auf einer dünnen Lage 4 aus Kunststoffmaterial auf, die die Bodenbereiche der Zellen 3 wirksam so abdichtet, daß Konvektionsströmungen der Flüssigkeit nicht in der Lage sind, sich durch eine Zelle nach unten zu bewegen und durch eine benachbarte Zelle sich nach oben zu bewegen. Die Kunststofflage 4 kann ihrerseits auf einer zweiten Schicht, Folie oder Lage 5 aus Kunststoffmaterial aufliegen, in dem kleine magnetisierte Partikel mit eingeformt oder auf andere Art und Weise mit einbezogen sind.

Die einzelnen Zellen der Zellenanordnung 3 haben eine Breite von etwa 5 mm, gemessen zwischen zwei gegenüberliegenden Sechseckseiten, und sind etwa zwischen 30 und 40 mm hoch.

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Wenigstens die Unterseite ist flach geschliffen, so daß durch die Auflage auf der dünnen Kunststofflage 4 die unteren Kanten der jeweiligen Zelle durch die Kunststofflage abgedichtet sind.

Zum Einsatz der erfindungsgemäßen Sedimentationseinrichtung werden die Bauteile entsprechend der Zeichnung auf dem Boden des Vorratsbehälters zusammengebaut, worauf man den Vorratsbehälter mit der Hydraulikflüssigkeit füllt und das System wie üblich in Betrieb nimmt. Während der Betriebszeit zirkuliert in der Flüssigkeit eine zunehmende Menge von Verschmutzungsstoffen, von denen einige von vornherein als Verunreinigung mit dur-ch die Flüssigkeit eingeführt worden sind, einige in das System als Staub aus der Luft her eingeführt werden und andere durch Abnutzung und Reibung in den hydraulischen Motoren, Pumpen und Ventilen des Systems selbst entstehen. Obwohl das System üblicherweise einen Filter enthält, der einen Teil der Verschmutzung zurückhält, ist ein Filter niemals absolut wirksam, so daß ein Teil der Verschmutzungsstoffe mit zirkuliert und zu einer erhöten Abnutzung und zu einem erhöhten Abrieb in den verschiedenen Bauteilen des Systems führt.

Normalerweise besitzen die Verschmutzungspartikel eine größere Dichte als diejenige des hydraulischen Mediums, so daß sie die Neigung haben, sich in Richtung auf den Boden des Vorratsbehälters hin abzusetzen. Während der Betriebszeiten des Systems befindet sich die Flüssigkeit in Umlauf, so daß die Möglichkeit zur Sedimentation bzw. zur Schlammablagerung reduziert ist und die bereits vorhandenen Ablagerungen wieder aufgerührt und in den Umlauf zurückgebracht werden können. Durch Anwendung der vorliegenden Erfindung wird die Zirkulation in dem Teil des Vorratsbehälters, der durch die Zellenanordnung 3 gefüllt ist,

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fast vollständig angehalten, so daß die Flüssigkeit innerhalb der Zellen in einem nahezu bewegungslosen Zustand verbleibt. In diesem Bereich des Behälters befindliche Verschmutzungsstoffe setzen sich daher innerhalb der Zellen ab und werden nicht mehr durch dieBewegung der Flüssigkeit in höher liegenden Ebenen in die Zirkulation zurückbefördert. Die Erfindung ist daher besonders wirksam, wenn, wie häufig der Fall, das Hydrauliksystem über längere Zeiten, z.B. über Nacht oder an den Wochenenden, vollständig abgeschaltet wird, so daß dann eine längere Zeitdauer zur Verfügung steht, in der sich die Schmutzstoffe absetzen können.

Da verschiedene Anteile der Verschmutzung auf die Abnutzung und den Abrieb von aus Stahl bestehenden Kolben und aus Gußeisen bestehenden Zylindern zurückzuführen sind, die sich als übliche Bauteile in den meisten Hydrauliksystemen befinden, haben solche Verschmutzungspartikel magnetische Eigenschaften. Durch Anordnung der magnetischen Schicht 5 wird die Absetzwirkung dieser magnetischen Partikel unterstützt und beschleunigt, und gleichzeitig werden die abgesetzten Partikel zurückgehalten.

Der Absetzvorgang dieser Verschmutzungsstoffe verringert den Anteil von Material, der aus den Filtern beseitigt werden muß und verringert somit beträchtlich die Kosten, da die Filterelemente nunmehr nur weniger häufig ausgewechselt werden brauchen und auch nur kurze Abschaltzeiten erforderlich sind.

Da die Zellen aus dünnem Material bestehen, das an der Oberseite der Zellen ziemlich scharfe Kanten besitzt, können sich Verschmutzungsstoffe auch nicht an den O-berkanten der

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Zellen absetzen, sie sinken vielmehr zum Behälterboden ab. Es ist außerdem von Bedeutung, daß die Zellenanordnung 3 nahezu vollständig die Bodenfläche des Vorratsbehälters ausfüllt. Die Zellen können auch eine kleinere Breite als die oben angegebenen 5 mm für die Querabmessung besitzen, jedoch ist es in einem solchen Fall zweckmäßig, daß der Vorratsbehälter zunächst auf eine Höhe mit der Arbeitsflüssigkeit gefüllt wird, die diejenige der Zellenhöhe übersteigt. Die Zellenanordnung wird dann allmählich in die Flüssigkeit abgesenkt, um sicherzustellen, daß die Flüssigkeit über die gesamte Höhe in die Zellen eindringt. Würde andererseits die hydraulische Flüssigkeit nur von oben auf die Zellenanordnung in den Behälter hineingegossen, so besteht bei engen Zellen die Wahrscheinlichkeit, daß Luft eingeschlossen wird und die Zellen nicht vollständig mit Flüssigkeit gefüllt und somit unwirksam sind.

Nach verhältnismäßig langen Zeitabständen ist es notwendig, die Zellenanordnung 3 herauszunehmen und die dort abgesetzten Verschmutzungsstoffe zu beseitigen. Dies kann dadurch erfolgen, daß man den Vorratsbehälter bis zu einer Höhe entsprechend der Oberseite der Zellen abläßt und dann die inneren Bauteile des Behälters entfernt, worauf man diese Behälterbauteile (Bodenmatte mit Zellenanordnung und darunter befindliche Dichtungsanlagen) sowie den Behälter getrennt reinigt. Es ist auch möglich, die Bodenlage 5 aus starrem Material herzustellen und mit einer Anhebeinrichtung zu versehen, so daß die gesamte Anordnung nach oben aus dem Behälter herausgezogen werden kann.

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Die Erfindung kann auch auf andere Art und Weise verwirklicht werden. Beispielsweise kann die Kunststofflage 4 weggelassen werden, während man die Zellenanordnung im Spritzformverfahren herstellt, ggf. in einzelnen voneinander getrennten Abschnitten, wobei die Zellen ggf. an ihren Bodenabschnitten geschlossen geformt werden und an ihren oberen Enden scharfkantig ausgeführt werden. Ein solcher Spritzformteil kann als Wegwerfteil ausgeführt werden, so daß sich die Notwendigkeit für eine nachträgliche Reinigung erübrigt. Die aus magnetischem Material bestehende oder solches Material enthaltende Lage ist selbstverständlich nicht notwendig, wenn die Verschmutzung keinen nennenswerten Anteil von magnetischen Partikeln enthält.

Wenn die Zellenanordnung aus einem Kunststoffformteil besteht, können magnetische Partikel auch in den unteren Abschnitt dieses Formteils mit eingeformt werden. Solche Partikel unterstützen nicht nur das Zurückhalten von ferromagnetischem Verschmutzungsmaterial, sondern sorgen zusätzlich dafür, daß die Zellenanordnung auch sicher auf dem Boden des Vorratsbehälters festgehalten wird. Die erfindungsgemäße Einrichtung bewirkt auch die Beseitigung von in hydraulischen Flüssigkeiten enthaltenen kleinen Wassertropfen, die aus den Kondensationsvorgängen innerhalb eines Hydrauliksystems entstehen und nicht durch normale Filtration aus der Flüssigkeit beseitigt werden.

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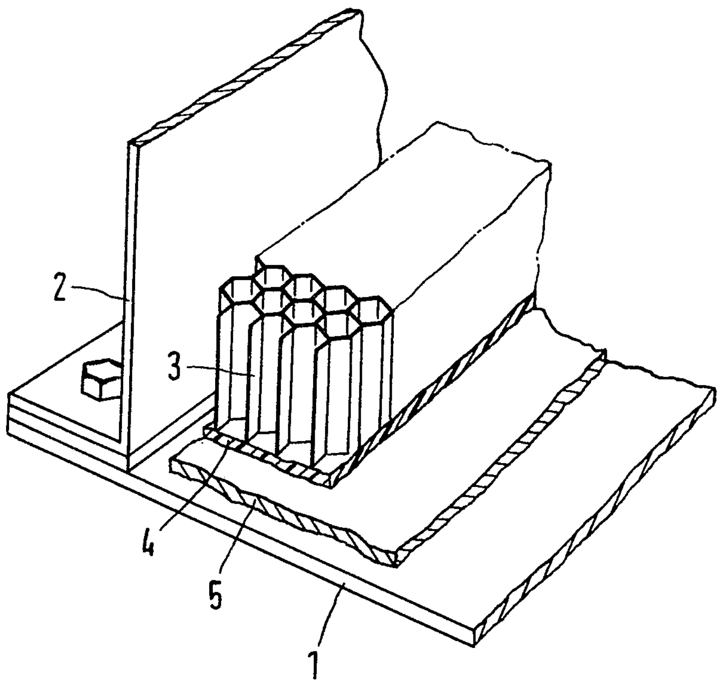

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(60) **Références à d'autres documents nationaux apparentés :**

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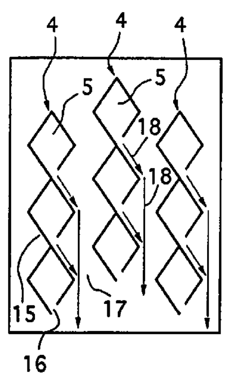
(54) **Séparateur lamellaire à courants croisés.**

(57) L'invention concerne un séparateur lamellaire pour la séparation d'un mélange fluide en écoulement formé d'une phase principale liquide et d'au moins une phase secondaire liquide, solide ou gazeuse dispersée dans ladite phase principale et présentant une densité différente de celle-ci, caractérisé en ce qu'il comprend un jeu de cellules (5) présentant un axe longitudinal essentiellement parallèle à l'axe d'écoulement dudit mélange, lesdites cellules (5) montrant au moins une paroi inclinée par rapport à l'horizontale délimitant un plan transversal de décantation (15) de ladite phase secondaire et étant munies, essentiellement sur toute leur longueur, d'une fente ou d'une lumière (16) servant d'orifice d'évacuation de ladite phase secondaire hors desdites cellules (5) vers une zone d'évacuation (17) dans laquelle ladite phase secondaire s'écoule sans rencontrer un autre fluide en mouvement dudit mélange.



FR 2 704 447 - A1

Séparateur lamellaire à courants croisés.

L'invention concerne le domaine des installations de séparation d'au moins une phase liquide, solide ou gazeuse dispersée dans une phase liquide en écoulement.

L'invention a été développée plus particulièrement pour le traitement des eaux et peut être mise en oeuvre dans une installation incluant au moins une unité de décantation assurant la séparation et la concentration des matières solides, liquides ou gazeuses en suspension présentes dans les eaux à des stades de traitement divers.

L'invention s'applique notamment :

- au traitement physico-chimique des eaux de surface en vue de leur potabilisation ;

- à l'épuration des eaux urbaines ou industrielles, soit au stade du prétraitement, soit au stade de la décantation primaire, soit encore au stade de la séparation des boues biologiques avant rejet de l'effluent clarifié en milieu naturel.

L'invention peut aussi être employée pour le traitement des eaux de ruissellement, et plus généralement pour séparer gravitairement deux phases distinctes d'un mélange quelconque.

Afin de séparer les matières en suspension présentes dans les eaux brutes et se présentant soit sous la forme de matières spontanément décantables soit, après coagulation et floculation en présence de réactifs, sous la forme de matières en suspension vraie ou colloïdale, il est connu d'utiliser des séparateurs lamellaires. De tels séparateurs sont formés par des plaques profilées, disposées parallèlement de façon inclinée et délimitant entre elles des espaces élémentaires interlamellaires permettant la séparation en un temps relativement court de l'eau et des matières en suspension. Dans le cadre du traitement biologique des effluents par boues activées, les séparateurs lamellaires ont pour fonction non seulement de séparer les eaux traitées des boues mais également de concentrer les boues de façon à les recycler et à les maintenir actives. Ils sont donc toujours munis de moyens de soutirage des boues accumulées sur le radier (racleur, trémies, suceur...). Le choix de ces moyens est conditionné par le type d'utilisation du séparateur.

Les séparateurs lamellaires sont essentiellement caractérisés par leur pouvoir de coupure, c'est-à-dire la taille limite des particules qui sont arrêtées dans le séparateur. Ce pouvoir de coupure est conditionné par plusieurs paramètres caractéristiques de l'installation :

- la STP (surface totale projetée) qui correspond approximativement à la projection horizontale de la surface totale des plaques du séparateur;
- la vitesse de Hazen qui correspond au rapport du débit du fluide traversant le séparateur sur la STP ;
- l'angle d'inclinaison des plaques délimitant les espaces interlamellaires, qui sera choisi en fonction de la densité de la phase à décanter ;
- l'écartement des plaques ;
- l'emprise au sol ;
- le flux de matières traversant l'installation.

On connaît essentiellement trois types de séparateurs lamellaires fréquemment utilisés pour clarifier des eaux brutes :

- les séparateurs à contre-courant, dans lesquels l'eau à clarifier circule de bas en haut dans les espaces interlamellaires alors que les particules sont déposées sur la face inférieure de ces espaces et glissent par gravité à contre-courant vers le bas ;
- les séparateurs à co-courant, dans lesquels l'eau à clarifier s'écoule par gravité de haut en bas dans les espaces interlamellaires, c'est-à-dire dans le même sens que les boues ;
- les séparateurs à courants croisés dans lesquels la vitesse de chute des particules et la vitesse du flux d'eau sont essentiellement perpendiculaires.

C'est à ce dernier type de séparateur que se rapporte l'invention.

Le brevet français FR 2 553 082 décrit un appareil de traitement des eaux présentant une chambre de décantation lamellaire à contre-courant avec recirculation des boues formées, ladite chambre étant constituée par une pluralité de plaques inclinées disposées parallèlement entre elles et entre lesquelles circulent de bas en haut les eaux à clarifier, dans un sens inverse au sens d'écoulement des boues formées. De façon à permettre l'autocurage des boues décantées, l'inclinaison des plaques doit être importante (généralement de l'ordre de 60°).

Dans les séparateurs lamellaires à contre-courant, l'écoulement selon des sens opposés des eaux à clarifier et des boues de décantation implique obligatoirement de limiter la vitesse d'écoulement des eaux dans les espaces interlamellaires. En effet, si la vitesse de circulation du flux dans le séparateur est trop importante, l'écoulement laminaire est perturbé et les eaux risquent de soulever les boues glissant sur la surface d'écoulement de chaque espace interlamellaire. Chaque type de séparateur lamellaire à contre-courant présente donc une vitesse limite d'écoulement des eaux relativement faible, ce qui conduit à des installations présentant un génie civil relativement important, de façon à répondre aux débits des eaux devant être traitées.

Pour éviter que les eaux à clarifier ne se mélangent aux boues s'écoulant dans les espaces interlamellaires, il existe également des séparateurs lamellaires dans lesquels les eaux et les boues s'écoulent dans le même sens. Ainsi, le brevet français FR 2 156 277 décrit une installation pour l'épuration des eaux usées incluant un séparateur lamellaire organisant l'écoulement à co-courant des eaux et des boues formées lors de la décantation de celles-ci. Ce séparateur présente dans sa partie supérieure une zone au niveau de laquelle l'eau à clarifier est répartie en plusieurs courants élémentaires parallèles et s'écoule dans des canaux délimités par des plaques inclinées par rapport à l'horizontale et au fond desquels le sédiment se dépose. L'écoulement des eaux et l'écoulement des sédiments se produisent donc dans le même sens, à savoir du haut vers le bas des canaux inclinés.

Les séparateurs de ce type présentent l'avantage de concourir à un bon compactage des boues décantées, du fait que le floc se formant dans les espaces interlamellaires roule sur lui même sous l'action de l'eau et s'accumule sous forme compactée dans la partie inférieure des séparateurs. Par ailleurs, ils ont également l'avantage de permettre une vitesse d'écoulement du flux d'eau à traiter plus élevée, puisque l'eau et les boues s'écoulent dans le même sens.

Le principal inconvénient des séparateurs lamellaires à co-courant réside dans le fait qu'ils rendent difficile la collecte des eaux clarifiées, celles-ci sortant des espaces inter-lamellaires parallèlement aux boues de décantation. Pour résoudre ce problème, il a donc été proposé dans l'état de la technique de récupérer les eaux grâce à des collecteurs installés en amont de la zone de sortie des boues. De tels collecteurs permettent de remonter les eaux clarifiées dans la partie supérieure des séparateurs afin de faciliter leur évacuation. Toutefois, ces collecteurs compliquent les installations de décantation et sont de surcroît susceptibles de se colmater et ainsi de ralentir considérablement la vitesse d'écoulement des eaux dans les espaces interlamellaires. Enfin, ils augmentent la taille des installations de génie civil sans augmenter la capacité de décantation des installations qu'ils équipent, puisque la surface des collecteurs ne rentre pas en ligne de compte pour le calcul de la vitesse de Hazen.

Par ailleurs, les opérations de prélèvement périodique des boues concentrées par ce type de séparateurs à écoulement à co-courant s'avèrent être aussi des opérations délicates susceptibles de perturber la décantation, comme dans le cas des séparateurs à écoulement à contre-courant.

Enfin, il existe dans l'état de la technique des séparateurs lamellaires à décantation transversale pour lesquelles les veines liquides présentent un flux horizontal et font un angle de 90 ° environ avec la pente des plaques sur lesquelles glisse la phase solide. Ces installations présentent l'avantage de ne pas provoquer de mélange des boues de décantation avec le liquide à décanter lors des purges. Toutefois, l'alimentation en fluide de telles installations à flux croisés est complexe, ainsi que la récupération des boues formées.

L'objectif de la présente invention est de présenter un séparateur lamellaire à courants croisés d'efficacité accrue pour la séparation de phases différentes d'un fluide en écoulement, en particulier pour la clarification d'eaux brutes de natures diverses.

Un autre objectif de l'invention est de décrire un séparateur lamellaire facilitant la collecte des eaux clarifiées.

Un autre objectif de l'invention est de proposer un tel séparateur dans lequel les boues, une fois décantées, s'écoulent librement sans rencontrer d'autres phases et interdisant ainsi à ces boues de se remélanger avec le mélange traversant le séparateur.

Ces objectifs, ainsi que d'autres qui apparaîtront par la suite, sont atteints grâce à un séparateur lamellaire d'un mélange fluide en écoulement formé d'une phase principale liquide et d'au moins une phase secondaire liquide, solide ou gazeuse dispersée dans ladite phase principale et présentant une densité différente de celle-ci, caractérisé en ce qu'il comprend au moins un jeu de cellules présentant un axe longitudinal essentiellement parallèle à l'axe d'écoulement dudit mélange, lesdites cellules étant délimitées par au moins une paroi inclinée par rapport à l'horizontale délimitant un plan transversal de décantation de ladite phase secondaire et étant munies, essentiellement sur toute leur longueur, d'une fente ou d'une lumière dont l'un des bords est préférentiellement en continuité avec ladite paroi inclinée, ladite fente ou ladite lumière servant d'orifice d'évacuation de ladite phase secondaire hors desdites cellules vers une zone d'évacuation dans laquelle ladite phase secondaire s'écoule sans rencontrer un autre fluide en mouvement dudit mélange traité dans lesdites cellules.

Le mélange à traiter est amené dans les cellules à une pression suffisamment élevée pour que seule la phase ayant décanté sur les parois des cellules faisant office de plans de décantation, puisse s'écouler par les fentes des cellules.

Un tel séparateur lamellaire à courants croisés, permet de séparer le courant de la phase ayant décantée du courant du mélange transitant à l'intérieur des cellules. Une telle séparation empêche tout dilution de la phase ayant décanté avec ce mélange.

De plus, les courants du mélange à traiter et de la phase ayant décanté étant séparés, la récupération de cette phase et du fluide traité est grandement facilitée.

Selon une variante de l'invention, lorsque ladite phase secondaire est plus lourde que ladite phase principale, ladite fente ou ladite lumière desdites cellules est prévue dans la partie inférieure de celles-ci. Une telle configuration pourra notamment être mise en oeuvre lorsque le séparateur lamellaire sera utilisé pour séparer un solide (tel que par exemple du sable) d'un liquide (tel que par exemple une eau). La phase ayant décanté sera alors récupérée dans la partie inférieure du séparateur.

Selon une autre variante de l'invention, lorsque ladite phase secondaire est de densité plus faible que la phase principale, ladite fente ou ladite lumière desdites cellules est prévue dans la partie supérieure de celles-ci. Cette configuration pourra notamment être utilisée lorsque le séparateur lamellaire sera destiné à séparer des hydrocarbures, d'un liquide (tel que par exemple, une eau). Dans ce cas, la phase de densité plus faible séparée sera récupérée dans le partie supérieure du séparateur.

Enfin, lorsque ledit mélange est constitué d'une phase principale, telle que l'eau, mélangée à une phase secondaire de plus forte densité et à une phase secondaire de plus faible densité que la phase principale, lesdites cellules présentent au moins deux parois inclinées par rapport à l'horizontale et au moins deux fentes ou lumières montrant chacune un bord en continuité avec l'une desdites parois inclinées, l'une desdites fentes ou lumières étant prévue dans la partie supérieure desdites cellules et l'autre étant prévue dans la partie inférieure de celles-ci. Dans ce cas, la phase de densité plus faible sera récupérée dans la partie supérieure du séparateur tandis que la phase la plus dense ayant décantée sera récupérée dans la partie inférieure de celui-ci.

Préférentiellement, lesdites cellules sont organisées en plaques disposées essentiellement parallèlement entre elles, chacune desdites plaques étant constituée par la superposition verticale de plusieurs cellules, l'espace prévu entre lesdites plaques de décantation constituant la zone d'évacuation de ladite phase secondaire. Une telle disposition en plaques destinées à être positionnées verticalement permet de faciliter la construction du séparateur selon l'invention, les cellules n'étant pas structurellement indépendantes les unes des autres mais organisées en associations verticales.

Selon une variante de l'invention, lesdites cellules présentent une section transversale parallélépipédique.

Avantageusement, ladite section transversale des cellules est en forme de losange.

Selon un aspect de l'invention, lesdites plaques sont disposées en quinconce, de façon telle que ladite zone d'évacuation entre deux plaques présente une section constante.

Selon une autre variante de l'invention, lesdites cellules présentent une section transversale en forme de chevrons.

Préférentiellement, ledit séparateur comprend une plaque amont et une plaque aval disposées respectivement à l'entrée et à la sortie dudit séparateur essentiellement perpendiculairement à l'axe longitudinal desdites cellules, ladite plaque amont présentant des ouvertures de forme correspondant à la section transversale desdites cellules et venant en regard de l'extrémité d'entrée de celles-ci, ladite plaque aval présentant des ouvertures formant diaphragmes venant en regard de l'extrémité de sortie desdites cellules. Les ouvertures formant diaphragme, et donc présentant des dimensions inférieures à celles disposées à la sortie des cellules, permettent d'inculquer une perte de charge prédéterminée au mélange amené dans le séparateur. Cette perte de charge permet d'assurer l'équirépartition du mélange dans l'ensemble des cellules du séparateur.

Avantageusement, le séparateur selon l'invention comprend au moins une plaque de renforcement présentant une structure sensiblement identique à celle de ladite plaque amont, ladite plaque de renforcement étant disposée essentiellement transversalement à l'axe longitudinal desdites cellules, lesdites cellules traversant ladite plaque de renforcement.

Egalement avantageusement, le séparateur lamellaire selon l'invention comprend une zone amont d'alimentation dudit mélange dans lesdites cellules, ladite zone amont pouvant être à surface libre ou en charge et alimentant lesdites cellules sous un angle de 0° à 90 °.

Egalement avantageusement, ledit séparateur lamellaire comprend des moyens de collecte de la phase principale à la sortie desdites cellules, lesdits moyens de collecte permettant d'assurer l'immersion permanente desdites cellules.

Ces moyens pourront être constitués, par exemple, par une goulotte ou par une paroi siphoïde permettant d'évacuer le liquide traité en charge, ou encore par un déversoir permettant d'évacuer le liquide traité en rupture de charge.

Préférentiellement, ledit séparateur lamellaire inclut une zone de collecte de boues munie d'un radier plat ou incliné accueillant ladite phase secondaire, lorsque celle-ci est plus lourde que la phase principale, ledit radier étant muni de tout moyen de soutirage de celle-ci comme par exemple par racleurs, les suceurs et les vis d'extraction. La zone de collecte de boues peut aussi être constituée d'une ou plusieurs trémies équipées de dispositifs de soutirage des boues.

L'invention concerne également une installation pour le traitement des eaux résiduaires comprenant au moins certaines desdites unités suivantes : une unité de dessablage, un débourbeur, une unité de décantation, un clarificateur de boues biologiques, caractérisée en ce qu'elle inclut au moins un tel séparateur lamellaire montrant des cellules munies de fentes dans leur partie inférieure, ledit séparateur constituant l'une desdites unités.

L'invention concerne aussi une installation pour le traitement des eaux résiduaires comprenant au moins une desdites unités suivantes : une unité de dessablage-déshuilage, un flottateur caractérisée en ce qu'elle inclut au moins un tel séparateur lamellaire montrant des cellules munies de fentes dans leur partie supérieure et dans leur partie inférieure, ledit séparateur constituant l'une desdites unités.

Enfin, l'invention concerne également une installation pour le traitement des eaux résiduaires incluant au moins une unité de séparation des hydrocarbures contenus dans lesdites eaux caractérisée en ce que ladite unité de séparation est constituées par un tel séparateur lamellaire montrant des cellules munies de fentes dans leur partie supérieure.

L'invention, ainsi que les différents avantages qu'elle présente, seront plus facilement compris grâce aux exemples de réalisation qui vont suivre en référence aux dessins dans lesquels :

- la figure 1 représente une vue en coupe d'un premier mode de réalisation du séparateur lamellaire selon l'invention ;

- la figure 2 représente une vue de dessus du séparateur lamellaire représenté à la figure 1 ;

- la figure 3 représente une vue en coupe d'un deuxième mode de réalisation du séparateur lamellaire selon l'invention ;

- les figures 4, 5 et 6 représentent des vues en coupe transversales de cellules pouvant être utilisées pour la réalisation d'un séparateur lamellaire selon l'invention du type de celui représenté à la figure 1 ;

- les figures 7, 8 et 9 représentent des vues en coupe transversale de cellules pouvant être utilisées pour la réalisation d'un séparateur lamellaire selon l'invention du type de celui représenté à la figure 3 ;

- les figures 10 et 11 représentent des vues en coupe transversale de cellules pouvant être utilisées pour la réalisation d'un séparateur lamellaire selon l'invention permettant la séparation d'un mélange gaz-liquide-solide ;

- la figure 12 représente une vue de face d'une plaque amont pouvant être utilisée pour la réalisation d'un séparateur lamellaire muni de cellules présentant une coupe transversale conforme à la figure 4, 7 ou 10 ;

- la figure 13 représente une vue de face d'une plaque aval pouvant être utilisée pour la réalisation d'un séparateur lamellaire muni de cellules présentant une coupe transversale conforme à la figure 4, 7 ou 10 ;

- la figure 14 représente une vue de face d'une plaque amont pouvant être utilisée pour la réalisation d'un séparateur lamellaire muni de cellules présentant une coupe transversale conforme à la figure 5 ;

- la figure 15 représente une vue de face d'une plaque amont pouvant être utilisée pour la réalisation d'un séparateur lamellaire muni de cellules présentant une coupe transversale conforme à la figure 11 ;

- la figure 16 représente une vue de face d'une plaque aval pouvant être utilisée pour la réalisation d'un séparateur lamellaire muni de cellules présentant une coupe transversale conforme à la figure 5, à la figure 8 ou à la figure 11 ;

- la figure 17 représente une vue de face d'une plaque amont pouvant être utilisée pour la réalisation d'un séparateur lamellaire muni de cellules présentant une coupe transversale conforme à la figure 6 ;

- la figure 18 représente une vue de face d'une plaque amont pouvant être utilisée pour la réalisation d'un séparateur lamellaire muni de cellules présentant une coupe transversale conforme à la figure 9 ;

- la figure 19 représente une vue de face d'une plaque aval pouvant être utilisée pour la réalisation d'un séparateur lamellaire muni de cellules présentant une coupe transversale conforme à la figure 6 ou à la figure 9 ;

En référence à la figure 1, un séparateur lamellaire selon l'invention destiné à séparer une phase solides (sable, boues etc...) d'une eau résiduaire est représenté en coupe transversale. Un tel séparateur peut être utilisé pour constituer une unité de dessablage, un débourbeur, un décanteur ou encore une unité de clarification de boues biologiques. Ce séparateur présente une zone amont 1 d'alimentation du mélange liquide à clarifier. Ce mélange arrive dans ladite zone amont 1 par une canalisation 2 qui débouche dans celle-ci. Le mélange est ensuite distribué dans deux modules 3 constitués de plaques verticales 4 disposées parallèlement entre elles selon un espacement sensiblement constant. Chacune de ces plaques 4 (dont deux - une pour chaque module 3 - sont représentées en coupe sur la figure 1) est pourvue de cellules 5 disposées, pour une même plaque, les unes au-dessus des autres et s'étendant sur toutes la largeur desdites plaques 4. On notera que chaque module 3 renfermant les plaques 4 est délimité, à son entrée, par une plaque amont 11 présentant des ouvertures venant en regard des cellules 5 et, à sa sortie, par une plaque aval 12 présentant des ouvertures formant diaphragme, (c'est-à-dire de plus faible dimension que les ouvertures de la plaque amont) afin de provoquer une rupture de charge dudit mélange et d'assurer la répartition du mélange à traiter dans l'ensemble des cellules 5.

Le liquide à clarifier transite dans les cellules 5 selon une direction parallèle à leur axe longitudinal. La structure des plaques 4, qui sera plus précisément décrite en référence aux figures 4 à 6, autorise une décantation transversale (c'est-à-dire essentiellement perpendiculairement à la direction de déplacement du liquide dans les cellules 5) de façon telle que la phase solide décantée soit récupérée dans la partie inférieure du séparateur formant une zone à boues 6. Cette zone à boues 6 présente un fond plat équipé de moyens de soutirage (non représentés) pouvant être constitués, par exemple, par un râcleur ou un suceur et est séparée des deux modules 3 par un plancher reposant sur des poutres 8.

Le liquide, débarrassé de la phase solide et ayant transité dans les cellules 5, est récupéré à la sortie de celles-ci, dans deux zones de collecte 9, prévues de part et d'autre du séparateur, et évacué par deux déversoirs 10 en rupture de charge.

Selon la vue de dessus du séparateur lamellaire représentée à la figure 2, chaque module 3, délimité par les plaques amont 11 et les plaques aval 12, est constitué par une pluralité de plaques 4 montées parallèles entre elles selon un espacement constant. Les espaces entre les plaques 4 constituent les zones d'évacuation 17.

L'eau à traiter est amenée dans la zone d'alimentation 1 puis transite à l'intérieur des plaques 4 afin que la phase solide qu'elle renferme puisse décanter dans les cellules constituant ces plaques. A la sortie des cellules, le liquide clarifié est récupéré par déversement dans les zones de collecte 10, comme le symbolise les flèches 14.

Selon les figures 4, 5 ,6 différents types de plaques 4, pouvant être utilisées pour constituer les modules de séparateurs lamellaires du type de celui montré à la figure 1 sont représentés en coupe transversale. On notera que, de façon arbitraire chacune des figures 4 à 6 présente trois plaques 4 parallèles, pourvues chacune de trois à sept cellules, alors que les séparateurs selon l'invention pourront inclure un nombre différent de plaques et de cellules (ainsi chaque module 3 du séparateur lamellaire selon l'invention représenté aux figures 1 et 2 est équipé de quatorze plaques 4).

Selon les figures 4 à 6, les cellules 5 des plaques 4 peuvent avoir différentes formes (losanges, parallélépipèdes, chevrons) et présentent toutes une paroi inclinée 15 formant un plan de décantation, sur lequel la phase la plus lourde du mélange vient se déposer. Ces cellules présentent par ailleurs une fente 16, située dans la partie inférieure des cellules et en continuité des parois 15, par laquelle s'échappe cette phase vers les zones d'évacuation 17 délimitées par les espaces existant entre les plaques 4, comme le symbolise les flèches 18.

Les fentes 16 des cellules 5 sont dimensionnées de façon à ne laisser passer que la phase ayant décantée sur les parois 15 à l'exclusion du mélange à décanter. Ainsi, cette phase se déplace librement dès sa sortie des cellules sans rencontrer une autre phase du mélange. Sa récupération s'en trouve ainsi grandement facilitée.

Selon la figure 3, un séparateur lamellaire conforme à la présente invention est représenté en coupe transversale. Un tel séparateur est destiné à traiter un mélange constitué d'un liquide à l'intérieur duquel est dispersée une phase de densité plus faible que l'on désire séparer dudit mélange. Un séparateur de ce type peut être utilisé notamment pour séparer les hydrocarbures des eaux résiduaires. A l'image du séparateur représenté à la figure 1, le séparateur montré à la figure 3 comprend deux modules 3 constitués chacun d'une pluralité de plaques 4 montées verticalement essentiellement parallèlement entre elles et pourvues de cellules 5 permettant la décantation et l'évacuation, dans la partie supérieure 21 du séparateur, du fluide plus léger initialement contenu dans le mélange. A la sortie des modules 3, deux zones de collècte 9 disposées de part et d'autre du séparateur et pourvues de déversoirs 10 sont prévues pour récupérer le liquide traité.

Les plaques 4 équipant un tel séparateur peuvent présenter différentes formes et notamment les formes représentées aux figures 7, 8 et 9. On notera que ces figures 7, 8 et 9 montrent trois plaques en coupe transversale munies chacune de trois à sept cellules, alors que, comme on l'a déjà précisé ci-dessus, les séparateurs selon l'invention pourront bien sûr être équipés d'un nombre différent de plaques avec un nombre de cellules également différent.

Les cellules des plaques représentées aux figures 7, 8 et 9 montrent une section transversale de forme variable, respectivement en losange, de forme parallélipédique, et en forme de chevrons. Ces cellules 5 présentent toutes une paroi inclinée 15 (voir figure 8) ou deux parois inclinées 15 (voir figures 7 et 9) faisant office de plan de décantation du fluide plus léger contenu dans le mélange transitant dans ces cellules 5. Celles-ci sont par ailleurs munies d'une fente 16 s'étendant essentiellement sur toute leur longueur et permettant l'évacuation du fluide décanté sur les parois 15 comme le symbolisent les flêches 18. On notera que, contrairement aux plaques représentées aux figures 4, 5 et 6, destinées à équiper un séparateur du type de celui représenté à la figure 1, les plaques représentées aux figures 7, 8 et 9, destinés à équiper un séparateur du type de celui représenté à la figure 3, présentent des fentes 16 et des plans de décantation 15 situés dans la partie supérieure des cellules 5.

Dans le cas où le séparateur selon l'invention sera destiné à traiter un mélange constitué d'un liquide dans lequel sont dispersées une phase plus lourde que le liquide, pouvant être constituée par exemple par un solide ou un liquide, et une phase moins dense, les cellules 5 seront munies de fentes permettant l'évacuation séparée des deux phases ainsi décantées. En référence aux figures 10 et 11, deux exemples de réalisation de plaques comportant de telles cellules sont représentées. Chacune des cellules, qui présente soit une forme de losange (figure 10), soit une forme de parallélépipède (figure 11), montre une fente 16_a située dans sa partie supérieure et une fente 16_b située dans sa partie inférieure.

En référence aux figures 12, 14, 15, 17 et 18, des exemples de réalisation de plaques amont 11 sont représentés de face. Les plaques amont montrent des ouvertures 19 présentant une forme correspondant à la section des cellules 5 des plaques 4. Ainsi, la plaque amont 11 représentée à la figure 12 pourra être adaptée à l'extrémité d'entrée des plaques 4 représentées aux figures 4, 7 et 10. Les plaques amont représentées aux figures 14, 15, 17 et 18 pourront quant à elles être adaptées respectivement aux extrémités d'entrée des plaques 4 représentées aux figures 5, 11, 6 et 9.

Conformément à l'invention, les plaques aval seront munies d'ouvertures 20 de dimensions plus faibles que celles des plaques amont 11. La plaque aval 12 représentée à la figure 13 peut ainsi être utilisée pour être placée à l'extrémité de sortie des plaques 4 représentées aux figures 4, 7 et 10. La plaque aval représentée à la figure 16 peut quant à elle être utilisée avec les plaques 4 représentées aux figures 5, 8 et 11 tandis que la plaque représentée à la figure 19 peut être utilisée avec les plaques 4 représentées à la figure 8.

On notera que, lorsque les plaques présenteront une section transversale en forme de losange, ces plaques 4 pourront avantageusement être disposées en quinconce de façon telle que l'espace entre chacune de ces plaques 4, délimitant les zones d'évacuation 17, soit constant.

Les modes de réalisation ici décrits de l'invention n'ont pas pour objet de réduire la portée de celle-ci. En particulier, on notera qu'il pourra être envisagé de réaliser des plaques présentant des cellules de formes différentes que celles représentées aux figures 4 à 11, ainsi que des plaques amont et aval pourvues d'ouvertures montrant des tailles et des formes autres que celles décrites.

REVENDICATIONS

1. Séparateur lamellaire d'un mélange fluide en écoulement formé d'une phase principale liquide et d'au moins une phase secondaire liquide, solide ou gazeuse dispersée dans ladite phase principale et présentant une densité différente de celle-ci, caractérisé en ce qu'il comprend au moins un jeu de cellules (5) présentant un axe longitudinal essentiellement parallèle à l'axe d'écoulement dudit mélange, lesdites cellules (5) étant délimitées par au moins une paroi inclinée (15) par rapport à l'horizontale constituant un plan transversal de décantation de ladite phase secondaire et étant munies, essentiellement sur toute leur longueur, d'une fente (16) ou d'une lumière servant d'orifice d'évacuation de ladite phase secondaire hors desdites cellules (5) vers une zone d'évacuation (17) dans laquelle ladite phase secondaire s'écoule sans rencontrer un autre fluide en mouvement dudit mélange traité dans lesdites cellules.

2. Séparateur lamellaire selon la revendication 1 caractérisé en ce que ladite fente (16) ou ladite lumière possède au moins un bord en continuité avec ladite paroi inclinée (15),

3. Séparateur lamellaire selon la revendication 1 ou 2 caractérisé en ce que ladite phase secondaire est plus lourde que ladite phase principale et en ce que ladite fente ou ladite lumière (16) desdites cellules (5) est prévue dans la partie inférieure de celles-ci.

4. Séparateur lamellaire selon la revendication 1 ou 2 caractérisé en ce que ladite phase secondaire est de densité plus faible que la phase principale et en ce que ladite fente ou ladite lumière (16) desdites cellules (5) est prévue dans la partie supérieure de celles-ci.

5. Séparateur lamellaire selon l'une des revendications 1 à 4 caractérisé en ce que ledit mélange comprend une première phase secondaire plus lourde que ladite phase secondaire et une deuxième phase secondaire de densité plus faible que la phase secondaire et en ce que lesdites cellules (5) présentent au moins deux parois inclinées (15a, 15b) par rapport à l'horizontale et au moins deux fentes ou deux lumières (16a, 16b), l'une desdites fentes ou lumières étant prévue dans la partie supérieure desdites cellules (5) et l'autre étant prévue dans la partie inférieure de celles-ci.

6. Séparateur lamellaire selon l'une des revendications 1 à 5 caractérisé en ce que lesdites cellules (5) sont organisées en plaques (4) disposées essentiellement parallèles entre elles, chacune desdites plaques (4) étant constituée par la superposition verticale de plusieurs cellules (5), l'espace prévu entre lesdites plaques de décantation constituant la zone d'évacuation (17) de ladite phase secondaire.

7. Séparateur lamellaire selon l'une des revendications 1 à 6 caractérisé en ce que lesdites cellules (5) présentent une section transversale parallélépipédique.

8. Séparateur lamellaire selon la revendication 7 caractérisé en ce que lesdites cellules (5) présentent une section transversale en losange.

9. Séparateur lamellaire selon la revendication 8 caractérisé en ce que lesdites plaques (4) sont disposées en quinconce, de façon telle que ladite zone d'évacuation (17) entre deux plaques présente une section constante.

10. Séparateur lamellaire selon l'une des revendications 1 à 6 caractérisé en ce que lesdites cellules (5) présentent une section transversale en forme de chevrons.

11. Séparateur lamellaire selon l'une des revendications 1 à 10 caractérisé en ce qu'il comprend une plaque amont (11) et une plaque aval (12) disposées respectivement à l'entrée et à la sortie dudit séparateur essentiellement perpendiculairement à l'axe longitudinal desdites cellules, ladite plaque amont (11) présentant des ouvertures (19) de forme correspondant à la section transversale desdites cellules (5) et venant en regard de l'extrémité d'entrée de celles-ci, ladite plaque aval (12) présentant des ouvertures (20) formant diaphragmes venant en regard de l'extrémité de sortie desdites cellules (5).

12. Séparateur lamellaire selon la revendication 11 caractérisé en ce qu'il comprend au moins une plaque de renforcement présentant une structure sensiblement identique à celle de ladite plaque amont (11), ladite plaque de renforcement étant disposée essentiellement transversalement à l'axe longitudinal desdites cellules (5), lesdites cellules (5) traversant ladite plaque de renforcement.

13. Séparateur lamellaire selon l'une des revendications 1 à 12 caractérisé en ce qu'il comprend une zone amont (1) d'alimentation dudit mélange dans lesdites cellules (5), ladite zone amont (1) pouvant être à surface libre ou en charge et alimentant lesdites cellules (5) sous un angle de 0° à 90°.

14. Séparateur lamellaire selon l'une des revendications 1 à 13 caractérisé en ce qu'il comprend des moyens de collecte (9,10) de la phase principale à la sortie desdites cellules (5), lesdits moyens de collecte permettant d'assurer l'immersion permanente desdites cellules (5).

15. Séparateur lamellaire selon l'une des revendications 1, 2, 3 et 5 à 14, caractérisé en ce qu'il inclut une zone de collecte de boues munie d'un radier plat (7) ou incliné accueillant ladite phase secondaire, ledit radier (7) étant muni de moyens de soutirage de celle-ci choisis dans le groupe constitué par les racleurs, les suceurs et les vis d'extraction.

16. Séparateur lamellaire selon l'une des revendications 1 à 3 et 5 à 14 caractérisé en ce qu'il inclut une zone de collecte de boues (6) constituée d'une ou plusieurs trémies équipées de dispositifs de soutirage.

17. Installation pour le traitement des eaux résiduaires comprenant au moins certaines desdites unités suivantes : une unité de dessablage, un débourbeur, une unité de décantation, un clarificateur de boues biologiques, caractérisée en ce qu'elle inclut au moins un séparateur lamellaire selon l'une des revendications 3 et 6 à 16 constituant l'une desdites unités.

18. Installation pour le traitement des eaux résiduaires comprenant au moins une desdites unités suivantes : une unité de dessablage-déshuilage, un flottateur caractérisée en ce qu'elle inclut au moins un séparateur lamellaire selon l'une des revendications 5 à 16 constituant l'une desdites unités.

19. Installation pour le traitement des eaux résiduaires incluant au moins une unité de séparation des hydrocarbures contenus dans lesdites eaux caractérisé en ce qu'elle comprend au moins un séparateur lamellaire selon l'une des revendications 4 et 6 à 14 constituant ladite unité.

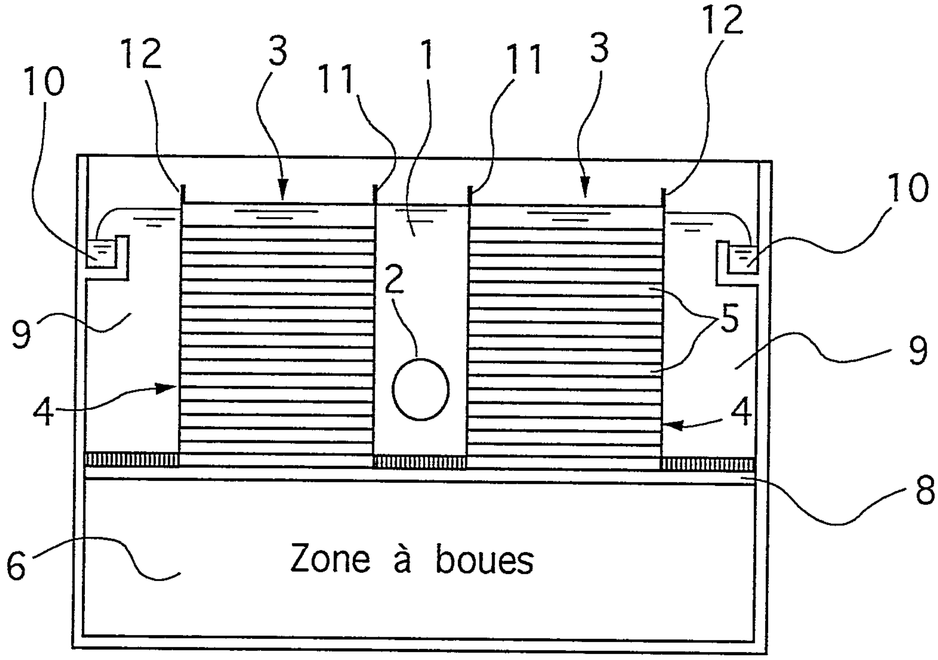


Fig. 1

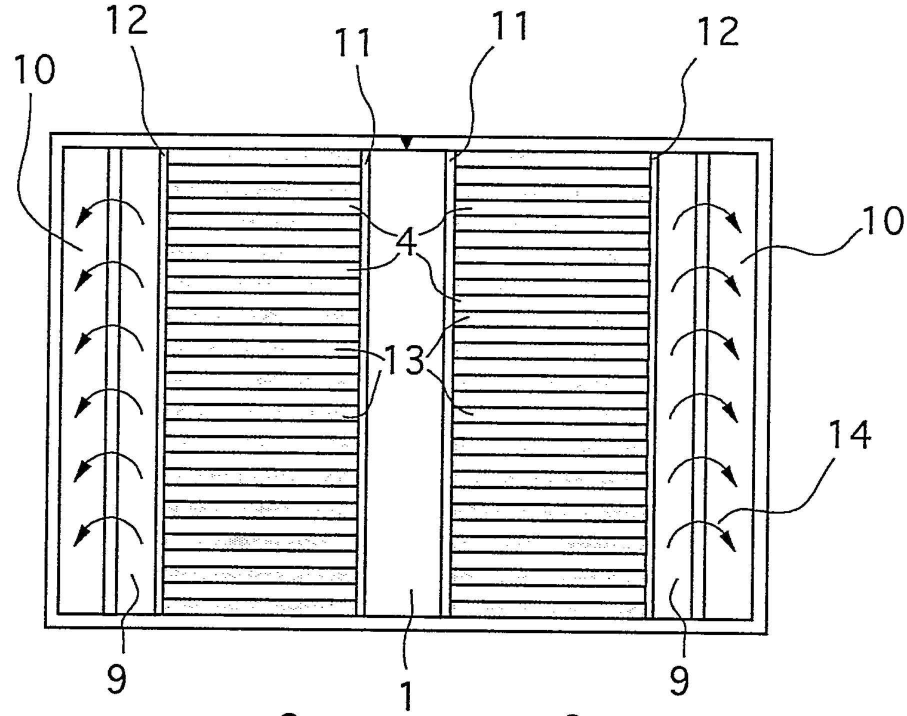


Fig. 2

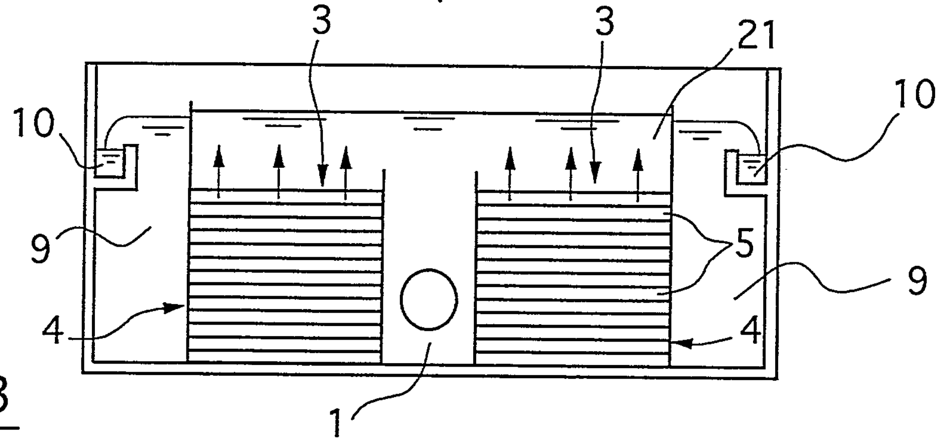


Fig. 3

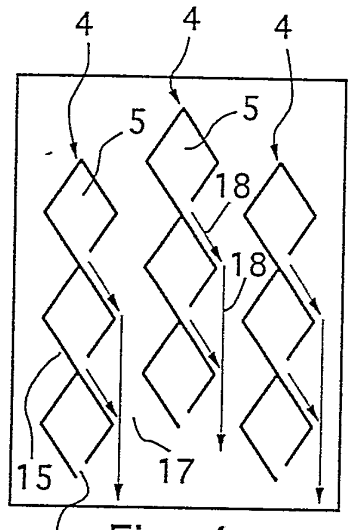


Fig. 4

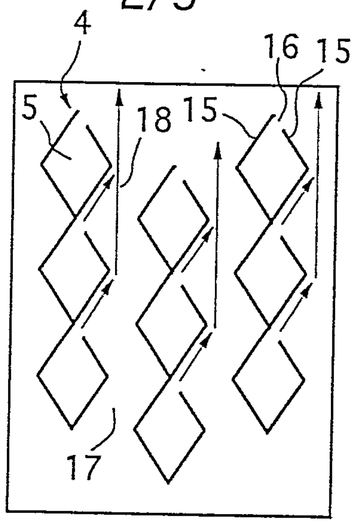


Fig. 7

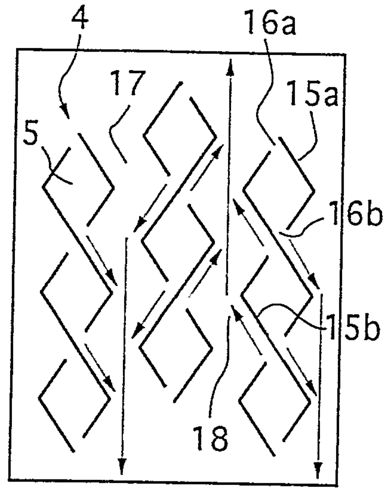


Fig. 10

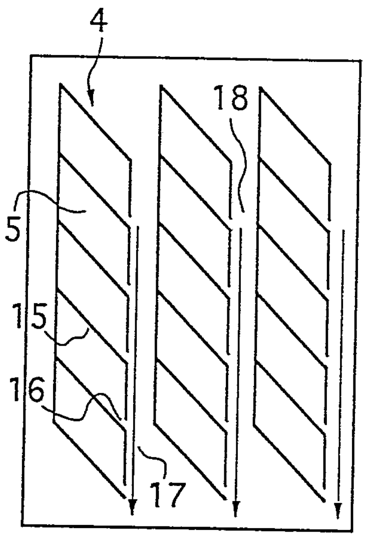


Fig. 5

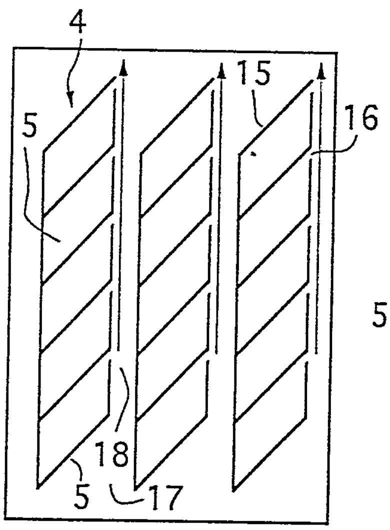


Fig. 8

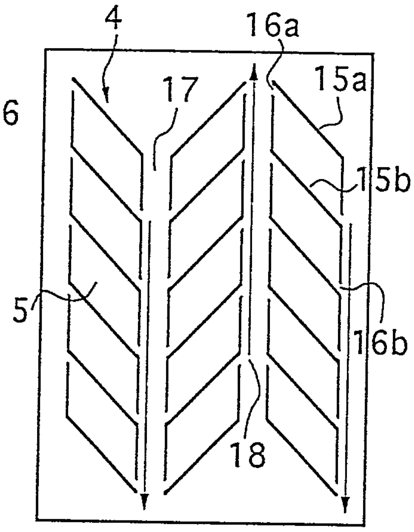


Fig. 11

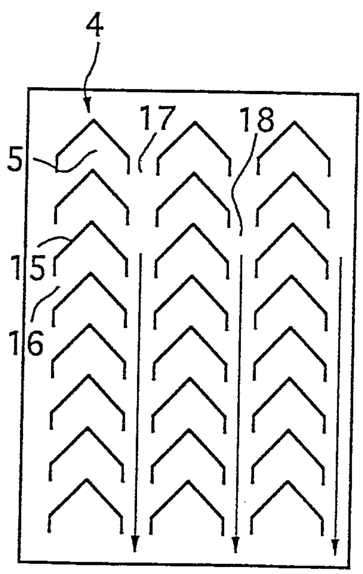


Fig. 6

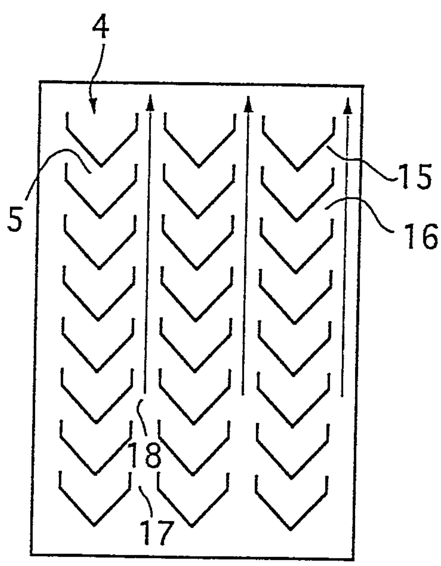


Fig. 9

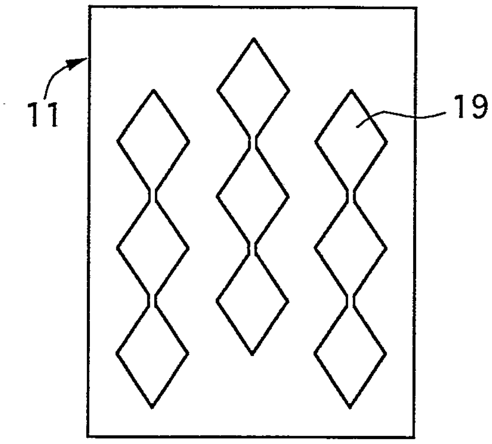


Fig. 12

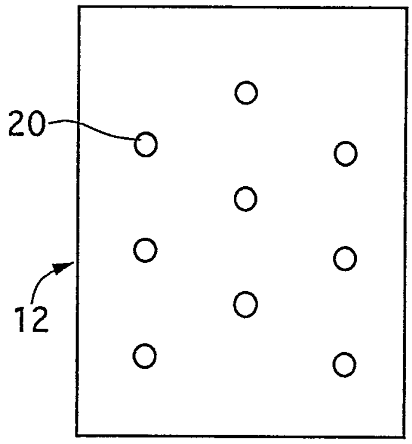


Fig. 13

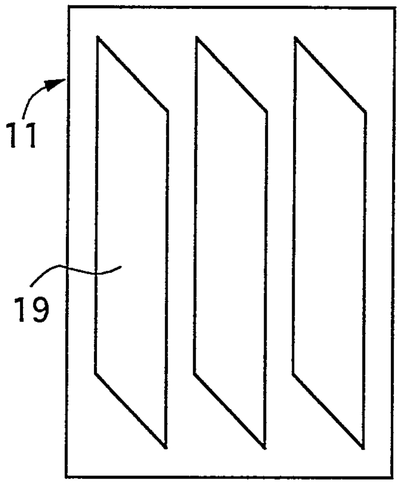


Fig. 14

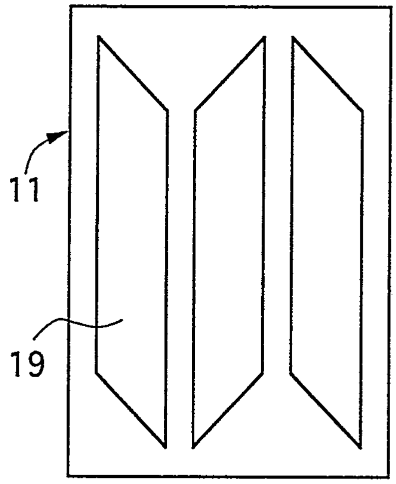


Fig. 15

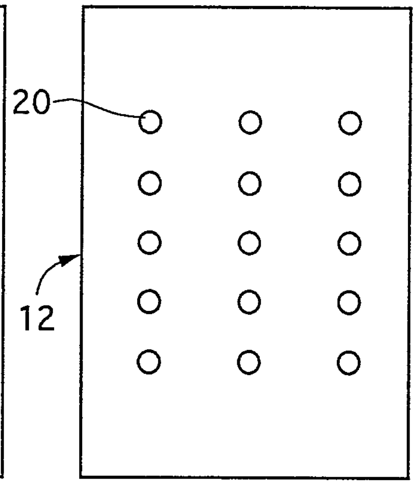


Fig. 16

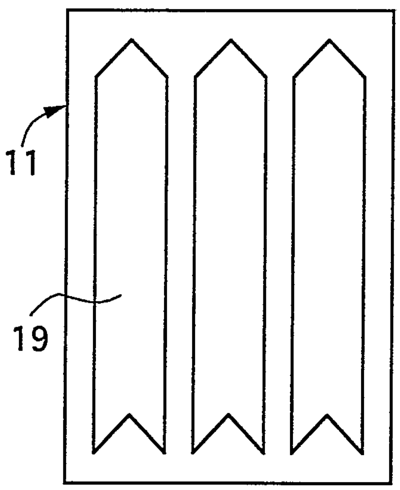


Fig. 17

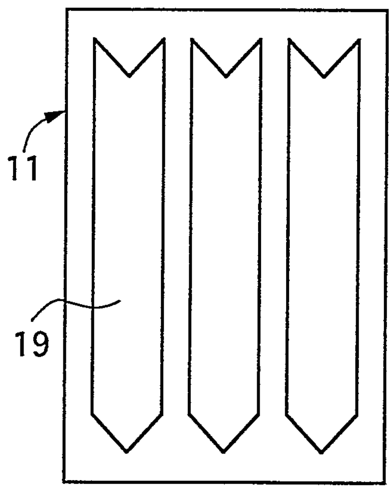


Fig. 18

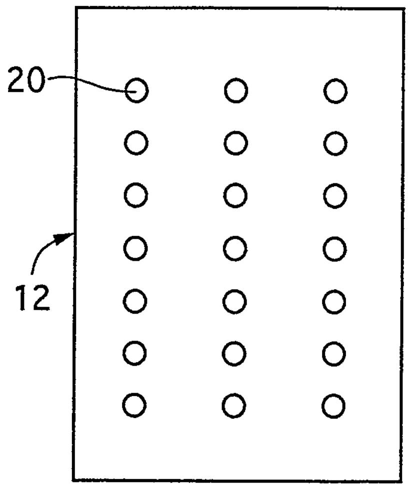


Fig. 19

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RAPPORT DE RECHERCHE PRELIMINAIRE

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FA 484240
FR 9305207

DOCUMENTS CONSIDERES COMME PERTINENTS

Catégorie	Citation du document avec indication, en cas de besoin, des parties pertinentes	Revendications concernées de la demande examinée
X	DE-A-20 52 640 (ERPAC, WASQUEHAL)	1-6,10, 13-19
Y	* page 1, alinéa 1; revendications 1-4; figures 1-5 * * page 4 *	11
Y	US-A-3 898 164 (HSIUNG)	11
A	* colonne 2, ligne 19 - ligne 31; figures 1,3 *	12
X	FR-A-2 588 483 (OMNIUM DE TRAITEMENTS ET DE VALORISATION) * abrégé *	1-6,10, 13-19
X	FR-A-1 028 282 (ETABLISSEMENTS NEYRPIC) * le document en entier *	1-6,10, 13-19
A	FR-A-2 099 372 (TADAO MOCHIZUKI) * figures *	1-19
A	DE-C-89 701 (SOLVAY & CIE) * le document en entier *	1-19
A	DE-A-25 51 623 (WILMS GMBH)	1-19

DOMAINES TECHNIQUES RECHERCHES (Int.Cl.5)

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Date d'achèvement de la recherche	Examinateur
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(54) **METHOD AND APPARATUS FOR OIL WATER SEPARATION**

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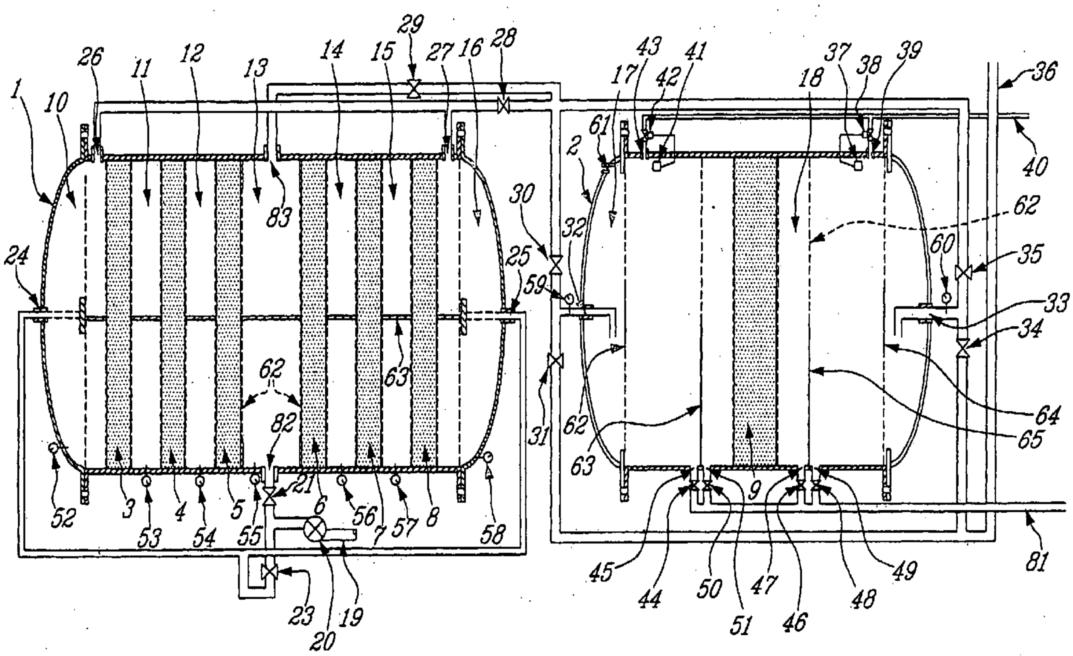
(57) **ABSTRACT**

A method and apparatus for separating immiscible liquids in a dispersion containing an aqueous liquid and at least one dispersed non-aqueous liquid by passing the dispersion through a series of absorbents, preferably polymeric. The direction of the flow through the absorbent is radically changed. The period required before a change of the flow direction is established by the differential pressure. There is a gradual increase in the differential pressure across the absorbents which indicates a blockage due to viscous oil and/or solids. The product produced by the method and the apparatus of the invention is a polished non-aqueous phase and a polished aqueous phase both having low contaminant levels. In a preferred embodiment when solids are also present in the dispersion, a solids stream is also recovered.



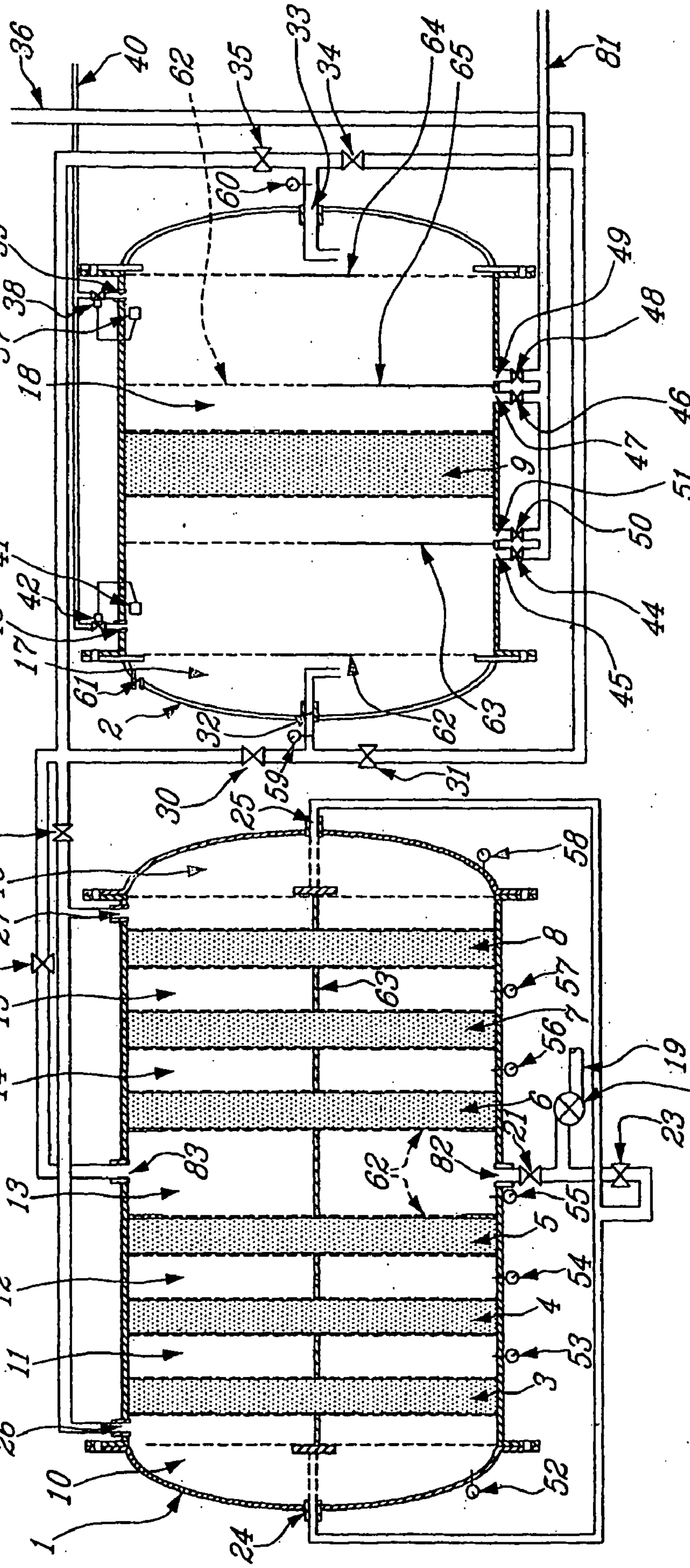


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Fig-1

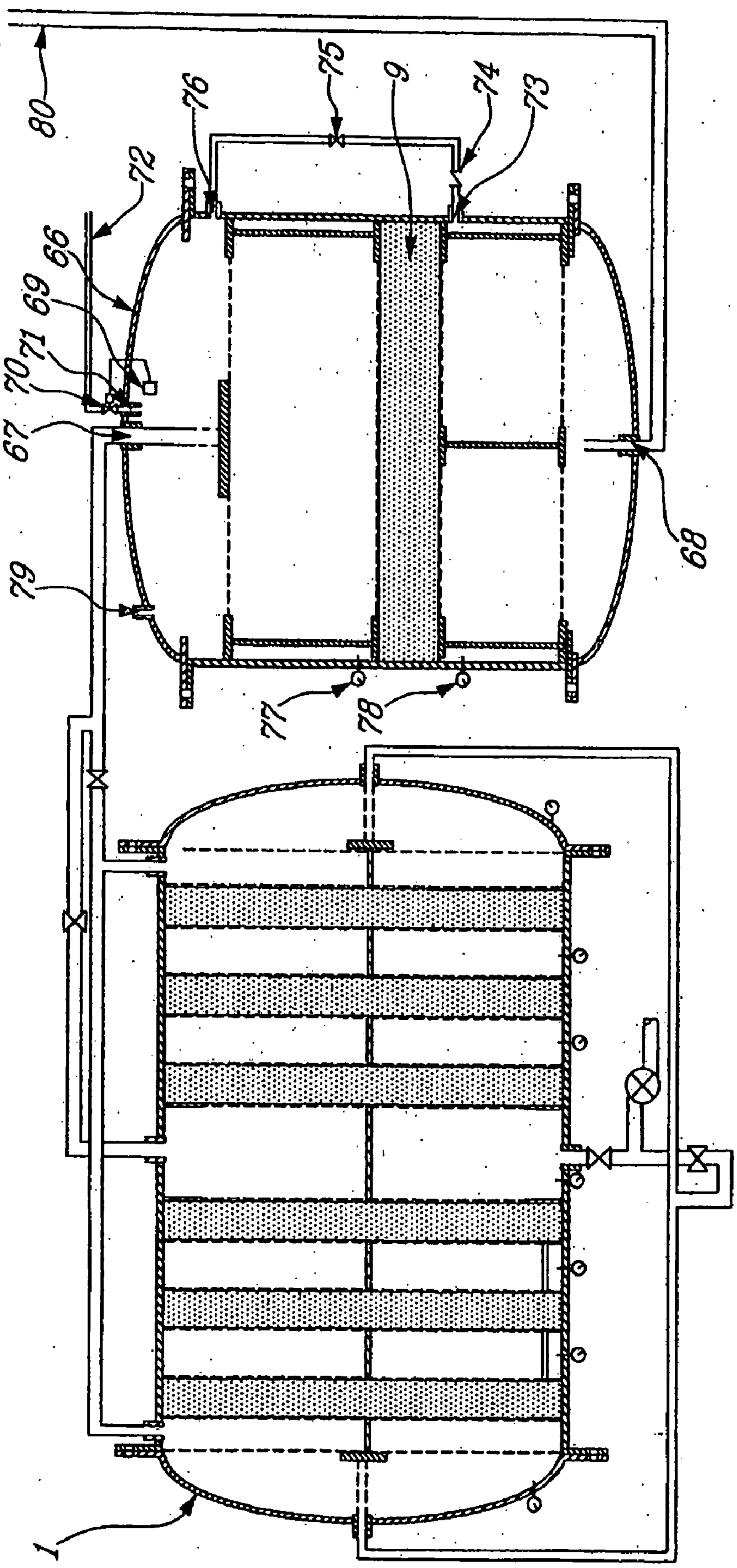

Fig-2

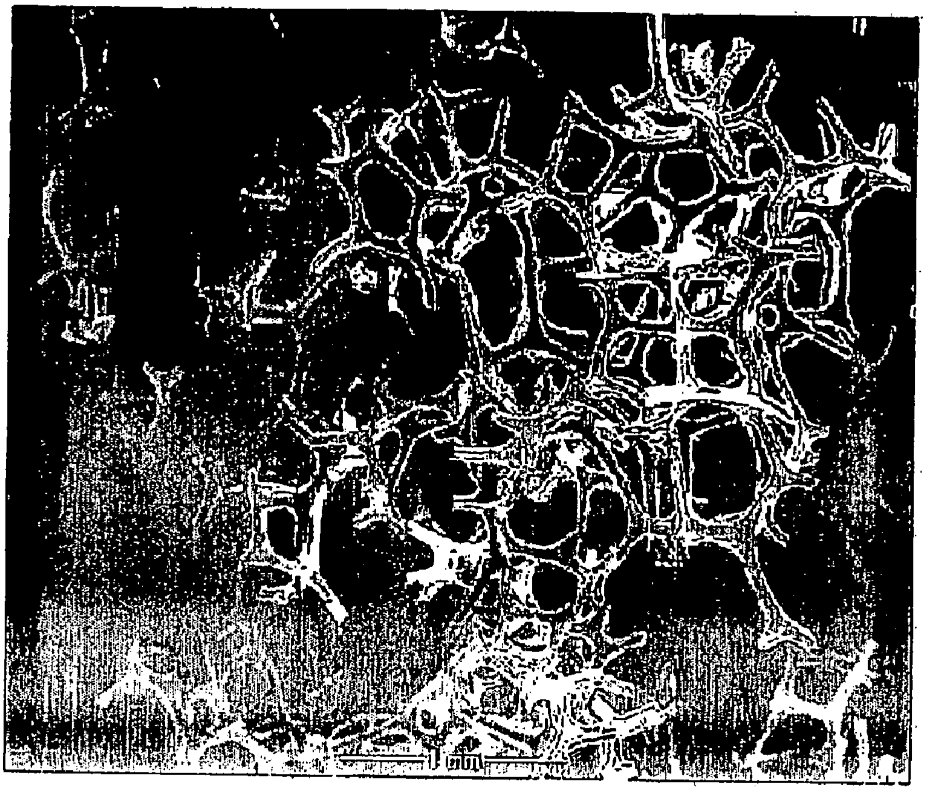

Fig-3

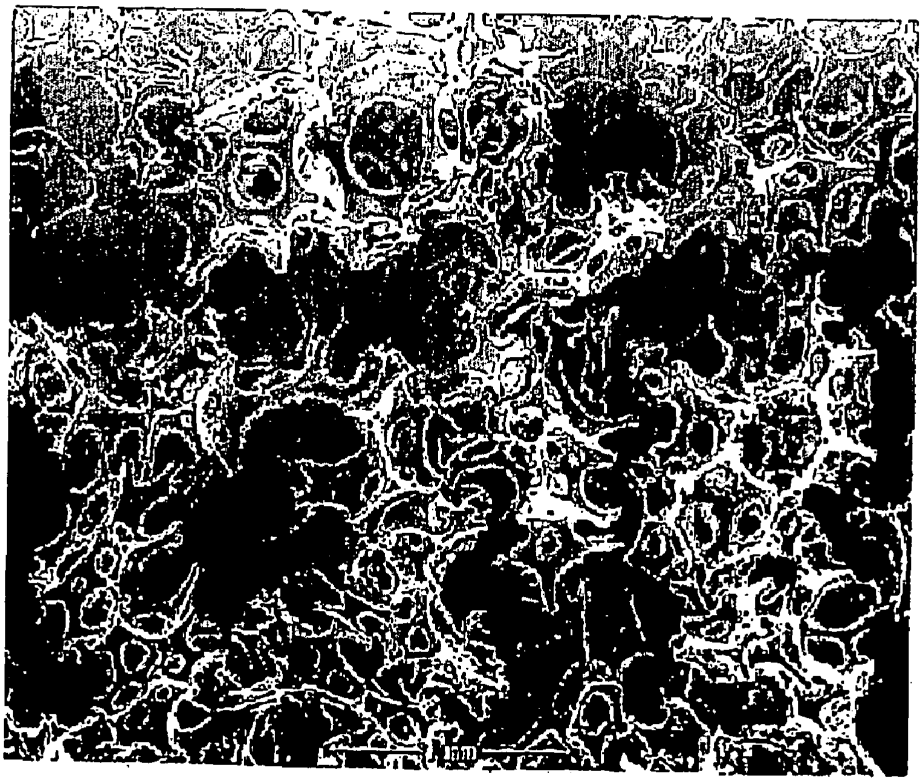

Fig-4

METHOD AND APPARATUS FOR OIL WATER SEPARATION

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] This invention relates to a method and apparatus for separation of two immiscible liquids, one aqueous and the other non-aqueous, such as water and oil, where one liquid is highly emulsified in the other.

[0003] 2. Description of Prior Art

[0004] Oily water is generated at many points during oil production, for example, at the wellhead, several barrels of oily water are generated for every barrel of oil produced. This oily water, also called produced water, must be treated to obtain acceptable levels of oil-in-water before re-injection into the well or disposal, i.e. into the ocean. Ballast and bilge waters also represents a big challenge because of the strict regulations with respect to disposing of such effluents. In the Great Lakes in North America, the bilge water must attain levels below 5 mg/l of total oil & grease before disposal. Oil spills and contaminated groundwater can generate high volumes of oily water which must be treated before disposal. Furthermore, most industries generate varying amounts of oily water, the quantity of which depends on their production rate and process. This industrially produced oily water must be treated to reduce the fouling of instruments and equipment, to minimize interference with other processes and to reduce oil accumulation in unwanted areas thereby minimizing hazards.

[0005] The treatment of oily water can be achieved by several well-known and accepted techniques. However, each technique has limitations which depend on the characteristics of the oily water to be treated. Most of the processes of the prior art use Stoke's Law as a basis for design.

[0006] Stoke's Law explains that the rising velocity of an emulsion particle (such as oil) in a continuous phase (water) is proportional to the square of the diameter of the emulsion particle. Therefore, by doubling the diameter of a given emulsion particle, the particle's rising velocity is multiplied by four, and thus, the time required for the droplet to rise to a collection surface is also reduced. As the emulsion particles get smaller, a random molecular motion called Brownian movement, tends to keep the emulsion particles in suspension. Through random molecular collisions of the surrounding aqueous phase with the finely dispersed emulsion particles, the effect of gravity on the emulsion particles tends to be suppressed, so that settling is slowed or completely halted.

[0007] One of the most widely used systems to treat oily water is an oil/water separator, such as the API (American Petroleum Institute) separator, which can remove free-floating oil but cannot separate fine emulsions (particles less than 150 μm in diameter). Other well-known and widely used systems are corrugated plates interceptors and parallel plates interceptors, which are limited to oil emulsions where particle sizes are 30 μm or larger. The removal of oil emulsions where the diameter of the particles is less than 20 μm is very difficult, because in many cases they make up a high proportion of the total oil content, and it is impossible to reduce the level in the discharge to the permissible levels with conventional equipment. To enhance the rising velocity of such emulsions, other techniques are used, like coagulation/flocculation followed by a gravity separation system. In this process, chemicals are used to destabilize and coalesce the emulsions in order to make them larger, and easier to separate from the water. Coagulation/flocculation processes produce an oil contaminated with expensive chemicals.

[0008] Filtration-like separation processes are another category of oil removal processes, that are effective in removing very fine emulsions (diameter of 2 μm or more) as described by Benachenhou in WO/02/20115. Several media materials are used alone or together The most commonly used media are polymeric materials, however sand, anthracite, and clay have also been used as separation media. When sand, anthracite and clay are used they are produced with a particular form or shape. These filtration technologies are also limited, because of their sensitivity to the presence of viscous oils and/or suspended solids. It is not unusual that the materials used as a separation media become clogged with highly viscous oils or with suspended solids within 24 hours of operation, thus requiring replacement of the filtration media or backwashing with fresh or treated water, which results in even more oily wastes or more contaminated backwash liquids.

[0009] Additional patents of some background interest are the following: U.S. Pat. No. 3,738,492; U.S. Pat. No. 4,022,694 ; U.S. Pat. No. 4,213,863; U.S. Pat. No. 6,015, 502; GB. 1418,806; GB 1,517,715

SUMMARY OF THE INVENTION

[0010] It is an object of this invention to provide a method and apparatus for separating an immiscible liquid in a dispersion containing an aqueous liquid and at least one dispersed non-aqueous liquid.

[0011] It is a particular object of the invention to provide a coalescing media which separates immiscible liquids in dispersion.

[0012] In accordance with one embodiment of the invention there is provided a method of separating immiscible liquids in a dispersion comprising an aqueous liquid and at least one non-aqueous liquid immiscible in the aqueous liquid and wherein the non-aqueous liquid is dispersed in the aqueous liquid, comprising: a) feeding the dispersion from a feed supply to a chamber housing a plurality of coalescing zones, in a first direction through the, zones from an initial upstream zone to a final downstream zone; b) partially coalescing the dispersed non-aqueous liquid in said coalescing zones; c) recovering a partially coalesced emulsion of said liquids, downstream of said final downstream zone, and d) periodically discontinuing the feeding in said first direction and feeding said emulsion in a second direction, counter to said first direction, such that said final downstream zone of a) becomes a second direction initial upstream zone and said initial upstream zone of a) becomes a second direction final downstream zone.

[0013] In another embodiment of the invention there is provided an apparatus for separating immiscible liquids in a dispersion comprising an aqueous liquid and at least one non-aqueous liquid immiscible in the aqueous liquid and wherein the non-aqueous liquid is dispersed in the aqueous liquid, comprising: a primary vessel including; an inlet means through which the dispersion enters the vessel and producing a flow within the vessel in a first direction; an outlet means through which a partially coalesced emulsion leaves the vessel; a plurality of coalescing compartments which contain a coalescing media on which the dispersed non-aqueous liquid partially coalesces to produce the partially coalesced emulsion; the compartments including a first direction upstream compartment and a first direction last downstream: compartment; a flow direction changing means acting on the inlet means and the outlet means for periodically changing the flow within the vessel to a second direction counter to the first direction, such that said first direction Upstream compartment becomes a second direction last downstream compartment and said first direction last downstream compartment becomes a second direction upstream compartment.

[0014] In a particular embodiment of the invention there is provided in an apparatus for separating immiscible liquids in a dispersion comprising an aqueous liquid and at least one non-aqueous liquid immiscible in the aqueous liquid and wherein the non-aqueous liquid is dispersed in the aqueous liquid and a polymeric coalescing media is used for separating the liquids in the dispersion by passing the dispersion through the coalescing media, the improvement wherein the coalescing media includes a substantially homogeneous porous mass, the porous mass including a network of fine filaments and substantially uniform sized open cells in the filaments, wherein the coalescing media can separate non-aqueous emulsions from the aqueous phase having a droplet diameter of at least 0.5 μm.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0015] This invention seeks to overcome the difficulties described above and provides a method and apparatus which will separate oil in water emulsions which may contain viscous oils; or solids, and have emulsion particle size diameters as small as 0.5 μm, quickly with a separation performance relatively unaffected by the level of solids, and which will provide the non-aqueous phase in a recoverable form.

[0016] The coalescing media may, in particular, be an absorbent or adsorbent material. Absorbent or adsorbent materials which have relatively low absorption or adsorbent ability or capacity, such that coalesced droplets are readily released from the material are especially advantageous in the invention.

[0017] The mass of the dispersion is allowed to flow directly through the absorbent material, with the bulk of the dispersion flowing through an extensive network of passages between the filaments and through the pores in the filaments. The absorbent preferably has a limited capacity that traps the dispersed oil droplets due to its affinity for them but also allows coalesced droplets to be released. Due to this valuable property, the absorbent is also an effective coalescing media. When the oily dispersion of fine droplets is passed through this coalescing media, some of the oil droplets will be trapped within the pores of the absorbent due to their attraction for the absorbent. Here the non-aqueous droplets will be held until others find their way into the pores, and as more enter they will eventually produce droplets that are sufficiently close to one another to coalesce. This process will continue until the pores are relatively full and the larger droplets will be forced out by the flow of the liquid and their willingness to start rising. The relatively uniform nature of the absorbent pores makes for the release of a substantially uniform size droplet.

[0018] Throughout the specification the terms oil, fuel and hydrocarbon are defined as a class of liquids which are not very soluble in water, and thus are essentially immiscible. Furthermore, the term non-aqueous is used to describe a liquid which is not water.

[0019] In one embodiment, the coalescing media of the invention has a high surface area, a substantially homogeneous porous mass, which is normally a polymeric matrix such as polyester, polystyrene, polypropylene and polyethylene, most preferably polyurethane, which has the ability to absorb/adsorb fine oil emulsions within or on its relatively uniform and fibrous network structure. The physical separation phenomenon on the polymeric matrix that produces the coalescence of the oil droplets and the separation of the aqueous and non-aqueous phases on the polymer, is a complex phenomenon and is likely to be a combination of absorption and adsorption followed by the coalescence of the small non-aqueous phase droplets, into larger droplets.

[0020] Throughout the disclosure the following terms are defined as synonyms:

[0021] 1) absorption=adsorption; 2) absorbent=sorbent=coalescing media(nouns); 3) absorbent=adsorbent(adjectives), and 4) absorb=adsorb(verbs).

[0022] Emulsions with droplets as small as 0.5 μm are separated by the method and in the apparatus of the invention. The emulsions coalesce within the network structure of the absorbent into larger droplets and are then released in a recoverable form, producing:

[0023] a polished aqueous phase containing an acceptable level of a non-aqueous phase, and

[0024] a polished non-aqueous phase containing an acceptable level of the aqueous-phase.

BRIEF DESCRIPTION OF DRAWINGS

[0025] **FIG. 1** is a schematic representation of the apparatus of the invention with a plurality of vertical absorbent compartments, and the primary and polishing vessels having a horizontal aspect;

[0026] **FIG. 2** is a schematic representation of apparatus of the invention with a plurality of vertical absorbent compartments, and a primary vessel having a horizontal aspect and polishing vessels having a vertical aspect and a horizontal absorbent compartment;

[0027] **FIG. 3** is a scanning electron micrograph (x30) showing the structure of the polyurethane polymeric absorbent of the invention, and,

[0028] **FIG. 4** is the scanning electron micrograph x30) of the polyurethane polymeric absorbent of Application WO/02/20 115.

DESCRIPTION WITH REFERENCE TO DRAWINGS

[0029] Polyurethanes are polymers which contain urethane groups. They are synthesized from a polyol and a diisocyanate, following the general scheme:

$$HO—R_1—OH+OCN—R_2—CNO \rightarrow OCN—R_1—[—NH—COO—R_1—OOC—NH—R_2—]_n—NCO$$

Polyol diisocyanate polyurethane in which R_1 and R_2 may be selected from a wide variety of aliphatic and aromatic radicals, as is well known in the polyurethane art.

[0030] Because of a variety of diisocyanates and a wide range of polyols that can be used to produce polyurethane, a broad spectrum of materials can be produced to meet the needs of specific applications. **FIGS. 3 and 4**, are Scanning Electron Microscopy (SEM) micrographs of two polyurethanes: A preferred absorbent material or coalescing media of the invention, is reusable oil de-emulsifier sorbent (RODS); and an absorbent material used in the process described in WO/02/20115, or recovered petroleum absorbent (RPA).

[0031] As with other polymers (polyester, polypropylene, etc.), polyurethaned materials are known to absorb and/or adsorb chemical compounds. Most oils, and fuels such as gasoline, are successfully absorbed by industrial absorbents which include polyurethanes.

[0032] The affinity of polyurethanes for the targeted chemical compound depends on the properties of the material, which include their chemical structure and that of their functional groups. Their absorption capability is due to the presence of ester (or ether) groups —COO— that are lipohilic, that is, have an affinity for oleophilic compounds such as petroleum hydrocarbons. Ester groups in the backbone of the polymer are also known to be highly hydrophobic. For these reasons polyurethanes are very useful materials for absorption when used as an oil/water separation media.

[0033] This absorption/adsorption by the polyurethane involves the accumulation of the targeted chemical compound at the interface or within the coalescing media. The accumulation of oil per unit area is small, thus highly porous materials with a very large internal surface area per unit volume preferred. The surfaces are usually irregular (as seen in **FIG. 4**), and the bonding energies (primarily from Van Der Waals forces) vary widely from one site to another. However, the adsorption/absorption surfaces and pores are provided by channels or cavities within a macro crystal structure; the cavities exhibit high uniformity of adsorbent surface (as shown in **FIG. 3**) with practically constant binding energy.

[0034] The following data, seen in **FIGS. 3 and 4**, was obtained by Scanning Electron Microscopy (SEM) micrographs; the cell wall thickness of the preferred polyurethane of the invention typically is from 40 to 55 μm (**FIG. 3**), as compared to a thickness between 60 and 80 μm (**FIG. 4**). The cell openings of the preferred polyurethane of the invention are quite regular in size while the cell openings of the polyurethane of **FIG. 4**, vary substantially.

[0035] The coalescing media, which is also called rods, is a reticulated fully open pore, flexible ester or ether type polyurethane foam. Unlike ordinary urethane foams, it is characterized by a totally open three-dimensional skeletal structure of strands which in an uncompressed form, provides up to 98% void space and a very high degree of permeability, which gives it special coalescing and filtering properties. The rods tend to have a preferred physical size between 1.5 and 2.0 but larger (5-10 mm) and smaller rods (approximately 1 mm) have been used successfully.

[0036] Some of the physical properties of the coalescing media of the invention include a totally open skeletal structure which is both flexile and resilient, a high surface area (2300 ft^3/ft^3) along with high void volume and a controlled pore size of 100 pores per linear inch (100 ppi) with a range from 65 to 125 ppi, and a particularly preferred range of 80 to 100 ppi.

[0037] The homogeneous structure of the coalescing media helps minimize the possibility of open channels which could drastically affect separation efficiency. Each cell in the media is completely interconnected with all surrounding cells. This allow for free passage of liquids (and thus low pressure drops) and at the same time provides high surface-area contact for coalescing emulsion particles. The resilience and strength of the foam helps prevent strand displacement under normal operating conditions. The structure of the coalescing media has an absorption or adsorbent character effective to trap dispersed non-aqueous droplets for coalescence, and readily release coalesced droplets of the non-aqueous liquid.

[0038] The principal physical property differences between the preferred absorbent of the invention and that of the prior art (WO 02/20115), are the percentage void space and the homogeneity of the porous mass. The preferred absorbent has at least one of the properties listed in Table 1 and preferably a plurality of properties listed in Table 1.

[0039] Table 1 presents a comparison of the properties of the preferred absorbent of the invention and the sorbent of WO 02/20115.

TABLE 1

Physical Property	unit	Test Method	Sorbent of the Invention (preferred range in brackets)	Prior Art Sorbent WO 02/20115
pores/linear inch (ppi)		ASTM D3574	65 to 120 (80 to 100)	Irregular pore sizes
Compressed density	lbs/ft^3	ASTM D3574	2.5 to 19	8
Non-Compressed density	lbs/ft^3	ASTM C29/ C29M	Avg. 1.9 (1.5–2.5)	1.9
tensile strength	kPa	ISO 1798	240 (100–240)	415
tear strength	N/mm	ISO 8067	0.7	3.5
Elongation at Break	%	ISO 1798	415% (190%–500%)	50%
Cell wall thickness	μm	Scanning Electron Microscopy (SEM)	(40–55)	60–80
Cell Diameter	μm	Scanning Electron Microscopy (SEM)	(160–220)	Irregular
Particle size of the bulk sorbent	mm		0.5–10 (1.5–2.0)	2.0–10
Void Space	%	ASTM C1252	typical 97% (80% to 98%)	30%
Void space (after compression to 900 ppi)	%	ASTM C1252	typical 70% (60% to 80%)	20%

[0040] The physical property information helps to explain the greater selectivity for smaller oil dispersion particles and their greater resolution and retention on the preferred polyurethane of this invention, which is able to retain 0.5 μm diameter emulsions or more, while the smallest size of oil dispersions separated with materials of the prior art, varies from 1.5 to 2 μm in diameter.

[0041] The coalescing media can also be compressed between 600 to 1000 pores per inch, by compressing the standard media (65-120 ppi) through a compression ratio of as much as 10. By varying the compression conditions, the ratio of initial foam thickness (initial ppi) to final thickness, the coalescing media can be given specific design properties. The compression ratio exerted on the coalescing media can be optimized for the separation of particular oils having different densities, viscosities and dispersion particle sizes.

SUMMARY OF PREFERRED EMBODIMENTS

[0042] The preferred embodiment of the invention, as represented in **FIG. 1**, comprises a first cylindrical vessel **1** and a second polishing vessel **2**. The vessels of the invention are adapted for a continuous or discontinuous operating mode for treating a fluid stream containing a dispersion including an aqueous-phase and a non-aqueous-phase which contains non-aqueous organic compounds wherein one phase is dispersed in the other. The dispersion may also include solid particles.

[0043] The first vessel includes inlet port **82** located at the center of the lower wall of the vessel and inlets ports on each side, **24** and **25**. Outlet ports are positioned near the top of the vessel, outlet port **83** in the center with outlet ports **26** and **27** at opposite ends. The vessel is divided in several compartments, with a sequence of liquid compartments followed by oil coalescing compartments. The oil coalescing compartments are each filled with a layer of polymeric coalescing media. In **FIG. 1**, seven liquid compartments **10**, **11**, **12**, **13**, **14**, **15** and **16**, and six layers or zones of the absorbent **3**, **4**, **5**, **6**, **7** and **8** are represented, however the number of compartments can vary depending on the characteristics of the fluid stream to be treated. Each liquid compartment is made by joining two parallel perforated plates **62** by a series of supports **63** which are joined to the perforated plates. Various types of screens partitions and support means can be envisaged to replace plates **62** and supports **63**.

[0044] The fluid stream to be treated is introduced via a feed pipe **19**, to a feed pump **20**. The pumped fluid stream, or feed supply, is directed to the inlet port **82** by opening the valve **21**, with valve **23** remaining closed. Valve **29** in outlet **83** is maintained closed, with valve **28** connected to the outlet ports **26** and **27** at opposite ends of the vessel left open. The fluid enters a central liquid compartment **13** and is distributed horizontally to both sides of the vessel **1**. The fluid stream passes through the layers or zones of absorbent **5** and **6**, where the non-aqueous phase of the emulsion coalesces into larger droplets. The differential pressure will be measured and controlled, with the layers slowly becoming saturated, they will coalesce the non-aqueous phase of the emulsion and will release larger droplets. The larger droplets due to their higher rising velocity float to the top of the liquid compartments **12** and **14**, while the fluid stream still containing smaller droplets will pass through the downstream polymeric absorbents **4** and **7** where the smaller droplets will be coalesced into larger droplets. As the layers of absorbent **4** and **7** slowly become saturated, they will continue to coalesce the non-aqueous phase of the emulsion and will also release larger droplets. These larger droplets due to their higher rising velocity will float to the top of the liquid compartments **11** and **15**, and the fluid stream containing even fewer emulsion droplets will pass through the zones of absorbent **3** and **8** where they too will be coalesced to larger droplets which will float to the top of the liquid compartments **10** and **16**. The result is a partially coalesced emulsion which is a mixture of the continuous-aqueous-phase containing non-aqueous phase droplets and the free-floating larger droplets of the non-aqueous-phase and is collected through the outlet ports **26** and **27**, and directed to the second cylindrical polishing vessel **2**.

[0045] With time there a gradual blockage of the absorbent zones, which is indicated by an increase in the differential pressure across the various compartments in vessel **1**. If solids are present in the inlet fluid stream dispersion, the increase in the differential pressure may be quite dramatic. This increase may be due to a highly viscous oil layer formation or the clogging by solid particles in the polymeric absorbent layers adjacent to the central liquid compartment **13**. The differential pressure is measured between pressure gauges **55** and **54** and/or pressure gauges **55** and **56** which will be monitored through a controller.

[0046] When a specified pressure differential across the layers of the absorbent **5** and/or **6** in vessel **1** is reached, the fluid flow into vessel **1** is changed, by opening valves **23** and **29** and by closing valves **21** and **28**. This change in the flow direction, causes the fluid stream to be directed through the first vessel via the inlet ports **24** and **25**, located at each end-side of the vessel. The flow of fluid into the vessel will be split, and enter from both ends of vessel **1**, through the absorbent layers **3**, **4** and **5** consecutively, and the absorbent layers **8**, **7** and **6** consecutively. In changing the flow direction, absorbent layers **5** and **6** which where the upstream or first treatment zones, become the downstream or final treatment zones, and zones **3** and **8** which were the downstream or last absorbent zones become the upstream or first zones.

[0047] It must be noted that although the differential pressure can be used as the means of determining when the flow direction towards the vessel should be changed, in the preferred embodiment this change is based on the time required to reach this blockage. If the primary vessel becomes blocked under normal circumstances after 1 day, the flow direction can be changed every 12 hours so that more consistent operations are maintained.

[0048] In a similar way to that previously described, absorbent zones coalesce the non-aqueous phase droplets and the free-floating non-aqueous phase droplets float to the top of the liquid compartments **10**, **11**, **12**, **16**, **15** and **14** and the absorbent layers **5**, **6** which were clogged with viscous oil or solid particles will be washed out by the flow of the fluid stream in the opposite direction. The resulting mixture of treated aqueous-phase, the free-floating non-aqueous phase and the enlarged solid particles is collected in the central liquid compartment **13** and directed via the outlet port **83** to vessel **2**. The outlets from the first vessel are oversized so that the liquid velocity within the outlets **26**, **27**, **83** towards the polishing vessel **2** is maintained at a low speed, to minimize the re-dispersion of the emulsion back to a highly dispersed form.

[0049] Once again the pressure differential will increase. After a certain time period has elapsed or when a given pressure drop across absorbent layers **3** and/or **8** of vessel **1** is reached, the fluid stream direction is reversed again, by opening valves **21** and **28** and by closing valves **23** and **27** and the same process of changing the direction of flow is repeated every time a particular pressure drop across the absorbent layers **5** and/or **6** or **3** and/or **8** is reached. The particular pressure selected is likely to be based on the type of pump **20** used to feed the dispersion to the vessel **1**. If a centrifugal pump is used, as the differential pressure across the polymeric absorbent increases, the flowrate of the pump will decrease, and if the flow is not changed while still well within the range of the centrifugal pump, the pump will overheat and may fail. Pumps capable of withstanding reasonable pressure variation are used.

[**0050**] It should be noted, that at steady operations of the apparatus, the time period required before the blockage of the absorbent occurs will be relatively uniform. The reversal of the flow direction through the absorbent zones, will be done automatically on a timed basis, well before the absorbent zones become blocked, with the differential pressure instruments still monitoring the pressure change in case an unexpected blockage occurs, and the flow direction must be changed unexpectedly due to a process upset.

[**0051**] The flow of the partially coalesced emulsion from vessel **1** is directed towards a second polishing vessel **2**. The second cylindrical pressure vessel **2** has two ports, **32** and **33**, one port on each of its sides. One of the ports will act as the inlet while the other serving as an outlet. The vessel is divided in three compartments: a liquid compartment **17**; a polishing polymeric compartment containing layer of the polymeric absorbent **9**, the sorbent is the same as that found in vessel **1**; and finally another liquid compartment **18**. Each liquid compartment is made by joining two parallel perforated plates **62** to supports **63** in a similar manner as in vessel **1**.

[**0052**] The outlet flow of partially coalesced emulsion, from the vessel **1**, is directed to vessel **2** via the inlet **32** by opening valves **30** and **34** and by closing valves **31** and **35**. The free-floating big droplets of the non-aqueous-phase will float to the top of the liquid compartment **17** due to their high rising velocity, pass through the top absorbent layer **9**, whereas the solid particles that were enlarged in vessel **1** will settle to the bottom of the liquid compartment **17**. If solids are present, they will be collected periodically, from outlets **45** and **51**, by actuating valves **44** and **50**. The polishing vessel **2** also has baffles **62**, **63**, **64** and **65** associated with the perforated plates which are designed to trap the settling solids in the polishing vessel **2**.

[**0053**] The emulsified non-aqueous-phase liquid still remaining in the aqueous-phase liquid will be coalesced into larger droplets in the absorbent layer **9**. Larger droplets of the non-aqueous-phase liquid will float to the top of the liquid compartment **18** and the polished aqueous phase with acceptable levels of the non-aqueous-phase will leave vessel **2** through outlet port **33**, and the clean water pipe **36**. When a certain thickness of free-floating polished non-aqueous phase oil is formed at the top of the liquid compartment **18**, a detector **37** will open an automatic valve **38** and the free-floating oil will be collected and recovered via the oil outlet port **39** and the oil pipe **40**.

[**0054**] When a certain time period has gone by or a given pressure drop across the layer of the absorbent **9** of vessel **2** is attained, as measured by the differential of pressure gauges **59** and **60**, due once again to highly viscous oil and/or solid particles in the layer of polishing absorbent, the inlet stream will be changed and the direction of flow reversed, by opening valves **35** and **31** and closing valves **30** and **34**. By reversing the flow direction, the inlet mixture stream is directed to vessel **2** via the inlet port **33**. The mixture stream will pass horizontally from right to left through the polishing polymeric absorbent layer **9**. The free-floating big droplets of the non-aqueous-phase will float to the top of the liquid compartment **18** due to their high rising velocity, pass through the top absorbent layer **9**. If solids are present, the solid particles which were enlarged in vessel **1** will settle to the bottom of compartment **18** from where the solids will be periodically collected through outlet ports **49** and **47**, by opening valves **48** and **46**. Nozzle **61** is closed with a plug during operation, but is used to purge air from the polishing vessel during the start-up and stoppage.

[**0055**] The emulsified non-aqueous-phase liquid still remaining in the aqueous-phase liquid will be coalesced into-larger droplets in the absorbent layer **9**, which will float to the top of the liquid compartment **17** and the polished water with an acceptable level of the non-aqueous-phase will be collected and recovered through-outlet port **32** and clean water pipe **36**. When a certain thickness of free-floating polished non-aqueous phase is formed in the top of the liquid compartment **17**, a controlling device **41**, will opening of an automatic valve **42** and the free-floating polished non-aqueous phase will be collected and recovered via the oil outlet port **43** and the oil pipe **40**.

[**0056**] The same process of reversing the flow through the polishing vessel **2** is repeated at a given time interval or at a given pressure drop across the absorbent layer **9** is reached.

[**0057**] When even by reversing the direction of the mixture stream through the second vessel will not allow to decrease the pressure drop through the single layer of the absorbent, this layer should be replaced. The saturated or clogged absorbent can be regenerated by centrifugation at 1000 g-force at least for 5 to 10 minutes. The centrifuged absorbent can be reused more than 100 times in the process.

[**0058**] Referring to **FIG. 2**, another preferred embodiment of the invention is represented which too is adapted for a continuous operating mode for treating a fluid stream containing a continuous aqueous-phase with dispersed non-aqueous-phase which contains non-aqueous organic compounds with very few solid particles. The embodiment of the invention comprises a first horizontal cylindrical pressure vessel **1** as described previously and a second vertical cylindrical pressure vessel **66**.

[**0059**] The partially coalesced emulsion recovered in the first vessel **1** is directed through the second vessel **66** via the inlet port **67** and be deflected by a baffle. The free-floating big droplets of the non-aqueous-phase will float to the top of the second vessel **66** due to their high rising velocity. The emulsified non-aqueous-phase liquid still remaining in the aqueous-phase liquid will be coalesced into larger droplets in a horizontal polymeric polishing absorbent layer **9**, the absorbent here too is the same as that in vessel **1**. This layer will eventually release large droplets of the non-aqueous-phase liquid which will be collected via the outlet port **73** to the inlet port **76** and thus, will rise to the top of the second vessel. A check-valve **74** and valve **75** on the pipe interconnecting the two previous ports will ensure that the fluid mixture will not by-pass the absorbent layer. The polished aqueous phase with an acceptable level of the non-aqueous-phase is collected and recovered through the outlet port **68** and the clean water pipe **80**. When a certain thickness of free-floating oil is formed in the top of the second vessel **66**, a detector **69** will control the opening of an automatic valve **70** and the free-floating polished non-aqueous phase will be collected and recovered via the oil outlet port **71** and the oil pipe **72**. Nozzle **79** is normally plugged and can be used to allow air in and out of the polishing vessel during start-up and maintenance operations.

[**0060**] When a given pressure drop across the layer of the absorbent **9** of the second vessel **66**, measured by the differential pressure between pressure gauges **77** and **78**, is reached due to a blockage by highly viscous oil or unexpected solid particles of the layer of absorbent, the absorbent must be removed from the vessel and replaced by a new or a refurbished (centrifuged) absorbent.

1. A method of separating immiscible liquids in a dispersion comprising an aqueous liquid and at least one non-aqueous liquid immiscible in the aqueous liquid and wherein the non-aqueous liquid is dispersed in the aqueous liquid, comprising:

a) feeding the dispersion from a feed supply to a chamber housing a plurality of coalescing compartments, in a first direction through the compartments from an initial upstream compartment to a final downstream compartment;

b) partially coalescing the dispersed non-aqueous liquid through all the coalescing compartments;

c) recovering a partially coalesced emulsion of said liquids, after passage through all the coalescing compartments downstream of said final downstream compartment, and

d) periodically discontinuing the feeding in said first direction and feeding said emulsion in a second direction, counter to said first direction, such that said final downstream compartment of a) becomes a second direction initial upstream compartment and said initial upstream compartment of a) becomes a second direction final downstream compartment.

2. A method according to claim 1, further comprising:

e) feeding the partially coalesced emulsion to a polishing vessel, housing at least one polishing coalescing compartment, in a first polishing direction;

f) partially coalescing the emulsion in the at least one polishing coalescing compartment;

g) recovering a polished aqueous phase and a polished non-aqueous phase, and

h) periodically discontinuing the feeding of the partially coalesced emulsion in said first polishing direction and feeding said emulsion in a second polishing direction, counter to said first polishing direction, such that a final downstream polishing compartment becomes an initial upstream polishing compartment and said initial polishing compartment becomes a final downstream compartment.

3. A method according to claim 2, wherein the polishing vessel includes only one coalescing compartment.

4. A method according to claim 2, wherein the dispersion also contains solids.

5. A method according to claim 4, wherein a solids stream is further recovered in g) from the polishing vessel.

6. A method according to claim 1, wherein the method is continuous or discontinuous.

7. A method according to claim 1, wherein the method is continuous.

8. A method according to claim 1, further comprising monitoring a differential pressure of the said initial upstream compartment of a) as a means of measuring a level of blockage in said initial upstream compartment, and performing d) in response to the a predetermined level of blockage in the initial upstream compartment.

9. A method according to claim 1, wherein the plurality of coalescing compartments is at least three.

10. A method according to claim 9, wherein the plurality of coalescing compartments is six, the compartments being disposed in two parallel series of three coalescing compartments.

11. A method according to claim 1, wherein the coalescing compartment contains a coalescing media with a substantially homogeneous porous mass, the porous mass including a network of fine filaments and substantially uniform sized open cells in the filaments, wherein the coalescing media can separate non-aqueous emulsions from the aqueous phase having a droplet diameter of at least 0.5 μm.

12. A method according to claim 11, wherein the porous mass has an absorption or adsorbent character effective to trap dispersed non-aqueous droplets for coalescence, and readily release coalesced droplets of the non-aqueous liquid.

13. A method according to claim 11, wherein the porous mass has a non-compressed state.

14. A method according to claim 13, wherein the porous mass in the non-compressed state has a non-compressed density varying from 1.5 to 2.5 lbs/ft^3; a void space from 80% to 98%: and 65 to 120 pores per linear inch.

15. A method according to claim 11, wherein the porous mass has a compressed state.

16. A method according to claim 15, wherein the porous mass in the compressed state has a compressed density varying from 2.5 to 19 lbs/ft^3; a void space of from 60% to 80%; and 120 to 900 pores per linear inch.

17. A method according to claim 11, wherein the cells have a cell wall thickness between 40 and 55 μm.

18. A method according to claim 11, wherein the cells have a cell diameter between 160 and 220 μm.

19. A method according to claim 11, wherein the coalescing media is of a polymer selected from the group consisting of polyurethane, polyester, polystyrene, polypropylene and polyethylene.

20. A method according to claim 19, wherein the coalescing media is of polyurethane.

21. An apparatus for separating immiscible liquids in a dispersion comprising an aqueous liquid and at least one non-aqueous liquid immiscible in the aqueous liquid and wherein the non-aqueous liquid is dispersed in the aqueous liquid, comprising:

a primary vessel including;

an inlet means through which the dispersion enters the vessel and producing a flow within the vessel in a first direction;

an outlet means through which a partially coalesced emulsion leaves the vessel;

a plurality of coalescing compartments which the dispersed non-aqueous liquid partially coalesces to produce the partially coalesced emulsion; the compartments including a first direction upstream compartment and a first direction last downstream compartment;

a flow direction changing means acting on the inlet means and the outlet means for periodically changing the flow within the vessel to a second direction counter to the first direction, such that said first direction upstream compartment becomes a second direction last downstream compartment and said first direction last downstream compartment becomes a second direction upstream compartment

whereby the partially coalesce emulsion leaving the vessel has passed through all the coalescing compartments.

22. An apparatus according to claim 21, further comprising:

a transferring means, communicating between said primary vessel and a polishing vessel;

the polishing vessel including;

a polishing inlet means through which the partially coalesced emulsion enters the polishing vessel in a first polishing direction;

at least one polishing coalescing compartment in which the partially coalesced liquid further coalesces to produce a polished non-aqueous phase and a polished aqueous phase;

a polished non-aqueous phase outlet means; and

a polishing outlet means through which a polished aqueous phase leaves the polishing vessel, and

a polishing flow direction changing means acting on the polishing inlet means and the polishing outlet means for periodically changing the flow within the polishing vessel to a second polishing direction counter to the first polishing direction.

23. An apparatus according to claim 21, wherein the apparatus operates in a continuous or discontinuous mode.

24. An apparatus according to claim 23, wherein the apparatus operates in a continuous mode.

25. An apparatus according to claim 22, wherein the polishing vessel further includes a solids removal outlet means for the removal of solids in the dispersion.

26. An apparatus according to claim 21, wherein the plurality of coalescing compartments is at least 3.

27. An apparatus according to claim 26, wherein the plurality of coalescing compartments is 6 and the compartments are arranged in two parallel series of three coalescing compartments.

28. An apparatus according to claim 27, wherein the coalescing compartments are disposed vertically.

29. An apparatus according to claim 21, wherein the primary vessel is cylindrical, disposed horizontally and includes heads.

30. An apparatus according to claim 21, wherein the coalescing compartments are disposed vertically in the cylindrical vessel to produce compartments with a circular cross section of the flow in the first direction.

31. An apparatus according to claim 22, wherein the polishing vessel is cylindrical, disposed horizontally and includes heads.

32. An apparatus according to claim 22, wherein the number of polishing coalescing compartments is one, disposed vertically in the cylindrical vessel to produce a circular cross section in the first polishing direction.

33. An apparatus according to claim 22, wherein the polishing vessel is cylindrical, disposed vertically and includes heads.

34. An apparatus according to claim 22, wherein the number of polishing coalescing compartments is one, disposed horizontally.

35. An apparatus according to claim 21, wherein

the primary vessel is disposed horizontally and comprises;

a cylindrical housing having a top wall, ends, and heads mounted on the ends of the housing;

a first inlet mounted centrally on the housing and two inlets mounted on the heads;

three outlets mounted on the top wall, a first outlet centrally mounted between two outlets adjacent to the ends;

six coalescing compartments mounted vertically and spaced substantially equally throughout the housing, each coalescing compartment and being separated by a liquid compartment,

the flow in the first direction is established with a first control valve opening to allow the dispersion into the first inlet, a second control valve remaining closed, a third control valve opened to collect the partially coalesced emulsion from the two outlets adjacent to the ends, and a fourth control valve closed;

the flow in the second direction is established with the first control valve closed, the second control valve opened to allow the dispersion to flow into the each of the two inlets mounted on the heads, the third control valve is closed and the fourth control valve opening to allow the first outlet centrally mounted on the housing to allow the partially coalesced emulsion to leave the primary vessel; and

differential pressure controllers measuring differential pressure across each of the coalescing compartments, the differential pressure increasing with time, at a particular pressure and at a particular time interval the controllers actuating the control valves and changing the flow from the first direction to the second direction, after the time interval has passed for a second time, the controllers actuating the control valves and changing the flow from the second direction to the first direction.

36. An apparatus according to claim 22, wherein the transferring means is a pipe connecting the primary vessel and the polishing vessel;

the polishing vessel is disposed horizontally and comprises

a cylindrical housing having a top wall, ends and heads mounted on the ends of the housing;

one polishing coalescing compartment mounted vertically located at the center of the housing

an polishing inlet and a polishing outlet through which the partially coalesced emulsion and the polished aqueous phase are interchangeable passed;

the polishing flow in the first polishing direction is established with a first polishing control valve open allowing the emulsion into the polishing vessel through a port on the first head, a second polishing control valve is closed, a third polishing control valve is closed and a fourth polishing control valve is open allowing the polished aqueous phase to leave the polishing vessel;

the polishing flow in the second polishing direction is established with a first polishing control valve closed, a second polishing control valve is open allowing the emulsion into the polishing vessel through a port on the first head, a third polishing control valve is open allowing the polished aqueous phase to leave the polishing vessel and a fourth polishing control valve is closed; and

differential pressure controllers measuring differential pressure across each of the polishing coalescing compartment, the differential pressure increasing with time, at a particular pressure and at a particular time interval the controllers actuating the control valves and changing the flow from the first polishing direction to the second polishing direction, after the time interval has passed for a second time, the controllers actuating the control valves and changing the flow from the second polishing direction to the first polishing direction.

37. An apparatus according to claim 21, wherein the coalescing compartments contains a coalescing media with a substantially homogeneous porous mass, the porous mass including a network of fine filaments and substantially uniform sized open cells in the filaments, wherein the coalescing media can separate non-aqueous emulsions from the aqueous phase having a droplet diameter of 0.5 μm.

38. An apparatus according to claim 37, wherein the porous mass has an absorption or adsorbent character effective to trap dispersed non-aqueous droplets for coalescence, and readily release coalesced droplets of the non-aqueous liquid.

39. An apparatus according to claim 37, wherein the porous mass has a non-compressed state.

40. An apparatus according to claim 39, wherein the porous mass in the non-compressed state has a non-compressed density varying from 1.5 to 2.5 lbs/ft^3; a void space from 80% to 98%: and 65 to 120 pores per linear inch.

41. An apparatus according to claim 37, wherein the porous mass has a compressed state.

42. An apparatus according to claim 41, wherein the porous mass in the compressed state has a compressed density varying from 2.5 to 19 lbs/ft^3; a void space of from 60% to 80%; and 120 to 900 pores per linear inch.

43. An apparatus according to claim 37, wherein the cells have a cell wall thickness between 40 and 55 μm.

44. An apparatus according to claim 37, wherein the cells have a cell diameter between 160 and 220 μm.

45. An apparatus according to claim 37, wherein the coalescing media is of a polymer selected from the group consisting of polyurethane, polyester, polystyrene, polypropylene and polyethylene.

46. An apparatus according to claim 45, wherein the coalescing media is of polyurethane.

47. In an apparatus for separating immiscible liquids in a dispersion comprising an aqueous liquid and at least one non-aqueous liquid immiscible in the aqueous liquid and wherein the non-aqueous liquid is dispersed in the aqueous liquid and a coalescing media is used for separating the liquids in the dispersion by passing the dispersion through the coalescing media,

the improvement wherein

the coalescing media includes a substantially homogeneous porous mass, the porous mass including a network of fine filaments and substantially uniform sized open cells in the filaments, wherein the coalescing media can separate non-aqueous emulsions from the aqueous phase having a droplet diameter of 0.5 μm.

48. An apparatus according to claim 47, wherein the porous mass has an absorption or adsorbent character effective to trap dispersed non-aqueous droplets for coalescence, and readily release coalesced droplets of the non-aqueous liquid.

49. An apparatus according to claim 47, wherein the porous mass has a non-compressed state.

50. An apparatus according to claim 49, wherein the porous mass in the non-compressed state has a non-compressed density varying from 1.5 to 2.5 Ibs/ft^3; a void space from 80% to 98%: and 65 to 120 pores per linear inch.

51. An apparatus according to claim 47, wherein the porous mass has a compressed state.

52. An apparatus according to claim 51, wherein the porous mass in the compressed state has a compressed density varying from 2.5 to 19 lbs/ft^3; a void space of from 60% to 80%; and 120 to 900 pores per linear inch.

53. An apparatus according to claim 47, wherein the cells have a cell wall thickness between 40 and 55 μm.

54. An apparatus according to claim 47, wherein the cells have a cell diameter between 160 and 220 μm.

55. An apparatus according to claim 47, wherein the coalescing media is of a polymer selected from the group consisting of polyurethane, polyester, polystyrene, polypropylene and polyethylene.

56. An apparatus according to claim 55, wherein the coalescing media is of polyurethane.

57. A method according to claim 11, wherein the coalescing medium separates non-aqueous emulsions from the aqueous phase having a droplet diameter of 0.5 micron.

58. An apparatus according to claim 37, wherein the coalescing media separates non-aqueous emulsions from the aqueous phase having the droplet diameter of 0.5 micron.

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