

AUSTRALIA
Patents Act 1990

NOTICE OF ENTITLEMENT

I/We PAQUES B.V.

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THE NETHERLANDS

being the applicant(s) in respect of an application for a patent for an invention entitled BIOREACTOR (Application No. 81075/91), state the following:

1. The nominated person(s) has/have, for the following reasons, gained entitlement from the actual inventor(s):

THE NOMINATED PERSON WOULD BE ENTITLED TO HAVE ASSIGNED TO IT A PATENT GRANTED TO THE ACTUAL INVENTOR IN RESPECT OF THE SAID INVENTION.

2. The nominated person(s) has/have, for the following reasons, gained entitlement from the applicant(s) listed in the declaration under Article 8 of the PCT:

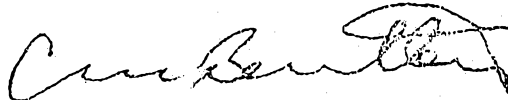
THE APPLICANT AND NOMINATED PERSON IS THE BASIC APPLICANT.

3. The basic application(s) listed in the declaration under Article 8 of the PCT is/are the first application(s) made in a Convention country in respect of the invention.

DATED: 8 January 1993

PAQUES B.V.

GRIFFITH HACK & CO.



Patent Attorney for and
on behalf of the applicant(s)



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BIOREACTOR
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9001654 19.07.90 NL THE NETHERLANDS
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- (71) Applicant(s)
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- (56) Prior Art Documents
AU 63640/90 C02F 3/28
- (57) Claim

1. A bioreactor comprising a reactor vessel having an inlet system for influent or a mixture of influent and recycled material and a reaction chamber located above the inlet system, the outflow openings of the inlet system being at least partially tangentially oriented, wherein the inlet system opens into an influent inlet chamber which is separated from the reaction chamber by a partition which has at least one radial slit, formed by two radial edge strips overlapping one another some vertical distance apart, which radial slit forms the connection between the said inlet chamber and the reaction chamber.

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APPLN. ID 81075 / 91

PA AOJP DATE 26/03/92

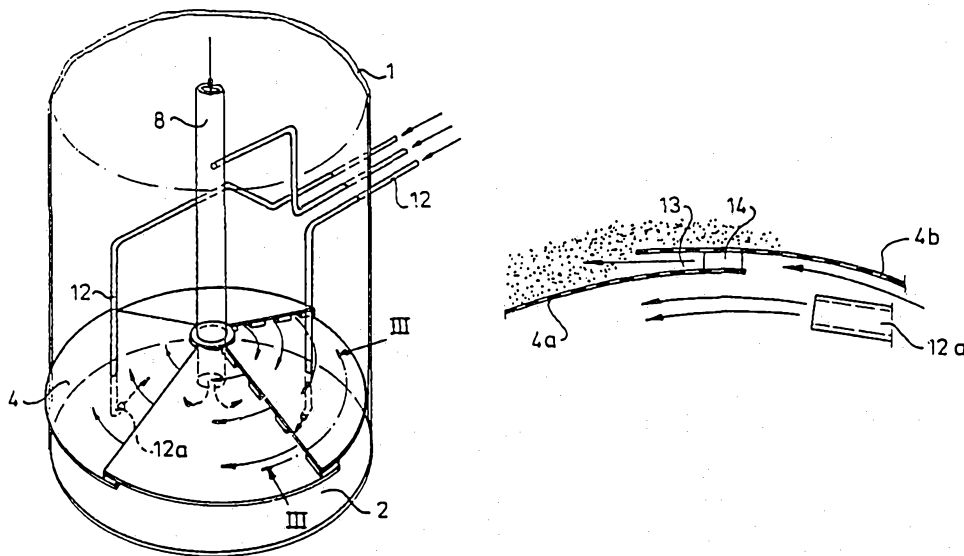
PCT NUMBER PCT/NL91/00118

INTERNATIO

TY (PCT)

<p>(51) International Patent Classification ⁵ : C02F 3/28, B01J 4/00</p>	<p>A1</p>	<p>(11) International Publication Number: WO 92/01637 (43) International Publication Date: 6 February 1992 (06.02.92)</p>
<p>(21) International Application Number: PCT/NL91/00118 (22) International Filing Date: 5 July 1991 (05.07.91) (30) Priority data: 9001654 19 July 1990 (19.07.90) NL (71) Applicant (for all designated States except US): PAQUES B.V. [NL/NL]; T. de Boerstraat 11-13, P.O. Box 52, NL-8560 AB Balk (NL). (72) Inventor; and (75) Inventor/Applicant (for US only): VELLINGA, Sjoerd, Hubertus, Jozef [NL/NL]; Pastoriesingel 23, NL-8458 CP Tjalleberd (NL). (74) Agents: DE BRUIJN, Leendert, C., et al.; Nederlandsch Octrooibureau, Scheveningseweg 82, P.O. Box 29720, NL-2502 LS The Hague (NL).</p>		<p>(81) Designated States: AT (European patent), AU, BE (European patent), BR, CA, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FI, FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, KR, LU (European patent), NL (European patent), NO, SE (European patent), US. Published With international search report. 654961</p>

(54) Title: BIOREACTOR



(57) Abstract

A bioreactor comprises a reactor vessel (1) having an inlet system for influent or a mixture of influent and recycled material and a reaction chamber located above this system. In order to produce an excellent distribution of the influent (which may be mixed with recycled material) without there being a risk of blockage and without excessive wear problems arising, the outflow openings of the influent inlet system (12) are at least partially tangentially oriented and the influent inlet system is located in a chamber (2) which is separated from the reaction chamber by a partition which has at least one radial slit (13), formed by two radial edge strips (4a, 4b) overlapping one another some vertical distance apart, which radial slit forms the connection between the said influent inlet chamber and the reaction chamber.

Title: Bioreactor

The invention relates to a bioreactor comprising a reactor vessel having an inlet system for influent or a mixture of influent and recycled material and a reaction chamber located above this system.

5 Reactors of this type are used to treat fluids (anaerobically or aerobically), or to prepare substances such as alcohol, with the aid of a biomass.

In the field of anaerobic treatment of waste water, new types of reactors having a high load-taking capacity have been developed in recent
10 years, which reactors are characterised by very high volume loads, a relatively small reaction volume and a slimline high construction. The main types are:

- fluidised bed reactors, in which, for example, sand is present as carrier material or adhesion material for the biomass (see EP-A-
15 0090450)),
- expanded bed reactors, in which an immobilised biomass is present in an expanded bed, and
- internal circulation reactors, in which biogas formed is used to generate circulation of the reactor contents (see EP-A-0170332).

20 A difficult point with these reactors is the distribution of the influent, which may be mixed with the recycled effluent, over the bottom surface of the reactor. Influent distribution systems are disclosed in EP-B-0090450 (Gist-Brocades), EP-A-0169620 (Paques) and US-A-4202774 (Dorr Oliver). In general, a distribution of the influent stream over the
25 reactor bottom such that the sludge bed is subject to a completely stable fluidisation or expansion is not achieved with these systems. The consequence of this is the generation of short-circuit flows and dead corners.

- It is known to improve the distribution of the influent by
- 30 - using a large number of inlet points uniformly distributed over the reactor bottom, for example by means of a pipe system, and
 - installing a perforated horizontal distributor plate above an inlet point in order to create a pressure drop which leads to a uniform distribution as a result of dissipation of energy.

35 These inlet systems, which in themselves operate satisfactorily, are subject to a number of disadvantages:

If sand or another hard material is present as carrier material, the influent distribution system will undergo enormous wear as a result of the sand blasting effect. If the reactor is temporarily taken out of

operation, the sludge bed settles and this causes difficulties in restarting the installation and, moreover, sludge particles can flow back into the distribution system, as a result of which blockages are formed.

5 The aim of the invention is to overcome these drawbacks and to provide a bioreactor, indicated in the preamble, which produces an excellent distribution of the influent (which may be mixed with recycled material) without there being a risk of blockage and without
10 excessive wear problems arising.

 According to the invention there is provided a bioreactor comprising a reactor vessel having an inlet system for influent or a mixture of influent and recycled material and a reaction chamber located above the inlet
15 system, the outflow openings of the inlet system being at least partially tangentially oriented, wherein the inlet system opens into an influent inlet chamber which is separated from the reaction chamber by a partition which has at least one radial slit, formed by two radial edge
20 strips overlapping one another some vertical distance apart, which radial slit forms the connection between the said inlet chamber and the reaction chamber.

 Preferably the partition consists of two or more segments which partially overlap one another.

25 Preferably further, the partition has an essentially conical shape. An advantage of this is that the material transport from the influent inlet chamber to the reaction chamber also takes place if the inlet chamber is incompletely filled.

30 It is known per se to use a downcomer to return recycled material to the influent inlet system (see, for example, EP-B-0170332). In this case, the downcomer can also have an outflow opening which is at least partially tangentially oriented.

35 The said radial slit or slits preferably have a height of between 0.25 and 10 cm, more preferably between



0.5 and 3.0 cm. The radial edge strips of the partition overlap one another preferably over a length of 0.5-50 cm, more preferably 2.5-25 cm.

5 Packing pieces can be placed in the slit or slits in order to reduce the passage surface of the slit or slits. The flow rate in the slits will consequently be increased, which leads to a greater pressure drop over the slits and thus to a better distribution.

10 The invention will now be illustrated in more detail with reference to the figures.

Figure 1 show a vertical cross-section of an anaerobic treatment installation having internal circulation.

15 Figure 2 shows a view of the bottommost section of the reactor

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according to Figure 1.

Figure 3 shows a cross-section of the wall between the influent inlet chamber and the reaction chamber.

The reactor shown in Figure 1 is an anaerobic waste water treatment installation and consists of a vessel 1, in the bottom of which an inlet chamber 2 for influent is located, which inlet chamber is separated from the reaction chamber 3 located above it by a conical wall 4. The influent inlet system which opens into the chamber 2 and which will be described in more detail ensures good distribution of the influent, which flows via openings, which will be described in more detail, in the conical wall towards the reaction chamber.

Under anaerobic conditions, fermentation takes place in the reaction chamber as a result of contact between sludge grains and water-soluble substances, inter alia lower fatty acids, and methane is formed.

In order to produce a steady turbulence-free flow in the uppermost section of the reactor and to ensure that virtually no sludge is discharged with the effluent, a collection system 5, shown diagrammatically, is installed in the reactor, which collection system feeds gas and floatable sludge into risers 6 which open into separation chambers 7, in which fluid and gas are separated from one another. Fluid collects on the bottom of the separation chamber and flows via a downcomer 8 back to the influent inlet chamber 2. Annular effluent gullies 9 having an effluent discharge 10 are located between the collection system 5 and the separation chamber 7. Gas is discharged via a pipe 11. The various features are described in detail in the Paques EP-B-01070332.

The influent inlet pipes ^{of the inlet system} are indicated by 12. The outflow ends of these pipes are tangentially positioned, as a result of which a rotary eddying motion directed in the direction of the arrows in Figure 2 is imparted to the fluid present in the inlet chamber 2. As a result of this rotary motion, complete mixing takes place. The outlet of the downcomer 8 can also be oriented tangentially to support the rotation.

The conical wall 4 consists of a number of segments 4a, 4b and so on, which overlap one another some vertical distance apart in order to form radial slits 13. These form the connection between the chamber 2 and the reaction chamber. The feed from the chamber 2 into the reaction chamber 3 is uniformly distributed over all free slit sections.

If the feed to the reactor is stopped, the biosludge will settle in the reaction chamber 3 (where appropriate with carrier material) on the



conical wall 4 and, as a consequence of the overlaps of the segments, the settled sludge is unable or barely able to flow back into the chamber 2. This back-flow is also prevented by the packing pieces 14. Blockage is consequently virtually impossible.

5

When the reactor is taken into service again, complete mixing of the contents of the chamber 2 is achieved again within a short time. This complete mixing and the exclusion of blockage are the most important advantages of the construction described.

10

Figure 2 indicates that one of the influent inlet pipes 12 opens into the downcomer. This can be advantageous, but is not necessary. The invention is not restricted to anaerobic waste water treatment installation, but can also be used on aerobic reactors. The biomass can be immobilised, for example, on an inert carrier material.

15

Further modification may be made to the invention as would be apparent to a person skilled in the art of bioreactor designs. Such modifications may be made without departing from the ambit of the invention, the nature of which is to be ascertained from the foregoing description, the drawings and the claims.

20



THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A bioreactor comprising a reactor vessel having an inlet system for influent or a mixture of influent and recycled material and a reaction chamber located above the inlet system, the outflow openings of the inlet system being at least partially tangentially oriented, wherein the inlet system opens into an influent inlet chamber which is separated from the reaction chamber by a partition which has at least one radial slit, formed by two radial edge strips overlapping one another some vertical distance apart, which radial slit forms the connection between the said inlet chamber and the reaction chamber.
2. A bioreactor according to claim 1, wherein the partition consists of two or more segments partially overlapping one another.
3. A bioreactor according to claim 1 or 2, wherein the partition has an essentially conical shape.
4. A bioreactor according to claim 1, having at least one downcomer for returning recycled material to the influent inlet system, wherein said downcomer also has an at least partially tangentially oriented outflow opening.
5. A bioreactor according to any one of the preceding claims, wherein said radial slit or slits have a height of between 0.25 and 10 cm.
6. A bioreactor according to any one of claims 1 to 4, wherein said radial slit or slits have a height of between 0.5 and 3.0 cm.
7. A bioreactor according to any one of the



preceding claims, wherein the radial edge strips of the partition overlap one another over a length of 0.5 to 50 cm.

5 8. A bioreactor according to any one of claims 1 to 6, wherein the radial edge strips of the partition overlap one another over a length of 2.5 to 25 cm.

10 9. A bioreactor according to any one of the preceding claims, wherein packing pieces are placed in the slit or slits to reduce the passage surface of the slit or slits.

10. A bioreactor substantially as herein described with reference to the accompanying drawings.

Dated this 1st day of September, 1994

PAQUES BV

15 By Its Patent Attorneys

GRIFFITH HACK & CO

Fellows Institute of Patent Attorneys of Australia



fig-1

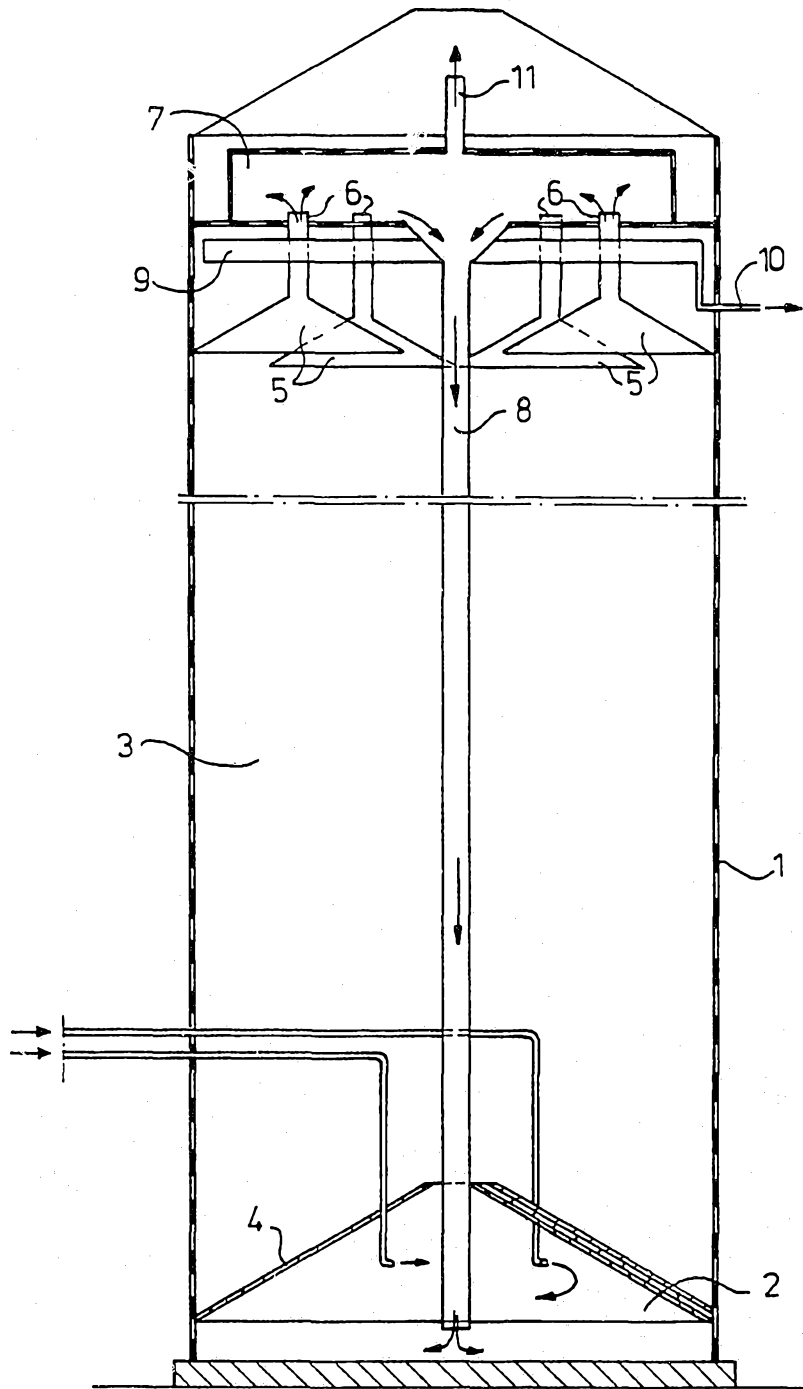


fig-2

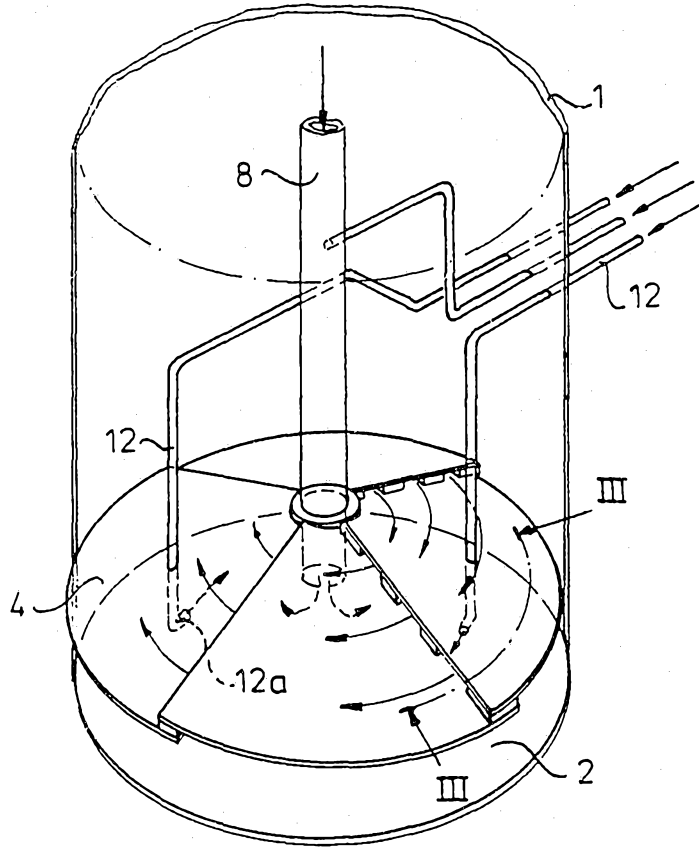
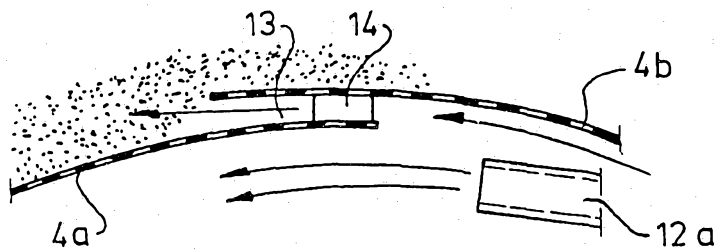


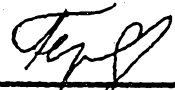
fig-3



INTERNATIONAL SEARCH REPORT

International Application No

PCT/NL 91/00118

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int.Cl. 5 C02F3/28 ; B01J4/00		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
Int.Cl. 5	C02F ; B01J	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹		
Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
A	EP,A,168 283 (DEGREMONT) January 15, 1986 see page 10; claims 1,2 see page 5, line 7 - line 22 ---	1
A	EP,A,153 299 (NÖBL E.) August 28, 1985 see page 15, line 7 - line 16 see page 16, line 15 - line 34 ---	1,3
A	EP,A,232 853 (CARO T.) August 19, 1987 see column 11; claims 1,4 see column 6, line 51 - column 7, line 28 ---	1,3
A	EP,A,164 508 (NIPPON SANGYO KIKAI KABUSHIKI KAISHA) December 18, 1985 see page 4, line 16 - page 5, line 3 see page 6, line 5 - line 23 ---	1
	-/--	
<p>¹⁰ Special categories of cited documents : 10</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family.</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
27 SEPTEMBER 1991	15. 10. 91	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	TEPLY J. 	

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	EP, A, 170 332 (PAQUES B.V.) February 5, 1986 cited in the application see page 8; claims 1-3 ---	1

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.**

NL 9100118
SA 49228

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on the International Patent Application. The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

27/09/91

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