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Method of separating solids from liquids and/or separating emulsions

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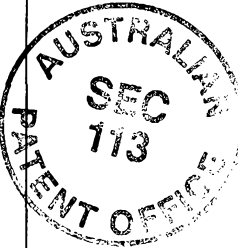
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<p>(21) Internationales Aktenzeichen: PCT/EP96/01112 (22) Internationales Anmeldedatum: 14. März 1996 (14.03.96) (30) Prioritätsdaten: 195 09 367.4 15. März 1995 (15.03.95) DE (71) Anmelder (für alle Bestimmungsstaaten ausser US): LINDE AKTIENGESELLSCHAFT [DE/DE]; Abraham-Lincoln-Strasse 21, D-65189 Wiesbaden (DE). (72) Erfinder; und (75) Erfinder/Anmelder (nur für US): FUCHS, Uwe [DE/DE]; Sulzbeckstrasse 10, D-80689 München (DE).</p> <p>(71) Uwe Fuchs Sulzbeckstrasse 10, D-80689 München Germany</p>	<p>(81) Bestimmungsstaaten: AU, CA, CN, CZ, HU, JP, KR, NO, PL, US, europäisches Patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</p> <p>Veröffentlicht Mit internationalem Recherchenbericht. Vor Ablauf der für Änderungen der Ansprüche zugelassenen Frist. Veröffentlichung wird wiederholt falls Änderungen eintreffen.</p> <p>(71) Austrian Energy and environment SGP/Wagner-Biro GmbH; Siemensstrasse 89, A-1211 Vienna, AUSTRIA</p> <div style="text-align: right;">   </div>	

(54) Title: METHOD OF SEPARATING SOLIDS FROM LIQUIDS AND/OR SEPARATING EMULSIONS

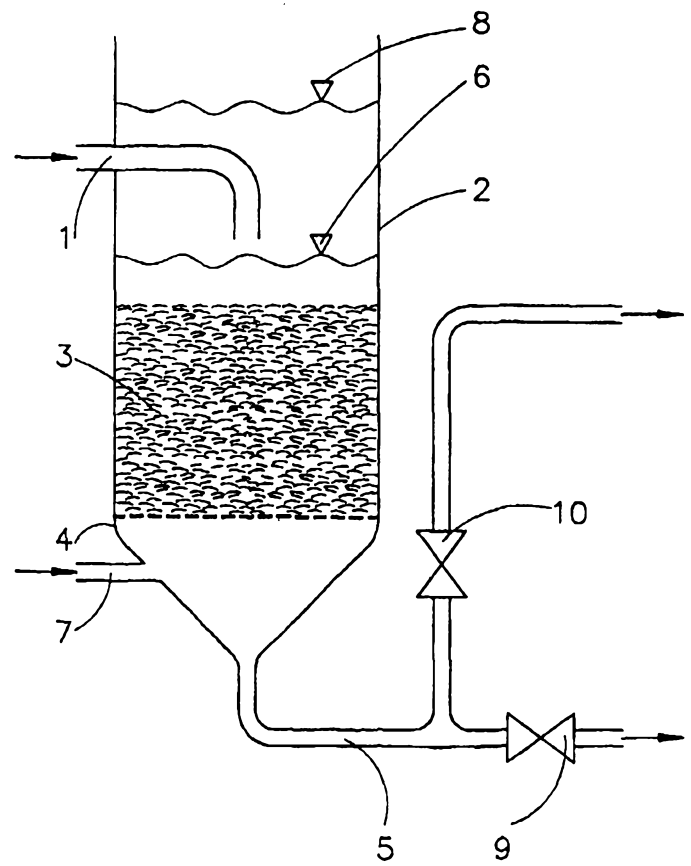
(54) Bezeichnung: VERFAHREN ZUR FEST-FLÜSSIG-TRENNUNG UND/ODER EMULSIONSSPALTUNG

(57) Abstract

The invention concerns a method of separating solids from liquids for use with liquids containing solid components (for example, for filtering effluent) and/or for separating emulsions such as oil-water emulsions. It is proposed that a filter layer (3) consisting of thin, film-like filter particles should be used. These filter particles can be retained by sieve floors (4), thereby permitting the use of non-standard regeneration techniques such as very rapidly siphoning off the liquid enriched with the solids and/or emulsified droplets, drawing it rapidly through a drainage pipe (5), and increasing the pressure in the gas chamber of the filter.

(57) Zusammenfassung

Die Erfindung betrifft ein Verfahren zur Fest-Flüssig-Trennung von feststoffhaltigen Flüssigkeiten, z.B. zur Filtration von Abwasser, und/oder zur Spaltung von Emulsionen, z.B. von Öl-Wasser-Emulsionen. Es wird vorgeschlagen, eine Filterschicht (3) aus dünnen, folienartigen Filterteilchen zu verwenden. Diese Filterteilchen können mittels Siebböden (4) zurückgehalten werden. Dadurch werden unübliche Regeneriertechniken, wie schlagartiges Ablassen der mit Feststoffen und/oder emulgierten Tröpfchen angereicherten Flüssigkeit, schnelles Absaugen über ein Ablaufrohr (5) und Druckerhöhung im Gasraum des Filters möglich.



Abstract**Method for solid-liquid separation and/or emulsion splitting**

The invention concerns a process for the solid-liquid separation of liquids containing solid material, e.g. for the filtration of sewage, and/or the splitting of emulsions, e.g. oil-in-water emulsions. It is proposed that a filtration layer (3) made of thin, foil-like filter particles be used. These filter particles can be retained by means of sieve bases (4). This creates the possibility of non-standard regeneration techniques, such as the draining in sudden bursts of the liquid enriched with solids and/or emulsion droplets, rapid removal by suction via a discharge pipe (5) and pressure increase in the gas chamber of the filter.

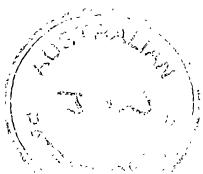
TRANSLATION FROM GERMAN

Description**5 Method for solid-liquid separation and/or splitting emulsions**

The invention relates to a method for solid-liquid separation of liquids containing solid matter and/or for the splitting of emulsions, where the liquid which contains
10 solid matter and/or the emulsion is passed through a filter layer of loose particles which are essentially planar with a surface area of approx. 5 (mm)² to approx. 1000 (mm)², which is held in place in a filter receptacle by at least one sieve, and in which process at least the greater part of the solid matter and/or emulsified droplets are deposited on the filter particles, whilst the remaining liquid is drawn
15 out of the receptacle via the sieve after passing through the filter layer.

“Three-dimensional” filtration methods are already in use. These involve the passing of a liquid containing solid matter through a mineral filtration layer consisting, for example, of sand or pebbles. Although cost-effective, these
20 mineral filtration layers have several disadvantages.

The filter layer consists of particles with a high specific gravity, necessitating a very robust construction of the filtration unit as a whole. In addition, the high specific gravity of commonly used mineral filter layers means they require a very
25 high energy input at the regeneration stage. This requires very high performance regeneration systems. The commonly used mineral filter layers also have a small void volume in the order of 25% to 30 % by volume, resulting in a small loading capacity of approx. 5 kg of solid matter per cubic metre. This necessitates the frequent regeneration of the filter layer. The small particle diameter of
30 commonly used filter particles necessitates expensive retention devices.



Often an additional simultaneous biological treatment of the liquid being filtered is desirable. In practice, however, the actual simultaneous biological cleansing usually fails because the biomass attached to the relatively smooth filter particles is removed from the filtration unit during regeneration and partial aeration of the filter layer.

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It is often necessary to split up emulsions, particularly hydrocarbon-water emulsions. For example, petroleum is often trapped in rock pores. To extract the petroleum, water is forced into the rock, carrying the petroleum, along with the water, to the earth's surface. The petroleum is then decanted from the water, but still leaves a residual petroleum-water emulsion.

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Splitting such emulsions has hitherto involved significant costs. In addition, this process usually fails to produce a satisfactory yield.

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DE-A-2 916 121 describes a filtration method where a filter bed of loose filter particles of porous polyurethane foam are used. The filter particles can be in shredded form with a particle size of 25 to 51 mm and a particle thickness of 0.6 mm. The specific gravity of the filter particles is selected such as to form a filter bed of sufficient compactness. This prevents the filter particles from being whirled up during the filtering process. This severely restricts the mobility of the individual filter particles thus impairing the filtration performance.

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We have now found a method for liquid-solid separation and/or for the splitting of emulsions which avoids the disadvantages of conventional methods as mentioned above.

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The present invention includes a method for the solid-liquid separation of liquids containing solid material and/or for the splitting of emulsions, the liquid containing solid material and/or emulsion is conveyed through a filtration layer of essentially planar filter particles with a surface area of approximately 5 (mm)^2 to approximately 1000 (mm)^2 , which layer is retained in a filter receptacle by means of at least one sieve, with at least a majority of the solids and/or emulsified droplets being deposited on the filtration particles, whilst the remaining liquid, after passing through the filtration layer, is being

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5 drawn off via the sieve from the filter receptacle, wherein a filter layer of loose filter particles which are capable of moving easily relative to each other is used, which consists of easily fluidised, foil-like filter particles with a thickness ranging from approx. 15 μm to approx. 500 μm and a weight per unit area ranging from approx. 10 to 500 g/m^2 .

10 Their lamellar or confetti-like structure gives these filter particles a good separation capacity. At a low specific gravity of preferably 1 g/cm^3 , these filter particles are easily fluidised, forming a quasi-floating filter layer of filter particles capable of slight movement relative to each other. In addition, the filter layer composed of these filter particles has a high void volume of approx. 75% by volume, giving a very high loading capacity. This results in the less frequent need for regeneration of the filter layer. Advantageously the particle size enables the simple retention of the filter particles by means of sieves.

15 As a result of the filter particles having a weight per unit area of approx. 10 to 500 g/m^2 the filter particles are able to move within the filter layer, thus increasing the filtration performance. In addition, the filter particles can be gently whirled up during the regeneration process of the filter layer.

20 During the regeneration process, the light, film-like filter particles can be whirled up by light-weight and weak regeneration systems without any great energy input, with the effect that the solid matter retained in the filter layer and/or the emulsion droplets deposited on the filter particles pass into the liquid. The liquid, now containing the solid matter and/or the emulsified droplets, can then be drawn out of the filter receptacle.

25 During regeneration of the filter layer, the drawing off of the liquid out of the filter receptacle is initially interrupted. The filter particles are then stirred up, causing at least the greater part of the solid matter and/or the emulsified droplets to pass into the liquid. 30 The liquid, now containing the solid matter and/or the emulsified droplets, is drawn out of the filter receptacle.



It is possible to use regeneration techniques for the whirled-up filter layer which deviate from the state of the art because the filter particles are retained by means of sieves. Thus according to an advantageous embodiment of the invention it is proposed that, during regeneration of the filter layer, the liquid now containing the solid matter and/or emulsified droplets be drained in sudden bursts from the filter receptacle. It is effective to suck the liquid out in sudden bursts using a waste pipe connection downstream from the sieve. Another preferred regeneration option is to raise the gas pressure in the filter receptacle.

10 If the process is used for the splitting of an emulsion, then by preference the filter layer is subjected to an extraction process at the regeneration stage. It is also possible to dispose of the filter layer and to replace it with a new one. Here, as with solid-liquid separation, the filter layer can also be regenerated by the whirling-up method, in which the emulsion droplets deposited onto the filter particles pass into the liquid. The emulsion droplets thus transferred to the liquid usually float on the surface of the liquid, because they generally have a lower specific gravity than the liquid. This is the case for example with oil-in-water emulsions. The emulsion droplets can then be decanted from the liquid.

20 It is possible with the proposed method to have a high concentration of emulsion droplets in a small quantity of regeneration liquid because the filter particles have a particularly high capacity to absorb emulsion droplets. This facilitates significantly the decanting of the emulsion droplets from the regeneration liquid.

25 Advantageously it is possible to use the present invention to split all conceivable emulsions. It is particularly suited to the splitting of hydrocarbon-water emulsions. For example, oil-in-water emulsions occurring during the petroleum extraction process can be split.

30 However, the process can also be used to rectify cases of damage caused by hydrocarbons. In particular, it is possible to treat liquids contaminated with oil by using this method in order to separate the oil from the liquid.



Advantageously, filter particles may be used which have a surface consisting of a heat-smoothed fleece material with a residual fleece structure at the micro level. At the macro level, filter particles of this nature have the appearance of smooth, opaque dense film, whereas at the micro level they have a residual fleece structure consisting of filament ramifications and openings there between. Thus, the filament ramifications may comprise a multitude of filaments which cross each other to define the openings therebetween and which are bonded to each other at many of the crossing points due to the thermal treatment.

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In a preferred embodiment, filter particles are used which have a heat-smoothed fleece surface consisting of filamentous ramifications with filament diameters ranging from 5 to 500 μm and with penetration openings therebetween ranging in diameter from 1 to 1000 μm .

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The effect of the heat-smoothed fleece surface of the filter particles is that these particles can even pick up solid matter particles of very small diameter. From another perspective, this heat-smoothed fleece surface gives the filter particles the necessary mechanical stability so that the latter can withstand even turbulent regeneration processes without sustaining damage.

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In a preferred embodiment, PE and/or PP base synthetic materials are used for the fleece material. The heat-smoothed fleece material can be made by feeding widths of fleece material through heated rotating metal rollers and compacting them, thus fusing the filaments together to a large extent.

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It is expedient to use filter particles which consist of a carrier foil to which the heat-smoothed fleece material is attached. Another preferred embodiment of the invention envisages using such filter particles with a heat-smoothed fleece surface which have been re-fleeced in a second stage of manufacture.

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In addition or as an alternative, the filter particles used can be subjected to a corona treatment process. This involves an electrical discharge in which ozone is released, which in turn attacks the matrix of the particle material and creates free valences. In this way the electrical properties of the particle surface are altered so that it is easier for the solid matter to collect on the surface and/or for the emulsified droplets to be deposited on the surface.

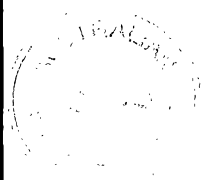
Advantageously, the invention includes the use of filter particles which have been subjected to a treatment using beta rays. It is also advantageous to use flame-perforated filter particles in which perforations have been melted into the filter particles using a flame.

Advantageously, a further enhancement of the filtration effect can be achieved by using filter particles doped with activated carbon, zeolites or titanium dioxide.

In a particularly preferred embodiment of the invention, biomass is applied to the filter particles in order to achieve an additional simultaneous biological cleansing of the liquid. Alternatively, conditions are set up which allow for a spontaneous growth of biomass. Advantageously, the filter particles used provide ideal conditions for colonisation by micro-organisms. The large surface area of the filter particles and the mobility of the filter particles within the filter layer make for high performance in terms of biological cleansing.

Advantageously, the filtration method of the present invention can be used for simultaneous residual denitrification of sewage water or drinking water. To this end, an anoxic environment is maintained in the filter layer. In addition, acetol(CH_3OH), for example, can be added in order to get the denitrification under way. Another option is to perform a residual nitrification in which the filter layer is gassed at least partially with a gas containing oxygen.

The process according to the invention has several advantages:

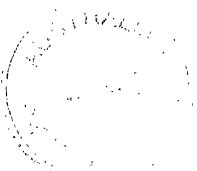


There is a possibility of capital expenditure savings of up to 40% over sand filters because the structure of the filter layer permits a higher filter loading. Further savings can be achieved by the lighter construction and the weaker regeneration systems. In the filter regeneration process the energy-related operating costs can be reduced by at least 40%. The filter material can also be used without great expense to convert existing filter units and is ideally suited to simultaneous repeat denitrification. This is particularly advantageous when retrofitting sewage treatment plants.

The following paragraphs give a more detailed description of the invention, by way of example only, with the aid of an exemplary embodiment shown in the schematic diagram.

Sewage water to be filtered is fed into the filter receptacle 2 via an intake 1. A filter layer 3 of loose filter particles capable of easy movement relative to each other is arranged in the filter receptacle 2. The filter particles used are predominantly planar particles with a thickness of approx. $500\mu\text{m}$ and a surface area of approx. 100 (mm)^2 . The filter particles have a weight per unit area of approx. 30 g/m^2 . The filter particles consist of a carrier foil made of polypropylene to which a heat-smoothed fleece material with a residual fleece structure at the micro level has been attached. The residual fleece structure has filamentous ramifications with filament diameters of approx. $10\mu\text{m}$ and permeable openings approx. $100\mu\text{m}$. A sieve base 4 is arranged in the lower area of the filter receptacle 2. This sieve base keeps the filter layer 3 in the filter receptacle 2. Below the sieve base 4 a waste pipe 5 is mounted via which the filtered liquid is drawn off. The filter unit as described is operated as a so-called flooded filter, i.e. during the filtering process the level of the liquid 6 is higher than filter layer 3.

During regeneration of the filter layer 3, the waste pipe 5 is closed by means of a valve 10 and regeneration air is fed into the lower area of the filter receptacle 2 via a gas intake pipe 7. This causes the particles in the filter layer 3 to be whirled up and the solid matter deposited on the filter particles to pass into the liquid. In addition, the level of the liquid is boosted to a regeneration liquid level 8. Next a valve 9 in a branch coming off the waste pipe 5 is opened and the liquid now containing the solid matter is



released in sudden bursts from the filter receptacle 2.

By comparison with conventional sand filters, it is possible to achieve significant reductions in energy costs using the filtration process described in the present invention.

5 In the sand filter the counterpressure during the regeneration process at a filter layer height of 1.5 m and a total filter receptacle height of 3 m gives a head of 4.6. By contrast the counterpressure in the process described in the present invention gives a head of only 3 owing to the lower specific gravity of the filter particles. This allows for savings of approx. 35% on compressor and pump feed operations. The filter layer loading capacity in the process according to the invention is approx. 15 kg solid matter per cubic metre. It is thus approximately three times higher than the loading capacity of sand filters. Accordingly, the filter can also run for longer. This results in less frequent regeneration runs, which in turn results in additional energy savings.

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15 Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

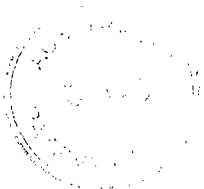
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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Method for the solid-liquid separation of liquids containing solid material and/or for the splitting of emulsions, the liquid containing solid material and/or emulsion is conveyed through a filtration layer of filter particles retained in a filter receptacle by means of at least one sieve, with at least a majority of the solids and/or emulsified droplets being deposited on the filter particles, whilst the remaining liquid, after passing through the filtration layer, is drawn off via the sieve from the filter receptacle, wherein the filter particles are in the form of loose foil-like particles with a surface area in the range of 5 mm² to 1000 mm², a thickness ranging from 15 μm to 500 μm and a weight per unit area ranging from 10 to 500 g/m², whereby the particles are capable of being easily fluidised.
2. Method according to Claim 1, wherein, in order to regenerate the filtration layer the drawing off of liquid from the filter receptacle is initially interrupted during the regeneration, after which the filter particles are whirled up, with at least a majority of the solids and/or emulsified droplets on the particles passing into the liquid, followed by the drawing off of the liquid enriched with solids and/or emulsified droplets from the filter receptacle, and wherein the liquid enriched with solids and/or emulsified droplets is drained in sudden bursts from the filter receptacle.
3. Method according to Claim 2, wherein the liquid enriched with solids and/or emulsified droplets is removed by suction in sudden bursts via a discharge pipe downstream from the sieve.
4. Method according to Claim 2 or 3, wherein gas pressure in the filter receptacle is increased.
5. Method according to any one of Claims 1 to 4, wherein the filter particles loaded with emulsified droplets undergo an extraction procedure.

6. Method according to any one of Claims 1 to 5, wherein the filter particles used have on their surface a heat-smoothed "fleece" material with a residual fleece structure at the micro level.
- 5 7. Method according to Claim 6, wherein the filter particles used have on their surface a heat-smoothed fleece material comprising filament ramifications with filament diameters in the range of 5 to 500 μm and penetration openings in the range from 1 to 1000 μm .
- 10 8. Method according to Claim 6 or 7, wherein the filter particles used consist of carrier foil to which heat-smoothed fleece material is applied.
9. Method according to any one of Claims 6 to 8, wherein the filter particles used have a heat-smoothed fleece surface which has been re-fleeced in a second pass.
- 15 10. Method according to any one of Claims 1 to 9, wherein the filter particles used have undergone corona treatment.
- 20 11. Method according to any one of Claims 1 to 10, wherein the filter particles used have undergone treatment with beta rays.
12. Method according to any one of Claims 1 to 11, wherein flame-perforated filter particles are used.
- 25 13. Method according to any one of Claims 1 to 12, wherein the filter particles are doped with activated carbon, zeolites or titanium dioxide.
14. Method according to any one of Claims 1 to 13, wherein biomass is applied to the filter particles, or the spontaneous growth of biomass is allowed to occur.
- 30 15. Method according to Claim 14, wherein anoxic conditions are maintained in the filtration layer for simultaneous biological denitrification.



16. Method according to Claim 14, wherein during filtration the filtration layer is at least partially gassed and a simultaneous biological nitrification procedure is carried out.
- 5 17. Method for the solid-liquid separation of the liquids containing solid material and/or for the splitting of emulsions substantially as hereinbefore described with reference to the accompanying drawing.

10 DATED this 17TH day of JUNE, 1999.

Austrian Energy & Environment SGP/Waagner-Biro GmbH

By its Patent Attorneys

DAVIES COLLISON CAVE

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