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(54) **Device and method for a bioreactor, catalysis reactor or crystallizer without internals.**

(57) The present invention relates to a device and method for a bioreactor, catalysis reactor or crystallizer without internals comprising at least one first cilindrical or rectangular fluid channel with a fluid inlet and a fluid outlet, at least a second and preferably also a third fluid side channel both connected to the first cilindrical or rectangular fluid channel, at least two acoustic wave generating means that are connected to the second and third fluid side channels respectively and that are capable to produce wave interference in at least the first cilindrical or rectangular fluid channel, control means for controlling the wave generating means capable to achieve a structure with the generated waves such that at least two node lines are formed in the first cilindrical or rectangular fluid channel whereby a significant angle of at least 5 degrees exists between at least two node lines and the axial direction of the first cilindrical or rectangular fluid channel. With the device and method according to the present invention, microorganisms and / or catalyst particles and / or crystals are immobilized in the first cilindrical fluid channel without using any internals and / or adsorption media in the first cilindrical fluid channel. As a result, a very effective bioreactor and / or catalysis reactor and / or crystallizer is obtained since mass transfer limitation is suppressed in such a reactor.

NL C 1039053

Device and method for a bioreactor, catalysis reactor or crystallizer without internals

The present invention relates to a device and method for a bioreactor, catalysis reactor or crystallizer without internals, comprising at least one first cilindrical or rectangular fluid channel with a fluid inlet and a fluid outlet, at least a second and preferably also a third fluid side channel both connected to the first cilindrical or rectangular fluid channel, acoustic wave generating means that are connected to at least the second and preferably also the third fluid side channels and that are capable to produce wave interference in at least the first cilindrical or rectangular fluid channel, control means for controlling the wave generating means capable to achieve a structure with the generated waves such that at least two node lines are formed in the first cilindrical or rectangular fluid channel whereby a significant angle of at least 5 degrees exists between at least two node lines and the axial direction of the first cilindrical or rectangular fluid channel. With the device and method according to the present invention, microorganisms and / or catalyst particles and / or crystals are immobilized in the first cilindrical fluid channel without using any internals and / or adsorption media in the first cilindrical fluid channel. As a result, a very effective bioreactor and / or catalysis reactor and / or crystallizer is obtained since mass transfer limitation is suppressed in such a reactor.

Introduction

In the (bio)chemical process industry and the water purification industry, most chemical and biochemical reactions are heteregeneous i.e., the reaction takes place at a solid – liquid interface, a liquid – liquid interface, a solid – gas interface or a liquid – gas interface. Some examples of heterogeneous reactions are crystallization reactions, biochemical conversions by microorganisms and catalytic conversions in fluids by the use of a solid catalyst. An important process design parameter in heteregenous reactors is the total surface area of the interface at which the reaction takes place per volume unit of the reactor. For catalysts, the specific surface area [m^2/g] is an important parameter defining the efficiency of the catalyst. Both the reaction rate and often also the selectivity of heterogeneous reactions comprising liquid – solid or liquid – liquid reaction interfaces are usually limited by mass transfer limitation for both transport of reactants from the bulk of the liquid phase to the reaction surface and by mass transfer limitation for transport of reaction product from the reaction surface to the bulk of the liquid phase. In those cases, the diffusion coefficient of the different components in the liquid phase(s) determine mass transfer. A small diffusion coefficient of a reactant will result in a low concentration of that reactant at the reaction surface and hence in a low reaction rate. For these reasons, the performance of heterogeneous reactors can be improved considerably by increasing the surface area of the reaction surface and / or by increasing the diffusion rate of reactants from the bulk of the

liquid phase(s) to the reaction surface and reaction product from the reaction surface to the bulk of the liquid phase(s).

The present invention relates to a device and method to improve the efficiency, rate and / or selectivity of heterogeneous reactions in general. More specifically, the present invention relates to a device and method for a bioreactor and / or a catalysis reactor and / or a crystallizer.

Description of the technology according to the present invention

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, such as, but not limited to, polygonic channels and / or intersections are possible and part of the present invention.

Now the basics aspects of the technology according to the present invention have been explained, a number of preferred embodiments will be discussed.

A first preferred embodiment of the present invention comprises application of the technology according to the present invention as a crystallizer. For this purpose, seed crystals and / or a supersaturated solution are fed into the first cilindrical or rectangular fluid channel that performs as a crystallizer. Preferably, the first cilindrical fluid channel is a flow through reactor with a fluid inlet and outlet as shown in figure 1. The crystallizer can be operated in a recirculation loop in such a way that a CSTR (continuously operated stirred tank reactor) is formed. Alternatively, the crystallizer can be operated as a plug flow reactor or as a fed batch reactor. In the latter case, reactants are preferably fed into the reactor at a

desired rate, thereby increasing the reaction volume.

A crystallizer according to the technology of the present invention has following advantages as compared to prior art crystallizers:

1. Since the crystals are captured in node lines and / or in node regions, they are suspended in the reaction mixture without introducing a high collision rate and / or shear rate near the crystal surface. At these conditions, it is possible to produce very pure crystals with a very low concentration of defects near the crystal surface.
2. 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.
3. The volume fraction of crystals in the node lines and / or node regions can be set at a desired level by proper design of the first fluid channel and the fluid side channel(s). Fine tuning can be realized by adjusting the frequency and / or amplitude of the acoustic waves.
4. Once the crystals exceed a predefined size, they cannot retained anymore by the node lines and / or node regions and can be tapped from the crystallizer. In this way a very narrow crystal size distribution can be realized.

It is clear to a person skilled in the art that the technology according to the present invention opens possibilities to improve the product quality of crystallization products in chemical and pharmaceutical industry and to improve the performance of water purification processes comprising crystallization of inorganic salts. Since the technology according to the present invention makes it possible to retain very small crystals in the crystallizer, high crystallization rates can be achieved with only a limited total crystal mass. It is noted that the crystallizer according to the present invention can be applied as a crystal nucleator and / or to destroy crystals or crystal aggregates by the use of ultrasound.

A second preferred embodiment of the present invention comprises application of the technology according to the present invention as a reactor for biomass such as bacteria. For this purpose a suspension of desired micro-organisms is added to the first cilindrical or rectangular fluid channel. In analogy with the crystallizer application, the biomass reactor can be operated as a CSTR, a plug flow reactor or as a (fed) batch reactor.

A biomass reactor according to the present invention has following advantages above prior art biomass reactors:

1. The reactor can be made selective for the desired biomass i.e., for the size and

shape of the micro-organisms that should be retained in the node lines and / or node regions. This means that other biomass or particles will leave the reactor after only a very limited residence time. Hence, the reactor will mainly contain the desired micro-organism. This desired situation can be achieved with even higher precision in case the technology according to the present invention is combined with other specific selective process conditions such as temperature, (ultra)sound frequency, alternating electric field, fluid composition.

2. In analogy with the crystallizer according to the present invention, the apparent diffusion coefficient of dissolved components in the fluid is increased, thereby increasing mass transfer to and from the micro-organisms.
3. Formation of a biofilm is suppressed and micro-organisms are suspended as single cells or small aggregates. Also this enhances the conversion rate that can be achieved per gram of biomass.

A third preferred embodiment of the present invention comprises the application of the technology according to the present invention as a catalysis reactor. In analogy with the crystallizer application, the catalysis reactor can be operated as a CSTR, a plug flow reactor or as a (fed) batch reactor.

A catalysis reactor according to the technology of the present invention has following advantages above prior art catalysis reactors:

1. Since the catalyst particles are captured in node lines and / or in node regions, they are suspended in the reaction mixture without introducing a high collision rate and / or shear rate near the catalyst surface. This will increase the performance and life time of the catalyst and opens possibilities to successfully apply catalyst particles with only limited mechanical stability.
2. 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 catalyst surface is enhanced, resulting in a higher reaction rate as compared to the situation that acoustic waves would be absent.
3. The volume fraction of catalyst particles in the node lines and / or node regions can be set at a desired level by proper design of the first fluid channel and the fluid side channels. Fine tuning can be realized by adjusting the frequency and / or amplitude of the acoustic waves.
4. In case the reaction product is a solid, reaction conditions can be chosen such that the reaction product is not captured in the node lines and / or node regions because

of the characteristic particle size of the product. As a result, the reaction product will leave the catalyst reactor whereas the catalyst remains suspended in the catalyst reactor. Hence, a separation step between catalyst and reaction product can already be achieved in the catalyst reactor without introducing additional separation steps.

A third preferred embodiment comprises application of the technology according to the present invention in combination with a so-called coax sensor. In this particular case the sensor is applied as a preconcentration system and sensor at the same time. An example of a coax sensor is an open ended quarter wave length coaxial stub. Such a sensor can be applied as in line flow through sensor with fluid inlet and fluid outlet. Depending of the dielectric properties of the fluid pumped through the coaxial stub, the resonant frequency and quality factor of the filter will change. By equipping the coaxial stub with fluid side channels and acoustic wave generating means according to the present invention, a coax sensor with integrated particle concentration system is obtained. In fact, the coaxial stub is in this case applied as first cilindrical or rectangular fluid channel according to the present invention. It is noted that the particle concentrator can be switched off easily by switching off the acoustic sound generating means. In this way, the concentrator is flushed. Preferably, the diameter of the side channels, connected to the first cilindrical or rectangular fluid channel according to the present invention, is sufficiently small to avoid undesired interaction of the side channel with the electromagnetic waves fed to the coaxial stub. The coax sensor can be applied as a sensor to monitor the conversion and performance of a bioreactor, catalysis reactor or crystallizer.

A fourth preferred embodiment of the present invention comprises application of the technology according to the present invention with a first cilindrical or rectangular channel that is equipped with internals i.e., geometrical structures, in order to optimize the effectiveness of the node lines inside of the first cilindrical or rectangular channel.

The frequency of the acoustic waves applied in the technology according to the present invention is in the range of 100 Hz to 1 GHz. Preferably ultrasound is applied. More preferably ultrasound in the frequency range between 20 kHz and 100 MHz is applied.

Finally, it is noted that the technology according to the present invention brings along following advantages as compared to prior art reactors:

1. Absence or at least strong reduction of reactor fouling because of the acoustic vibrations in the reactor
2. Increase of the apparent diffusion coefficient of components present in the fluid, resulting in higher reaction rates and / or higher selectivity of the desired reactions.
3. Absence of undesired particle shear and / or particle collisions normally inevitably resulting from stirring the reactor.
4. Possibilities to separate reaction products and immobilized particles in the reactor

without introducing additinal separation steps.

5. Absence of internals in the filter / concentrator or at least possibilities for a very low volume fraction of internals in the filter concentrator

Additionally, it is noted that the technology according to the present invention will result in a lattice of volume elements containing high particle concentrations (node lines and / or node regions) and volume elements containing low particle concentrations.

Also, it is noted that an increase of the number of fluid side channels equipped with acoustic sound generating means is equivalent to applying a lower number of fluid side channels equipped with acoustic sound generating means at a higher acoustic sound frequency. Hence, a design parameter is obtained to realize the desired reactor performance at any desired frequency of the acoustic waves. This may be important since some particles (e.g., bacteria) or particle aggregates are destroyed at their resonant frequency. From this reasoning, it is concluded that, if desired, the technology according to the present invention can be designed such that the particles are destroyed. Also, it can be ensured that no particles are destroyed in the first cilindrical or rectangular fluid channel.

Finally it is noted that the lattice of node regions results in a much better distribution of the particles over the fluid volume in the first cilindrical or rectangular fluid channel. This may be an important advantage above prior art technology in case the first cilindrical or rectangular fluid channel is used as a sensor at the same time. A non limiting example of such advantage is the application of a first cilindrical or rectangular fluid channel as a particle suspension device and coax sensor at the same time. In this particular case, homegeneously distributed particles over the fluid within the first cilindrical fluid channel will result in an effective dielectric permittivity of the particle suspension that hardly changes as a function of the length coordinate of the first cilindrical or rectangular fluid channel. As a result, the properties and / or volume fraction of particles within the coax sensor can be determined from the resonant frequency of the coaxial stub.

Based upon these advantages above prior art, a person skilled in the art will recognize that the technology according to the present invention is very feasible for realizing reliable and fully automated catalysis reactors, crystallizers or bioreactors. Also, a person skilled in the art will recognize that the technology according to the present invention can be applied to other active particles suspended in a fluid.

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 reactor without internals comprising
   - at least one first fluid channel with a fluid inlet and a fluid outlet
   - at least a second fluid side channel both connected to the first cilindrical or rectangular fluid channel whereby the angle between the first fluid channel and the second fluid side channel is more than 5 degrees.
   - acoustic wave generating means connected to at least the second fluid side channel, the acoustic wave generating means being capable to produce wave interference in at least the first fluid channel
   - control means for controlling the wave generating means capable to achieve a structure with the generated waves such that at least two node lines or node regions are formed in the first fluid channel as a result of wave interference whereby a significant angle of at least 5 degrees exists between at least two node lines or node regions and the axial direction of the first cilindrical or rectangular fluid channel, resulting in particle being trapped in and / or near the node lines or node regions.
2. Device according to clause 1 further comprising at least a microprocessor and software to control the acoustic wave generating means thereby steering the particle concentration and / or filtration process.
3. Device according to clauses 1 or 2 further comprising at least one sensor for sensing the fluid properties of the first cilindrical or rectangular fluid channel and a control loop to tune the acoustic sound generating means in order to achieve a desired particle filtration and / or concentration performance.
4. Crystallizer according to one of the previous clauses 1-3.
5. Bioreactor according to one of the previous clauses 1-3.
6. Catalysis reactor according to one of the previous clauses 1-3.
7. Method for a heterogeneous reactor characterized by a device described by one of the previous clauses 1-6.

Conclusies

1. Inrichting voor een heterogene reactor zonder internals gekenmerkt door
   - tenminste een eerste vloeistofkanaal met een instroomopening voor vloeistof en een uitstroomopening voor vloeistof
   - tenminste een tweede vloeistof zijkanaal dat werkzaam verbonden is met het eerste cilindrisch vloeistofkanaal en waarvan de axiale as een hoek van tenminste 5 graden maakt met de axiale as van het eerste vloeistofkanaal.
   - tenminste een inrichting voor het opwekken van acoustische golven die werkzaam verbonden is met het tweede vloeistof zijkanaal en die interferentie van de acoustische golven opwekt in tenminste het eerste cilindrisch vloeistofkanaal
   - middelen om de inrichtingen voor het opwekken van acoustische golven te regelen opdat tenminste twee knooplijnen of knoopgebieden worden gevormd in het eerste cilindrische vloeistofkanaal ten gevolge van interferentie met het kenmerk dat een significante hoek van tenminste 5 graden bestaat tussen tenminste twee knooplijnen of knoopgebieden en de axiale as van het eerste cilindrische vloeistofkanaal opdat deeltjes in en / of nabij de knooplijnen worden ingevangen.
2. Inrichting volgens conclusie 1 vermeerderd met tenminste een microprocessor en software om de inrichtingen voor het opwekken van acoustische golven te regelen en daarmee het filtratie- en / of concentratieproces van de deeltjes te sturen.
3. Inrichting volgens een van de voorgaande conclusies 1 of 2 vermeerderd met tenminste een sensor om de eigenschappen van de vloeistof in het eerste cilindrische vloeistofkanaal te meten en een control loop om de inrichtingen voor het opwekken van acoustische golven zodanig in te stellen dat het filtratieproces en / of het deeltjesconcentratieproces op de gewenste wijze verloopt.
4. Kristallisator volgens een van de voorgaande conclusies 1 t/m 3.
5. Bioreaktor volgens een van de voorgaande conclusies 1 t/m 3.
6. Katalysereaktor volgens een van de voorgaande conclusies 1 t/m 3.
7. Werkwijze voor een heterogene reaktor gekenmerkt door een inrichting volgens een van de voorgaande conclusies 1 t/m 6.

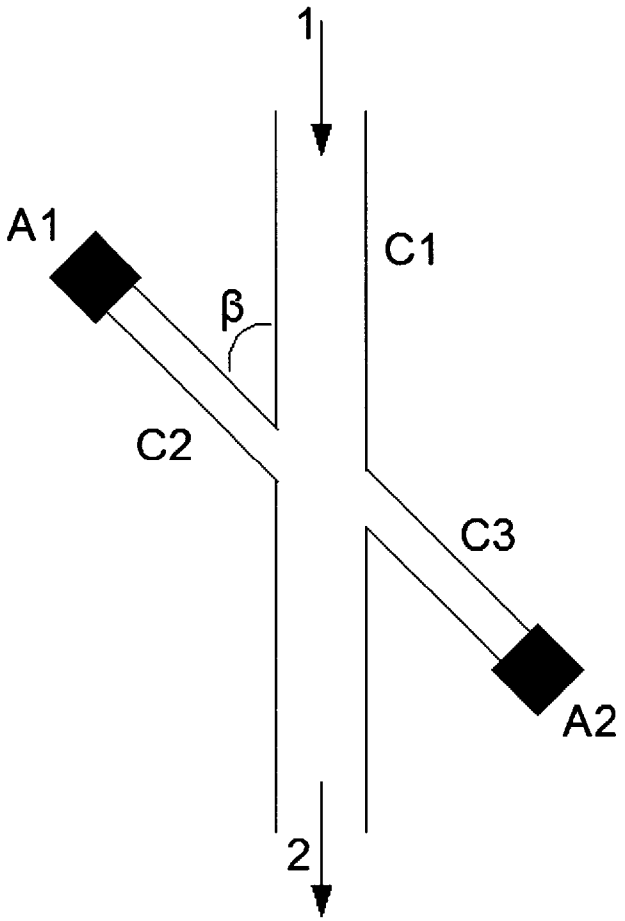

Figure 1.

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE
Nederlands aanvraag nr. **1039053**	Indieningsdatum **19-09-2011**
	Ingeroepen voorrangsdatum
Aanvrager (Naam) **Wetsus Centre for sustainalbe water technology**	
Datum van het verzoek voor een onderzoek van internationaal type **24-12-2011**	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. **SN 57381**

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

Volgens de internationale classificatie (IPC)

B01J19/10

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

Classificatiesysteem	Classificatiesymbolen
IPC	**B01J**

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 1039053

A. CLASSIFICATIE VAN HET ONDERWERP
INV. B01J19/10
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)
B01J

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, 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	EP 0 488 097 A1 (EURATOM [LU]) 3 juni 1992 (1992-06-03) * samenvatting; figuur 1 *	1,7
X	US 3 825 481 A (SUPITILOV M) 23 juli 1974 (1974-07-23) * kolom 8, regels 26-33; figuur 2 *	1,7
A	US 2010/279373 A1 (CORDEMANS DE MEULENAER ERIC [BE] ET AL DE MEULENAER ERIC CORDEMANS [BE]) 4 november 2010 (2010-11-04) * alineas [0032], [0051]; figuur 2 *	1
A	US 2007/138911 A1 (TESSIEN ROSS A [US] ET AL) 21 juni 2007 (2007-06-21) * figuur 10 *	1

☐ 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
12 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	Veronesi, Sergio

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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 1039053

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)		Datum van publicatie
EP 0488097	A1 03-06-1992	CA	2097070 A1	28-05-1992
		DE	59102932 D1	20-10-1994
		EP	0488097 A1	03-06-1992
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US 2007138911	A1 21-06-2007	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.
SN57381	19.09.2011		NL1039053

International Patent Classification (IPC)
INV. B01J19/10

Applicant
Wetsus Centre 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
	Veronesi, Sergio

Application number

WRITTEN OPINION

NL1039053

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, 7
Inventive step	Yes:	Claims	
	No:	Claims	1-7
Industrial applicability	Yes:	Claims	1-7
	No:	Claims	

2. Citations and explanations

see separate sheet

Application number

WRITTEN OPINION

NL1039053

Box No. VII Certain defects in the application

see separate sheet

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 The document D1: EP 0 488 097 describes (Fig. 1) a device comprising

a first fluid channel (3, 6, 7) with a fluid inlet and a fluid outlet,

a second side channel and a third side channel both obliquely connected to the first rectangular fluid channel whereby the angle between the first fluid channel and the second side channel is more than 5 degrees, and

acoustic wave generating means (4, 5) connected to the second side channel and to the third side channel, the acoustic wave generating means being capable to produce wave interference in the first fluid channel.

It is clear that the acoustic wave generating means will be provided with control means for controlling the wave generating means.

The feature "capable to achieve a structure with the generated waves such that at least two node lines or node regions are formed in the first fluid channel as a result of wave interference whereby a significant angle of at least 5 degrees exists between at least two node lines or node regions and the axial direction of the first cylindrical or rectangular fluid channel, resulting in particle being trapped in and / or near the node lines or node regions" is unclear; the description does not give any information concerning the two node lines or node regions or as to how said two node lines or node regions are achieved or measured or determined. Moreover, said feature in the apparatus claim 1 appears to relate to a method of using the apparatus rather than clearly defining the apparatus in terms of its technical features. The intended limitations are therefore not clear from this claim.

Since an unclear feature is not suitable for clearly distinguishing the claimed subject-matter from the prior art, claim 1 lacks novelty over D1.

2 D2: US 3 825 481 shows (Fig. 2) a device with a first fluid cylindrical channel and two side channels, both connected to the first channel at 90°, and acoustic wave generating means ("transducers") connected to the side channels, the acoustic wave generating means being capable to produce wave interference in the first fluid channel.

For the reasons set out in point 1, claim 1 lacks novelty also over D2.

3 The remaining claims do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of novelty and/or inventive step.

Re Item VII

Certain defects in the application

1 The features of the claims are not provided with reference signs placed in parentheses.

2 The background art disclosed in the relevant documents is not mentioned in the description, nor are these documents identified therein.

Re Item VIII

Certain observations on the application

1 It appears that a third side channel (C3) (provided with acoustic wave generating means (A2) and whose axis is shifted with respect to the axis of the second side channel (C2)) is a necessary and thus an essential feature, in order to produce wave interference in the first channel (C1) and to form two node regions in the first channel.

Since independent claim 1 does not contain this feature it does not meet the requirement of clarity that any independent claim must contain all the technical features essential to the definition of the invention.

2 Claim 1 is not harmonized with the description:

In claim 1 (lines 5-6) a first cylindrical or rectangular fluid channel appears to be mandatory; the description (page 3, line 14-15) considers this as a preferred embodiment.

This inconsistency between the claims and the description renders the claims unclear.