(19) NL Octrooicentrum

(11) **1039052**

(12) C **OCTROOI**

(21) Aanvraagnummer: **1039052**

(22) Aanvraag ingediend: **19.09.2011**

(51) Int.Cl.:
C02F 1/36 (2006.01) ***C02F 11/12*** (2006.01)

(43) Aanvraag gepubliceerd:
-

(47) Octrooi verleend:
21.03.2013

(45) Octrooischrift uitgegeven:
27.03.2013

(73) Octrooihouder(s):
Stichting Wetsus Centre of Excellence for Sustainable Water Technology te Leeuwarden.

(72) Uitvinder(s):
Hendrik Jannes Cappon te Kapelle.
Karel Jacob Keesman te Bennekom.
Mateo Jozef Jacques Mayer te Amersfoort.

(74) Gemachtigde:
Ir. A.A.G. Land c.s. te DEN HAAG.

(54) **Device and method for a heterogeneous waste water treatment reactor.**

(57) The present invention relates to a device and method for a heterogeneous waste water treatment reactor without internals and / or membranes, comprising at least one first fluid channel with a fluid inlet and a fluid outlet, acoustic wave generating means that are attached to the surface of the fluid channel or mounted in the fluid channel such that the active part of the transducer is in contact with the fluid in the fluid channel whereby the acoustic sound generating means cause wave interference, resulting in node lines or node regions inside of the fluid channel, thereby capturing and concentrating activated sludge and immobilizing it in, at least, radial direction. The result is that parallel channels of concentrated activated sludge and water are transported through the fluid channel. Both streams are recycled over an optionally aerated sludge tank and water tank respectively. Part of the water stream is discharged as purified waste water, optionally after treatment by an acoustic polishing filter, high troughput microfiltration unit or settler.

Device and method for a heterogeneous waste water treatment reactor

The present invention relates to a device and method for a heterogeneous waste water treatment reactor without internals and / or membranes, comprising at least one first fluid channel with a fluid inlet and a fluid outlet, acoustic wave generating means that are attached to the surface of the fluid channel or mounted in the fluid channel such that the active part of the transducer is in contact with the fluid in the fluid channel whereby the acoustic sound generating means cause wave interference, resulting in node lines or node regions inside of the fluid channel, thereby capturing and concentrating activated sludge and immobilizing it in, at least, radial direction. The result is that parallel channels of concentrated activated sludge and water are transported through the fluid channel. Both streams are recycled over an optionally aerated sludge tank and water tank respectively. Part of the water stream is discharged as purified waste water, optionally after treatment by an acoustic polishing filter, high throughput microfiltration unit or settler.

Introduction

A membrane bioreactor (MBR) comprises a water purification system in which waste water is purified by the use of activated sludge. Purified water is removed from a MBR system by the use of microfiltration membranes. These membranes retain both sludge and bacteria in the reactor system. An important advantage of MBR systems as compared to waste water treatment systems without membranes is the relatively small footprint of a MBR system. This relatively small footprint can be realized since the sludge concentration can be a factor 3 to 5 higher in a MBR system as compared to a system without membranes. Additionally, it is not required to apply a large settler at the end of the MBR process in order to separate the sludge from the purified water. Disadvantages of MBR systems are the relatively high investment and maintenance cost for membranes and the susceptability of membranes for fouling, resulting in transmembrane pressure drop and relatively high energy cost.
The technology according to the present invention provides a solution for waste water treatment, bringing along the advantages for MBR systems without the disadvantages of high membrane investment, high maintenance cost and membrane fouling.

Description of the technology according to the present invention

Basic idea of the technology according to the present invention is the separation of activated sludge and bacteria from waste water and treated waste water by the use of ultrasound. Briefly summarized, activated sludge is immobilized and concentrated in node lines and / or node regions caused by interference of acoustic waves that are generated in a system of parallel pipes, together forming a bioreactor. The acoustic waves are generated inside the pipes by mounting ultrasound transducers on the pipes and / or by mounting

ultrasound transducers inside of the pipes so that the transducer head is in contact with the fluid to be treated. Preferably a λ/2 or λ/4 resonator is applied to achieve particle separation. The pipes can be cilindrical, rectangular or can have any other geometry. As a result of the acoustic vibrations in each pipe, the apparent diffusion coefficient for components dissolved in the fluid is increased thereby reducing mass transfer limitation for decomposition of organics in the fluid. The reaction mixture is recycled over an aerated tank in order to ensure a sufficiently high oxygen concentration in the reaction mixture. It is noted that recycling of the reaction mixture pumped through the system of parallel pipes will cost some electrical energy. However, it is noted that this amount of energy is limited as compared to the energy required for microfiltration. Now that the basic concept has been explained, a number of preferred embodiments of the technology according to the present invention will be elucidated.

In a first preferred embodiment, the acoustic wave generating means are attached to rectangular pipes, resulting in node lines or node regions in axial direction of each parallel pipe. As a result, a continuous flow of parallel concentrated sludge channels and water channels is created in the pipes. As a result of the acoustic vibrations in the pipes, mass transfer between the fluid and the sludge is enhanced. The concentrated sludge is recycled over a sludge vessel that is optionally aerated and the water leaving the pipes is discharged as purified waste water or is aerated again and recycled over the distribution system of pipes. Optionally, purified waste water is treated by an ultrasound filtration system according to the present invention, as described in aspects one to seven further in this patent application, before it is discharged. Alternatively, the purified waste water is treated by high throughput microfiltration or fed into a settler before being discharged.

In a second preferred embodiment, the distribution system of pipes is placed in the aeration tank. The pipes are perforated with small holes. As a result, the fluid in the pipes is continuously refreshed. The pipe structure serves as a framework to achieve node lines and node regions in the pipes. In these node lines and node regions, the activated sludge is concentrated. Both the fluid convection caused by aeration and ultrasound in the pipes result in a high fluid refreshment rate in the pipes. As a result, a reactor system is obtained in which a distribution system of perforated pipes is applied as a sludge concentration system in the aeration tank. It is noted that the activated sludge concentration in the fluid outside of the perforated pipes is relatively low since activated sludge entering the perforated pipes is partly immobilized in the node lines and / or node regions. Preferably, the aeration tank also contains a number of non perforated parallel pipes. These parallel pipes are operated as fluid filters preferably by application of a system as described below in aspects one to six. Reaction mixture in the aeration tank is continuously fed into these non perforated pipes and the fluid leaving these pipes can be discharged as purified waste

water. Alternatively, the reaction mixture in the aeration tank outside of the perforated pipes, containing a relatively low concentration of activated sludge, is filtered in a polishing filter i.e., a high throughput microfiltration unit or fed into a settler before being discharged.

In this particular case, the system consists of a slurry reactor and of a polishing filter. The slurry reactor is characterized by channels in axial direction whereas the acoustic polishing filter does not have such channels.

Now the basic concept of the technology according to the present invention has been elucidated, a number of aspects of the acoustic polishing filter that can be used to enhance the quality of the purified waste water before it is discharged will be explained.

According to a first aspect, the present invention relates to at least one first cilindrical or rectangular fluid channel with a fluid inlet and a fluid outlet. This first cilindrical or rectangular fluid channel is preferably equipped with at least an inlet and an outlet to enable a continuous fluid flow through the channel.

According to a second aspect, the present invention relates to at least a second and preferably also a third fluid side channel, both connected to the first cilindrical or rectangular fluid channel. Preferably, at least one fluid side channel is connected to acoustic wave generating means. More preferably two fluid side channels are connected to acoustic wave generating means. Most preferably more than two fluid side channels are connected to acoustic wave generating means.

According to a third aspect, the present invention relates to control means for controlling the acoustic wave generating means of at least a second cilindrical fluid side channel. Preferably more than one cilindrical fluid side channels are equipped with controlling means for controlling the acoustic wave generating means. Most preferably, the controlling means for controlling the acoustic wave generating means are controlled by the use of at least a microprocessor and software.

According to a fourth aspect, the present invention relates to at least one sensor for sensing properties of the fluid present in the first cilindrical or rectangular fluid channel. Preferably the sensing principle of at least one sensor for sensing the fluid properties in the first cilindrical or rectangular channel is based upon at least one of the following sensing techniques: acoustic measurements, light scattering measurements, light reflection measurements, conductivity measurements, pH measurements, temperature measurements. In case temperature measurements are applied, these measurements preferably comprise temperature measurements using infrared technology and / or PTCs and / or NTCs and / or Pt100 sensing elements preferably placed in the fluid of the first cilindrical or rectangular fluid channel and / or connected to the inner wall and / or outer wall of the first cilindrical or rectangular fluid channel.

The signal(s) produced by the sensor(s) for sensing the fluid properties are preferably fed to

a microprocessor, preferably to a microcontroller, preferably by the use of an analog to digital converter.

According to a fifth aspect, the present invention relates to software for controlling the acoustic wave generating means. Preferably the software contains a feed back loop from the sensor to the acoustic wave generating means.

According to a sixth aspect, the present invention relates to software for controlling the acoustic wave generating means in such a manner that wave interference occurs so that node lines and / or node regions are produced in the first cilindrical or rectangular fluid channel. In these node lines and / or node regions solids will collect, resulting in a heterogeneous system of solids that are suspended in fluid.

Figure 1 gives a schematic overview of the technology according to the present invention. It is noted that figure 1 is one of the many possible embodiments of the technology according to the present invention and the present invention is by no means limited to figure 1.

The arrows 1 and 2 in figure 1 show the flow direction of the fluid. C1 relates to the first cilindrical or rectangular fluid channel. It is noted that the cilindrical or rectangular shape of the first fluid channel is a preferred embodiment. It is stressed that a large number of other geometrical shapes of the first fluid channel are technically feasible and part of the technology according to the present invention. Fluid channels C2 and C3 relate to the second and third fluid side channel respectively. A1 and A2 relate to the first and second acoustic sound generating means respectively. The angle β relates to the angle between the first cilindrical or rectangular fluid side channel and the second fluid side channel. According to the present invention, this angle is at least 5 degrees. It is noted that the angles between the different fluid side channels and the first cilindrical or rectangular fluid channel may be different. It is also noted that the location at which each fluid side channel is connected to the first cilindrical or rectangular fluid channel is a design parameter. Further, it is noted that other shapes of the fluid side channels than cilindrical or rectangular are possible.

A third preferred embodiment of the present invention comprises application of the technology according to the present invention as polishing filter for removing activated sludge from purified waste water. For this purpose, purified waste water still containing particles is fed into the first cilindrical or rectangular fluid channel that performs as a filter. Preferably, the first cilindrical fluid channel is a flow through reactor with a fluid inlet and outlet as shown in figure 1. Preferably, the polishing filter is operated in plug flow.

A waste water treatment reactor according to the technology of the present invention has following advantages as compared to prior art waste water treatment systems:

1. A small foot print because of the application of highly concentrated activated sludge and because of the absence of a large settler to separate activated sludge from

purified waste water.

2. No membrane fouling and no energy losses because of pressure drop over the membranes since the membranes have been replaced by a distribution system of pipes in which the sludge is concentrated by the use of ultrasound.
3. Because of the acoustic waves in the solution, the apparent diffusion coefficient of the molecules in the solution is increased. This is even the case in the node lines and / or node regions in which or near which the pressure fluctuations are never perfectly reduced to zero. As a result of the increased apparent diffusion coefficient, mass transfer of the reactants to the crystal surface is enhanced, resulting in a higher crystallization rate as compared to the situation that acoustic waves would be absent.
4. It is possible to steer the (settling) properties of the activated sludge by the design of the distribution system of pipes and the frequency and amplitude of the acoustic waves applied.

Finally, a fourth preferred embodiment of the technology according to the present invention is explained. In case of a relatively small turbid waste water stream, the technology according to the present invention can be applied to split this waste stream into a clear water stream and a turbid stream with a relatively high concentration of particles. The clear water stream can be treated by the use of UV radiation. The second stream is treated with a relatively high ozone concentration. In this way, the overall energy consumption required to purify both streams is smaller as compared to the situation that the original unsplit waste water stream would have been treated with UV radiation and / or ozone. It is noted that the technology according to the present invention can be applied for waste water treatment but also for other heterogeneous reactions in which active particles are to be concentrated and / or immobilized in axial or radial direction of the reactor coordinate.

The present invention is not limited to the above described example embodiments thereof; the rights sought are defined by the following claims, within the scope of which many modifications can be envisaged.

Clauses

1. Device for a heterogeneous waste water treatment reactor comprising
   - at least one first fluid channel with a fluid inlet and a fluid outlet
   - acoustic wave generating means that are attached tot the surface of the fluid channel or mounted in the fluid channel such that the active part of the transducer is in contact with the fluid in the fluid channel whereby
   - the acoustic sound generating means cause wave interference, resulting in node lines or node regions inside of the fluid channel thereby
   - capturing and concentrating activated sludge and immobilizing it at least in radial direction resulting in
   - parallel channels of concentrated activated sludge and water transported through the fluid channel.
2. Device according to clause 1 whereby the activated sludge stream and the water stream leaving the reactor are recycled over a sludge tank and water tank respectively.
3. Device according to clause 2 whereby the sludge tank and / or water tank are aerated.
4. Device according to one of the clauses 1-3 whereby more than 10 fluid channels are operated in parallel.
5. Device according to one of the clauses 1-4 whereby at least one fluid channel is perforated and placed in an aerated tank with activated sludge.
6. Device according to one of the clauses 1-5 further comprising an acoustic polishing filter as described in the text of this patent application.
7. Device according to one of the clauses 1-5 further comprising a high throughput microfilration unit and / or a settler to filter the purified waste water prior to discharging it.
8. Method for a heterogeneous waste water treatment reactor characterized by a device described by one of the previous clauses 1-7.

Conclusies

1. Inrichting voor een heterogene reaktor voor de zuivering van afvalwater gekenmerkt door
   - tenminste een eerste vloeistofkanaal met een instroomopening voor vloeistof en een uitstroomopening voor vloeistof
   - tenminste een inrichting voor het opwekken van acoustische golven die bevestigd is op het eerste vloeistofkanaal of in het kanaal is gemonteerd op een zodanige wijze dat het aktieve deel van de transducer contact maakt met de vloeistof in het vloeistofkanaal waarbij
   - de inrichting voor het opwekken van acoustische golven interferentie veroorzaakt hetgeen resulteert in knooplijnen en / of knoopgebieden in het vloeistofkanaal met als gevolg dat
   - aktief slib in de knooplijnen en / of knoopgebieden wordt ingevangen, geconcentreerd en tenminste in radiale richting ook wordt geimmobiliseerd resulterend in
   - parallelle kanalen van geconcentreerd actief slib and water dat door het vloeistofkanaal wordt getransporteerd.
2. Inrichting volgens conclusie 1 waarbij de stroom van aktief slib en de waterstroom respectievelijk worden gerecirculeerd over een slibtank en watertank.
3. Inrichting volgens conclusie 2 waarbij de slibtank en / of watertank worden belucht.
4. Inrichting volgens een van de voorgaande conclusies 1 t/m 3 waarbij meer dan 10 vloeistofkanalen parallel worden bedreven.
5. Inrichting volgens een van de voorgaande conclusies 1 t/m 4 waarbij tenminste een vloeistofkanaal geperforeerd is en in een tank met actief slib is geplaatst.
6. Inrichting volgens een van de voorgaande conclusies 1 t/m 5 vermeerderd met een acoustisch polishing filter zoals beschreven in de tekst van deze aanvrage.
7. Inrichting volgens een van de voorgaande conclusies 1 t/m 5 vermeerderd met een high throughput microfiltratie unit en / of een bezinker om het gezuiverde afvalwater te filtreren alvorens dit wordt geloosd.
8. Werkwijze voor een heterogene reaktor voor de zuivering van afvalwater gekenmerkt door een inrichting volgens een van de voorgaande conclusies 1 t/m 7.

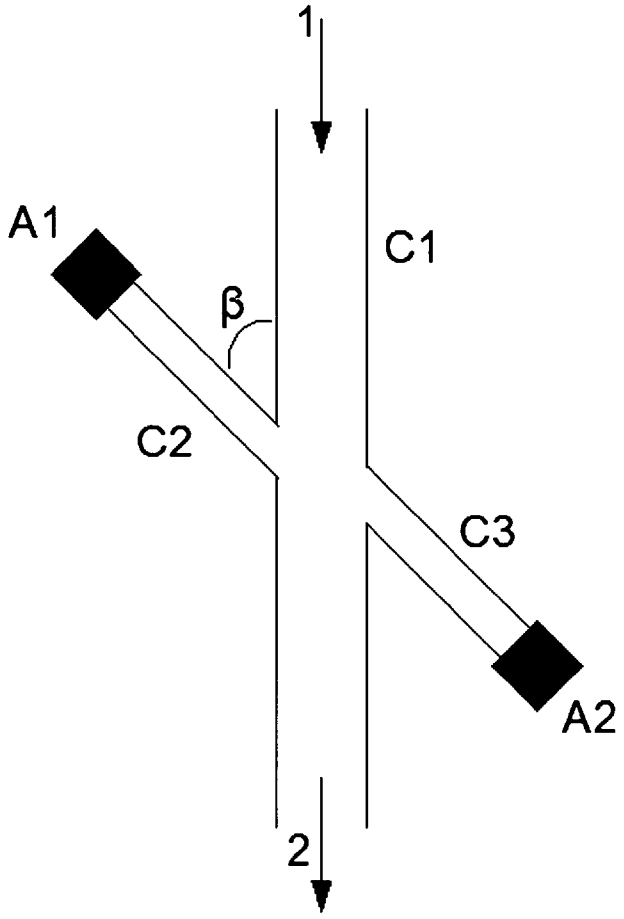

Figure 1.

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE
Nederlands aanvraag nr. **1039052**	Indieningsdatum **19-09-2011**
	Ingeroepen voorrangsdatum

Aanvrager (Naam)

Wetsus, centre of excellence for sustainable water technology

Datum van het verzoek voor een onderzoek van internationaal type	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr.
24-12-2011	**SN 57380**

I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

C02F1/36 **C02F11/12**

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

Classificatiesysteem	Classificatiesymbolen
IPC8	**C02F**

Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

III.	☐	**GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES**	(opmerkingen op aanvullingsblad)
IV.	☐	**GEBREK AAN EENHEID VAN UITVINDING**	(opmerkingen op aanvullingsblad)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 1039052

A. CLASSIFICATIE VAN HET ONDERWERP
INV. C02F1/36 C02F11/12
ADD.

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte miminum documentatie (classificatie gevolgd door classificatiesymbolen)
C02F

Onderzochte andere documentatie dan de mimimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)
EPO-Internal, COMPENDEX, WPI Data

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	US 2010/155327 A1 (WOODARD STEVEN [US] ET AL) 24 juni 2010 (2010-06-24) * figuren 6,9 * * alinea [0047] * * alinea [0052] *	1-8
A	WO 2006/080969 A1 (ASHLAND LICENSING & INTELLECTU [US]; DE MEULENAER ERIC CORDEMANS [BE];) 3 augustus 2006 (2006-08-03) * het gehele document *	1-8
A	JP 2002 018491 A (BABCOCK HITACHI KK) 22 januari 2002 (2002-01-22) * het gehele document *	1-8

☐ Verdere documenten worden vermeld in het vervolg van vak C.

☒ Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

° Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid	Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type
27 april 2012	

Naam en adres van de instantie	De bevoegde ambtenaar
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Janssens, Christophe

Formulier PCT/ISA/201 (tweede blad) (Januari 2004)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 1039052

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
US 2010155327 A1	24-06-2010	AU 2010293066 A1	29-03-2012
		CA 2773310 A1	17-03-2011
		US 2010155327 A1	24-06-2010
		WO 2011031305 A1	17-03-2011
WO 2006080969 A1	03-08-2006	CN 101061071 A	24-10-2007
		EP 1828059 A1	05-09-2007
		JP 2008520473 A	19-06-2008
		US 2008020079 A1	24-01-2008
		WO 2006080969 A1	03-08-2006
JP 2002018491 A	22-01-2002	GEEN	

Agentschap NL
Ministerie van Economische Zaken,
Landbouw en Innovatie

WRITTEN OPINION

File No.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
SN57380	19.09.2011		NL1039052

International Patent Classification (IPC)
INV. C02F1/36 C02F11/12

Applicant
Wetsus, centre of excellence for sustainable water technology

This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the application
- ☒ Box No. VIII Certain observations on the application

	Examiner
	Janssens, Christophe

Application number

WRITTEN OPINION

NL1039052

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material:

   ☐ on paper

   ☐ in electronic form

   c. time of filing/furnishing:

   ☐ contained in the application as filed.

   ☐ filed together with the application in electronic form.

   ☐ furnished subsequently for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes:	Claims	
	No:	Claims	1-8
Inventive step	Yes:	Claims	
	No:	Claims	1-8
Industrial applicability	Yes:	Claims	1-8
	No:	Claims	

2. Citations and explanations

see separate sheet

WRITTEN OPINION

Box No. VIII Certain observations on the application

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 Reference is made to the following documents:

D1 US 2010/155327 A1 (WOODARD STEVEN [US] ET AL) 24 juni 2010 (2010-06-24)

2 The present application does not meet the criteria of patentability, because the subject-matter of claim 1 is not new.

2.1 The document D1 is regarded as being the prior art closest to the subject-matter of claim 1, and discloses (the references below applying to this document):

Device (see fig. 9) for a heterogeneous wastewater treatment reactor comprising

a) a fluid channel with an inlet (16) and an outlet (83, 52);

b) acoustic wave generator means (262, 264, 266, 268, 270, see fig.6), attached to the surface of this first channel (76 is part of a branch of the channel which transports water from 16 to one of the exits 83 and 52); and

c) parallel channels (76, 72) of concentrated sludge (sludge is concentrated in (46) and water (there is always some water in the concentrated sludge) transported through the fluid channel.

2.2 The subject-matter of claim 1 is therefore not new.

3 Independent claim 8 does not define a method (see item VIII below). The document D1 therefore also takes away the novelty of claim 8.

4 Dependent claims 2-7 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of novelty and/ or inventive step. The device depicted in figure 9 of D1 implicitly comprises a sludge tank (biological reactor 12) and a water tank (46). The sludge tank (12) is aerated (with air 22). The fluid channel 20 introducing air in sludge tank 12 is perforated. Tank 46 also functions as a settler, to filter the water prior to discharging it.

Re Item VIII

Certain observations on the application

5 Independent claim 1 contains some features (acoustic sound means cause wave interference, capturing and concentrating activated sludge) which relate to the operating of the device and not to physical entities of the device itself. It appears that the physical entities capable of performing the desired operation are identical to those known from the prior art. The intended limitation is therefore not clear from this claim.

6 Independent claim 8 intends do protect a method but does not define any method step, nor what the intention of the method is. The reader therefore does not understand the subject-matter of claim 8.

7 Claim 6 contains a reference to the description of the application.

8 Claim 7 contains a typing error (microfilration).