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(54) **Method for reducing sludge.**

(57) The present invention relates to a method for reducing sludge, comprising holding anoxic sludge in a container, in particular a sedimentation tank, and contacting the anoxic sludge with oligochaete material. Furthermore, the invention relates to a method wherein oligochaete material is added to the container wherein the oligochaete material comprises intact oligochaetes, severed oligochaetes, debris from oligochaetes, oligochaete extract, excrements of oligochaetes, parts of oligochaetes or a combination thereof. The invention also relates to a sedimentation tank and the use thereof for reducing sludge.

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Method for reducing sludge

The present invention relates to a method for reducing sludge, a sedimentation tank suitable for performing the method and the use thereof.

Sludge is a solid or semi-solid residue left after processing of domestic and/or industrial waste comprised by wastewater, in particular sewage. Such processing can for example be performed in a sewage plant or wastewater-purification plant. Contemporary processing of wastewater, such as sewage, can comprise several treatments of biological, mechanical and/or chemical nature. Such biological treatment can include aerobic and/or anaerobic conversion processes, digestion, decomposition, fermentation, or the like, whereas mechanical or chemical treatments include purification steps, extraction of substances, filtering, thickening, dewatering, drying, or the like.

One of the main purposes of the biological treatment steps of wastewater or sewage is to reduce the amount of residue for disposal by progressively converting organic matter comprised by the wastewater or sewage into a solid or semi-solid mass (i.e. sludge). Different compounds are obtained or produced during the conversion processes such as water, minerals, nutrients and/or biogas. The sludge as finally obtained from the subjected wastewater or sewage comprises of in essence decomposed or digested organic matter, inorganic matter and water.

This sludge as finally obtained needs to be disposed of in a safe and effective manner for which some possibilities are available. Depending on the quality of the sludge and prevailing legislation, disposal of sludge can be by incineration, land filling, or use as soil conditioner.

Besides that sludge is obtained from wastewater treatment, an effluent stream of water is produced which, when sufficiently clean, can be discharged to the environment.

Biological treatment of sludge using oligochaete worms has been described previously. However, such methods are expensive when considering the costs per kilogram sludge treated. Such high expenses are caused by, for example, the requirement to use expensive reactors, the need for input of significant amounts of heat to provide suitable conditions to sustain populations of oligochaete worms, the need for aeration during sludge treatment, or combinations thereof.

Besides the economic requirement to reduce costs for purifying wastewater or sewage, the need for more efficient and effective methods of reducing sludge is becoming an important issue as well. As prices for disposing sludge are high and may be expected to increase, the need to develop more effective methods by which it is possible to increase reduction of sludge more and more present.

The present invention has for its object the provision of a solution to the above-mentioned problems by a method and device for reducing sludge.

This goal is achieved according to the invention by the provision of a method for reducing sludge, comprising holding anoxic sludge in a container, in particular a sedimentation tank, and contacting the anoxic sludge with oligochaete material.

An advantage of the present invention is that a low-cost, labour-extensive, effective method of reducing sludge is provided. During the research that led to the invention it was found that when anoxic sludge was held in a container and was contacted with oligochaete material, a reduction of up to 70% in the amount of sludge could be

achieved. This is the first time such high reduction of dry matter content of sludge is disclosed in this field of research. The fact that such low quantities of sludge remain after contacting sludge with oligochaete material according to the invention, makes the present invention particularly effective and cost-efficient. A direct consequence of the effective reduction of sludge is that the amount of sludge which needs to be disposed of is reduced which is an important factor which contributes to the economical benefit of the present invention.

The sludge which is held in the container can comprise of sludge derived from wastewater treatment, secondary sludge, digested sludge, oligochaete-treated sludge, or a combination thereof. It is also intended to include primary sludge.

The terms primary sludge, digested sludge and secondary sludge herein are all used in its art-recognized meaning. Primary sludge herein comprises the settled fraction obtained after primary sedimentation of raw domestic sewage or industrial wastewater before being subjected to further processing steps. The term secondary sludge, also known as activated sludge or surplus sludge, herein comprises sludge which is obtained after treatment of primary sludge with biological floc. Active sludge particles are largely composed of saprotrophic bacteria, and may include protozoan flora, such as amoebae, Spirotrichs, Peritrichs including Vorticellids, and a range of other filter feeding species and/or motile and sedentary Rotifers. Digested sludge is sludge of which the for fermentation accessible content has in essence been completely fermented. Such sludge is for example derived from primary or secondary sludge which is subsequently digested.

It is currently hypothesized that the surprising

high efficiency of sludge reduction as obtained by the present invention is based on improved release of compounds comprised by sludge particles, subsequent increased exposure or accessibility of such compounds to biological, (bio)chemical and/or physical degradation processes which allows significant improvement and prolonged sludge reduction in a container. In this model, the reduction of sludge in the container results from a combination of effective micro-organism activities, prolonged effects induced by oligochaete activities, increased enzymatic activities, release of bacterial content resulting from oligochaete feeding on those bacteria, increased physical decomposition of sludge particles which allows further degradation thereof and/or occurrence of particular biochemical reactions in the sedimentation tank or from compounds formed as a result of digestion or partial digestion of sludge by oligochaetes.

The demonstrated effect of sludge reduction by holding sludge in a container and contacting sludge with aquatic oligochaete material can be a result of the following underlying combination of processes which are hypothesized to allow improved sludge reduction in the container.

a) Pre-treatment of sludge by oligochaete worms releases an increased amount of previously inaccessible sludge. Subsequent containing in and/or adding to a container of this oligochaete-treated sludge allows prolonged oligochaete-induced sludge treatment in the tank and subsequent sludge reduction. For example, dry matter content of sludge streams or size of sludge particle may be reduced due to the passing of sludge particles through the gastrointestinal tract of these worms adding to the improved sludge reduction in the container.

b) During sludge pre-treatment, bacteria or enzymes may be excreted by the oligochaetes which subsequently end up in the sedimentation tank. Such bacteria or enzymes may further reduce the sludge during the containment thereof in the sedimentation tank. It is also conceived possible that the from oligochaete-treated sludge originating oligochaetes or parts thereof, but also the contents of their gastrointestinal track, decompose in the sedimentation tank thereby further contributing, e.g. in a synergistic manner, to the reduction process which takes place in the container.

c) Increased fermentation of organic matter leading to methane and carbon dioxide production. The amount of methane as formed per tonne sludge organic dry matter amounts to between 150-450 m^3. Fermentation takes place naturally but is facilitated by the increased release of sludge.

d) Anoxic oxidation of solids by denitrification, i.e. the mineralisation of solids by using nitrite or nitrate as electron acceptor or DNRA. Consequently, CO_2, ammonium and nitrogen gas are produced.

e) Leaching, i.e. dissolving of inorganic salts leading to reduction of dry matter.

f) Other biochemical reactions, e.g. Sharon reactions and/or other such biochemical reactions. Such reactions lead to reduction of sludge as the reaction products comprise soluble minerals or gaseous (N_2) products or H_2O.

g) Presence of bacteria which are able to use nitrite and/or nitrate as a source of energy which further aids in the reduction of sludge.

By analysing and reconstructing the presently disclosed invention, it becomes clear that pre-treatment of

sludge with oligochaete material, in combination with microbial activity originating from the sludge contained in the container, and the (bio)chemical and physical processes that occur herein, a synergistic effect is obtained leading to improved or prolonged sludge reduction. For example, release of sludge would lead to increased accessibility of dry matter for subsequent conversion processes which in turn would allow more efficient denitrification, fermentation, leaching and the like, ultimately leading to increased sludge reduction.

Irrespective of the precise underlying mechanisms, this is the first disclosure that holding of sludge in a container and contacting the sludge with oligochaete material, in particular aquatic oligochaetes, provides a reduction of about 70% dry matter or more. Such an effect has not been disclosed previously, nor these measures to achieve this effect.

The conditions under which the sludge is held in the container comprise temperatures, such as between 4 to 45°C, more preferably between 4 to 36°C, most preferably between 20 to 28°C. The container comprises between 5 to 120 g/l dry matter, preferably between 15 to 50 g/l dry matter. The retention time of the sludge contained in the container is between 40 to 150 days, preferably between 60 to 90 days. Obviously, longer retention times would be possible but the efficiency of the present invention does not require longer retention times. Furthermore, the content, i.e. sludge, of the container is in essence anoxic. Hence, it is understood by the skilled person that the sludge comprised by the container is “anoxic sludge”. A consequence of the contents of the container being anoxic is that the conditions for oligochaete worms, aquatic oligochaetes in particular, are such that life of these worms cannot be sustained. Bound

oxygen is however present in the sludge, for example from nitrate, which microbes can use as electron acceptor for mineralization of solids. From the above it follows that the conditions in the container are adverse for oligochaete worms in such a manner that growth and development of such worms, or development of a population of such worms, is not a likely possibility.

A container according to the invention can be any sedimentation tank, storage device, pond or lagoon that be used to hold, keep or contain and/or collect sludge to allow the sludge to settle resulting in the formation of a sediment. Such devices are for example used in a sewage plant or wastewater-purification plant. Consequently, the term “container” herein is meant to include any suitable device for holding sludge such as a sedimentation tank, settling tank, sludge tank, digester, storage tank or other holding tank but also any suitable lagoon or pond.

According to a preferred embodiment of the invention, oligochaete material is added to the sludge holding container. An advantage of addition of oligochaete material to the container is that the enhanced reduction of sludge as obtained can be further supported, prolonged or improved to allow more effective sludge reduction according to the invention to take place.

The oligochaete material according to another preferred embodiment of the invention can comprise intact oligochaetes, severed oligochaetes, debris from oligochaetes, oligochaete extract, excrements of oligochaetes, parts of oligochaetes or a combination thereof. An advantage of using such oligochaete material is that enzymes and/or bacteria capable of converting or reducing sludge that are comprised by th**e** worms are also added to the container. Species that can be used as a source

for such material preferably comprise aquatic oligochaetes, such as species from the Naididae family, such as *Aulophorus furcatus*, but also other species from other families such as the Aeolosomatidae, Tubificidae, free swimming or sessile aquatic oligochaetes, but also non-aquatic oligochaetes from the Lumbriculidae and Lubricidea family such as earthworms, terrestrial worms or any other suitable oligochaete worm that can be used to reduce sludge is intended useful. Wherever in the text the term “oligochaete material” is used, this is meant in the context of the oligochaete material and oligochaete species as mentioned according to the invention.

Additionally or alternatively according to yet another preferred embodiment of the invention, sludge is added to the sludge holding container. Such sludge added to the container comprises of primary sludge, secondary sludge, digested sludge, oligochaete-treated sludge, sludge derived from wastewater treatment or a combination thereof.

Oligochaete-treated sludge as used herein is intended to comprise sludge derived from wastewater treatment, secondary sludge, digested sludge or a combination thereof, which has been treated in a conditioned environment with oligochaetes as meant herein in such a manner that these worms were allowed to reduce the sludge by feeding thereon. One such treatment of sludge with oligochaetes, in this case aquatic oligochaetes, which can be used to obtain oligochaete-treated sludge is comprised by the invention as disclosed in PCT/NL2006/000076. However, besides the particular aquatic oligochaetes used according to the invention disclosed therein, any oligochaete worm that can be used to reduce sludge is intended useful for reducing sludge in a container according to the present invention.

An advantage of adding, or containing, oligochaete-treated sludge is that oligochaetes are first allowed to treat the sludge by passage of sludge through the digestive tract of these worms. Such treatment likely improves accessibility for further biological degradation of organic matter or release of inorganic matter contained in sludge particles which contributes to the reduction of sludge. Also any combination of oligochaete-treated sludge with primary or secondary sludge is preferred as oligochaete-treated sludge contains oligochaete material which can contribute to subsequent reduction of sludge held in the container.

In another embodiment of the invention, an aqueous medium is added to the sludge containing container in an amount such that water comprised by the aqueous medium has a hydraulic retention time of between 5 to 500 hours, preferably 10 to 96 hours. The hydraulic retention time herein is a measure of the average length of time that water remains in the container. Hydraulic retention time is calculated by dividing the volume of aeration tank by the influent flow rate, wherein volume is in m^3 and influent flow rate is in m^3/h. The aqueous medium could be added in a batch-wise manner or preferably continuously such that a continuous flow of water is generated. Embodiments of the invention wherein an aqueous medium is used comprise water or preferably sludge, or a combination thereof.

An advantage of adding an aqueous medium to the container is that a flow of water is created through the container as a result of which slow release of inorganic material such as salts, i.e. leaching, is promoted thereby reducing the amount of dry matter.

Another advantage of adding an aqueous medium to the container is that gentle movement of the content of the

container is caused which likely contributes to a better distribution of the content of the container and/or better distribution of added oligochaete material through the sludge in the container.

In a preferred embodiment of the invention, the sludge which is added as the aqueous medium comprises secondary sludge, digested sludge, oligochaete-treated sludge, sludge derived from wastewater treatment or a combination thereof. Also intended useful for practicing the invention is primary sludge. The sludge according to this embodiment comprises between 0.1 and 5.0 g/l dry matter.

An advantage of adding sludge as an aqueous medium is that particles contained by the sludge are retained in the container by filtering. Such filtering is caused by large aggregates of dry matter, such as a blanket of dry matter which is floating in the container or submerged aggregated dry matter in the container, through which the sludge flows. Particles comprised by the sludge are consequently retained in the container by filtering. The water to be discharged is clear and merely needs removal of ammonium, phosphate and/or nitrogen, before disposal to the environment.

An additional advantage of adding oligochaete-treated sludge is that oligochaete-material as herein described is added to the container allowing suitable sludge reduction.

In yet another preferred embodiment of the invention, the aqueous medium is added to the container at any depth lower than 70%, preferably lower than 80%, more preferably lower than 90% of the average depth of the container. The addition of aqueous medium to the container preferably occurs at such a depth that the flow of water through the container extends over a distance stretching

across the container, preferably over the diagonal distance of the container. Also, filtering through aggregates of dry matter, such as a blanket of dry matter which is floating in the container or submerged aggregated dry matter in the container, is enhanced by discharging the sludge at a sufficient depth as disclosed.

It will be clear to the skilled person that in order to allow such preferred flow of water through the container, an inlet for allowing addition of the aqueous medium to the tank and an outlet for allowing discharge of the effluent water stream should be positioned such that the flow of water occurs through in essence the entire or most of the container.

It will also be clear to the skilled person that discharging of water from the container occurs preferably by overflowing of the tank. Consequently, the inlet for filling of the tank is preferably positioned in close proximity of the bottom and/or a side of the container according to the invention. Other suitable embodiments are also possible wherein the water flows through the container over a shorter distance.

In another embodiment of the present invention, the content of the container is gently stirred using a stirring means. Such a stirring means can comprise a mechanical stirring means, such as a mixer, agitator, shaker, stirrer, such as a magnetic or mechanical stirrer, airlift which allows gentle mixing or blending of the content of the container thereby increasing contact between active components and convertible matter, increasing diffusion and/or reducing aggregate formation such that sludge reduction is increased, for example by more efficient conversion of organic matter and/or leaching of salts. The sludge in the container is also brought into motion,

although the effect is subtle, as a result of escape of gas bubbles formed by fermentation, occurrence of exothermic reactions, active transport and the like. Additional stirring of the container can lead to a more even distribution of the content of the container, better distribution of added oligochaete material through the sludge in the container and/or improved settling of sludge. This prevents or diminishes formation of channels through which aqueous media comprising sludge particles flow. Reduction of such channels forces newly added aqueous media comprising sludge particles through sludge thereby acting as filter. It will be clear to the skilled person that stirring of the content of the container should be such that dewatering of the sludge is not compromised.

According to another embodiment of the invention, the added sludge comprises between 0.1 to 5.0 g/l dry matter. Such sludge comprises sludge derived from wastewater treatment, secondary sludge, digested sludge, oligochaete-treated sludge, or a combination thereof. Also intended useful for practicing the invention is primary sludge.

In yet another embodiment of the invention, sludge contained in the container is mechanically dewatered. Mechanical dewatering has the advantage that sludge can be obtained with higher dry matter content than 20-50 g/l.

It is further contemplated that combining measures and/or more efficiently applying particular measures such as increasing the stirring of the content of the container, or adding more bacteria, enzymes and/or oligochaete material, or more efficiently releasing the content of bacteria through the action of oligochaete worms, a further increase in the reduction of sludge to 85 or 90% is possible.

Another aspect of the present invention relates to a sedimentation tank or container for performing the method

as described suitable for holding sludge. In a preferred embodiment, the sedimentation tank comprises an inlet for filling of the sedimentation tank with sludge. Also preferred is that the sedimentation tank comprises an outlet or discharging means for discharging an effluent water stream out of the sedimentation tank.

The inlet is positioned at a depth lower than 70%, preferably lower than 80%, more preferably lower than 90% of the average depth of the sedimentation tank. The outlet preferably comprises a vertically positioned outlet in close proximity to a side of the tank, along in essence the entire side or along most of the depth of the sedimentation tank. The vertical outlet is preferably provided over in essence its entirety with a plurality of independently operable outlets. This configuration allows discharge of the effluent water stream along in essence the entire depth of the sedimentation tank. Preferably, the effluent water is discharged by overflow of the tank or through any of the plurality of independently operable outlets positioned along the depth of the sedimentation tank. When the inlet is positioned in close proximity to the bottom of the tank, an in essence diagonal flow of water is created in the sedimentation tank.

The content of the sedimentation tank can be further agitated, blended, mixed or stirred when the tank is provided with a stirring means.

In a more preferred embodiment, the inlet is combined with a stirring means such that the sludge and/or aqueous medium entering the sedimentation tank causes a slow distribution of newly added material and the content of the tank. For example, a stirring means which scrapes the bottom of the tank with vertical bars, such as in a thickening tank, wherein the scraper comprises one or more outlets for

allowing material to enter the tank. While the scraper slowly moves in a circular motion in close proximity to the bottom of the tank, sludge is then allowed to enter the tank. The vertical bars gently disturb the sludge while the scraper moves around, cause of gentle stirring of the content of the tank and simultaneously allow better dewatering of the sludge.

Finally, the invention relates to the use of a sedimentation tank for reduction of sludge comprising containing sludge in a sedimentation tank and contacting the sludge with oligochaete material.

In a preferred embodiment, the sludge is primary sludge, secondary sludge, digested sludge, oligochaete-treated sludge, sludge derived from wastewater treatment or a combination thereof.

The invention is further illustrated by the following examples which are in no way meant to restrict the invention in any manner.

Example 1

A continuous effluent stream of oligochaete-treated sludge, derived from a reactor to which secondary sludge was added and which comprised a population of nestling aquatic oligochaetes (*Aulophorus furcatus*), with a dry matter content of between 0.1 and 3.0 g/l was added with a rate of between 10-30 m^3/h to a sedimentation tank with a capacity of 900 m^3. The sludge is gravitationally dewatered in the sedimentation tank wherein the sludge is allowed to settle by way of which the dry matter content is raised to about 30g/l. The effluent stream of water is clear and of sufficient quality for further treatment, i.e. removal of

dissolved nitrogen and phosphate in an aeration tank or the like. The hydraulic retention time is about 3.5 days as the average flow is 11 m^3/h and the tank is 900 m^3). The oligochaete-treated sludge is added to the sedimentation tank in close proximity to the bottom thereof, at a depth of 2.8 meter of the total depth of 3 meter.

In the sedimentation tank a cover of sludge is formed which acts as filter to filter out sediment from newly added sludge. This cover, or blanket, is continuously flushed with water flowing from the inlet of the tank to the surface after which the water subsequently overflows out of the tank creating an effluent stream. The sedimentation tank also forms submerged larger aggregates of sludge particles and there among flowing water. Consequently, the process of filtering and flushing is expected to be amenable for further optimization. The sludge retention time is up to 135 days for the sludge which was first added. The sedimentation tank was placed under ambient temperatures of between 4 to 25°C. The sludge comprised by the sedimentation tank is essentially anoxic.

It was found that approximately 20-25 tonnes dry matter of sludge was recovered from the sedimentation tank whereas a total amount of 50 tonnes dry matter was added. The theoretical capacity of the sedimentation tank is 27 tonnes of sludge (900 m^3 and 30g/l). Apparently, very effective and extended decomposition of sludge takes place in the tank. Table 1 provides a more detailed overview of the results.

The ash-content of the recovered sludge was slightly higher than the ash-content of the sludge which was added to the sedimentation tank but less than expected. The amount of ashes was around 40% in the sedimentation tank compared to around 30% at the start of the process.

Surprisingly, the reduction of sludge as demonstrated herein is very effective with reduction of sludge of 40 and up to about 70%. Sludge reduction herein is measured as the amount of recovered sludge (in kg dry matter) as a function of the total amount of added sludge.

Example 2.

The experimental set-up and conditions for reducing sludge were similar to the conditions as mentioned in example 1 with the exception that the sludge added to the sedimentation tank was a mixture of oligochaete-treated sludge and wastewater-derived or secondary sludge. The percentage wastewater-derived or secondary sludge was between about 13 and about 50 percent by weight of the total amount of sludge (cf table 1).

Also the reduction of sludge by adding oligochaete-treated sludge and wastewater-derived or secondary sludge is very effective with sludge reduction percentages of up to about 70%. Sludge reduction herein is measured as the amount of recovered sludge (in kg dry matter) as a function of the total amount of added sludge.

	Sedimentation tank					
Period (days)	IN from worm reactor	IN direct	IN total	OUT	Sludge decrease	%
84	44946		44946	14742	30204	67%
65	23590		23590	16356	7234	31%
70	29845		29845	20832	9013	30%
137	48135	7775	55910	23256	32654	58%
75	18750	14776	33526	16207	17319	52%
90	31933	13455	45388	22680	22708	50%
122	27254	21299	48552	18202	30350	63%

Table 1: Sludge input and output of sedimentation tank comprising anoxic sludge. The first column indicates the number of days the sludge was contained in the sedimentation

tank. The second column indicates the amount of oligochaete-treated sludge in kg which is added from the oligochaete-comprising reactor. The third column indicates the amount of sludge derived from wastewater treatment in kg without prior oligochaete-treatment. The fourth and fifth columns indicate the total amount of sludge in kg added and retrieve from the sedimentation tank respectively. The sixth and seventh columns indicate the decrease of the amount sludge in kg and as percentage by weight respectively. Results were obtained from 7 non-overlapping periods of time.

Conclusies

1. Werkwijze voor het verminderen van slib, omvattende het houden van anoxisch slib in een houder, in het bijzonder een sedimentatie tank, en het in contact brengen van het anoxische slib met materiaal van oligochaeten.

2. Werkwijze volgens conclusie 1, waarbij materiaal van oligochaeten wordt toegevoegd aan de houder.

3. Werkwijze volgens conclusie 1 of 2, waarbij het materiaal van oligochaeten intacte oligochaeten, beschadigde oligochaeten, overblijfselen van oligochaeten, extract van oligochaeten, uitscheidingen van oligochaeten, delen van oligochaeten of een combinatie daarvan omvat.

4. Werkwijze volgens een van de conclusies 1-3, waarbij slib wordt toegevoegd aan de houder.

5. Werkwijze volgens een van de conclusies 1-4, waarbij een waterig medium wordt toegevoegd aan de houder in een zodanige hoeveelheid dat het water omvat door het waterige medium een hydraulische retentietijd heeft van tussen 5-500 uur, bijvoorkeur 10-96 uur.

6. Werkwijze volgens conclusie 5, waarbij het waterige medium slib of water omvat of een combinatie daarvan.

7. Werkwijze volgens conclusie 5 of 6, waarbij het slib primair slib, secundair slib, gedigesteerd slib, met oligochaeten-behandeld slib, slib afkomstig van afvalwaterzuivering of een combinatie daarvan is.

8 Werkwijze volgens een van de conclusies 5-7, waarbij het waterige medium wordt afgegeven aan de sedimentatie tank op een diepte lager dan 70%, bijvoorkeur lager dan 80%, meer bijvoorkeur lager dan 90% van de gemiddelde diepte van de sedimentatie tank.

9. Werkwijze volgens een van de conclusies 1-8, waarbij de inhoud van de sedimentatie tank middels een roerinrichting voorzichtig wordt geroerd.

10. Werkwijze volgens een van de conclusies 1-9, waarbij het toegevoegde slib tussen 0,1 - 5,0 g/l drogestof omvat.

11. Werkwijze volgens een van de conclusies 1-10, waarbij het toegevoegde slib en/of slib in de sedimentatie tank is primair slib, secundair slib, gedigesteerd slib, met oligochaeten-behandeld slib, slib afkomstig van afvalwaterzuivering of een combinatie daarvan is.

12. Werkwijze volgens een van de conclusies 1-11, waarbij de oligochaeten aquatische oligochaeten, in het bijzonder aquatische nestelende oligochaeten, zoals soorten gekozen uit de groep bestaande uit soorten uit de Naididae familie, zoals *Aulophorus furcatus* en/of soorten uit de Aeolosomatidae familie; en/of in de grond levende oligochaeten, in het bijzonder Lumbriculidae en/of Lubricidea.

13. Werkwijze volgens een van de conclusies 1-12, waarbij de houder tussen 5 - 120 g/l drogestof, bijvoorkeur tussen 15 - 50 g/l droge stof omvat.

14. Werkwijze volgens een van de conclusies 1-13, waarbij het slib in de houder een temperatuur heeft van tussen 4 - 45°C, bijvoorkeur tussen 4 - 36°C, meest bijvoorkeur tussen 20 - 28°C.

15. Werkwijze volgens een van de conclusies 1-14, waarbij de retentietijd van het slib in de houder 40 - 150 dagen, bijvoorkeur 60 - 90 dagen is.

16. Sedimentatie tank voor het uitvoeren van de werkwijze volgens een van de conclusies 1-15, geschikt voor het houden van anoxisch slib waarbij het slib primair slib, secundair slib, gedigesteerd slib, met oligochaeten-

behandeld slib, slib afkomstig van afvalwaterzuivering of een combinatie daarvan is.

17. Sedimentatie tank volgens conclusie 16, omvattende een toevoer voor het vullen van de sedimentatie tank met slib.

18. Sedimentatie tank volgens conclusie 16 of 17, omvattende een afvoer voor het afvoeren van water.

19. Sedimentatie tank volgens een van de conclusies 16-18, omvattende een roerinrichting.

20. Sedimentatie tank volgens een van de conclusies 16-19, waarbij de toevoer is geplaatst op een diepte lager dan 70%, bijvoorkeur lager dan 80%, meer bijvoorkeur lager dan 90% van de gemiddelde diepte van de sedimentatie tank.

21. Gebruik van een sedimentatie tank voor het verminderen van slib omvattende het houden van anoxisch slib in a sedimentatie tank en het in contact brengen van het slib met materiaal van oligochaeten.

22. Gebruik volgens conclusie 21, waarbij het slib primair slib, secundair slib, gedigesteerd slib, met oligochaeten-behandeld slib, slib afkomstig van afvalwaterzuivering of een combinatie daarvan is.

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE
	L/2HL08/MIM/2
Nederlands aanvraag nr. **2003191**	Indieningsdatum **13-07-2009**
	Ingeroepen voorrangsdatum
Aanvrager (Naam) **Elsdon B.V.**	
Datum van het verzoek voor een onderzoek van internationaal type **03-11-2009**	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. **SN 53174**

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

Volgens de internationale classificatie (IPC)

A01K67/33 **C02F11/02**
C02F3/32

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

Classificatiesysteem	Classificatiesymbolen
IPC 8	**A01K** **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 2003191

A. CLASSIFICATIE VAN HET ONDERWERP
INV. A01K67/033 C02F11/02
ADD. C02F3/32

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)
A01K 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 2005/194310 A1 (YAMAMOTO KAZUO [JP] ET AL YAMAMOTO KAZUO [JP] ET AL) 8 september 2005 (2005-09-08) * figuur 1 * * alinea [0023] - alinea [0024] *	16-20
X	JP 2000 237797 A (KOBE STEEL LTD) 5 september 2000 (2000-09-05) * samenvatting *	16-20

-/--

[X] Verdere documenten worden vermeld in het vervolg van vak C.

[X] 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
25 februari 2010	

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

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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

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2003191

C.(Vervolg). VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	HUANG ET AL: "Excess sludge reduction induced by Tubifex tubifex in a recycled sludge reactor" JOURNAL OF BIOTECHNOLOGY, ELSEVIER SCIENCE PUBLISHERS, AMSTERDAM, NL, deel 127, nr. 3, 1 december 2006 (2006-12-01), bladzijden 443-451, XP005787037 ISSN: 0168-1656 * figuur 1 *	16-20
X	WO 2007/040397 A1 (WAGENINGEN UNIVERSITEIT AGROTE [NL]; ELISSEN HELLEN JOHANNES HUBERT [N) 12 april 2007 (2007-04-12) * bladzijde 2, regel 24 - bladzijde 5, regel 15 * * figuren 1,2 *	1-18, 21-22
A	HENDRICKX T L G ET AL: "The effect of operating conditions on aquatic worms eating waste sludge" WATER RESEARCH, ELSEVIER, AMSTERDAM, NL, deel 43, nr. 4, 1 maart 2009 (2009-03-01), bladzijden 943-950, XP025962091 ISSN: 0043-1354 [gevonden op 2008-12-06] * het gehele document *	1-22
A	WEI Y ET AL: "Sludge reduction potential of the activated sludge process by integrating an oligochaete reactor" JOURNAL OF HAZARDOUS MATERIALS, ELSEVIER, deel 163, nr. 1, 15 april 2009 (2009-04-15), bladzijden 87-91, XP025880392 ISSN: 0304-3894 [gevonden op 2008-06-26] * het gehele document *	1-22

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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 2003191

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)		Datum van publicatie
US 2005194310	A1 08-09-2005	GEEN		
JP 2000237797	A 05-09-2000	GEEN		
WO 2007040397	A1 12-04-2007	CN	101198554 A	11-06-2008
		EP	1912904 A1	23-04-2008
		NL	1029052 C2	23-11-2006

OCTROOICENTRUM NEDERLAND

WRITTEN OPINION

File No.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
SN53174	13.07.2009		NL2003191

International Patent Classification (IPC)
INV. A01K67/033 C02F11/02
ADD. C02F3/32

Applicant
Elsdon B.V. te Raalte

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

NL2003191

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	1-15, 21-22
	No:	Claims	16-20
Inventive step	Yes:	Claims	
	No:	Claims	1-22
Industrial applicability	Yes:	Claims	1-22
	No:	Claims	

2. Citations and explanations

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 2005/194310 A1 (YAMAMOTO KAZUO [JP] ET AL YAMAMOTO KAZUO [JP] ET AL) 8 september 2005

D2 JP 2000 237797 A (KOBE STEEL LTD) 5 september 2000

D3 HUANG ET AL: "Excess sludge reduction induced by Tubifex tubifex in a recycled sludge reactor" JOURNAL OF BIOTECHNOLOGY, ELSEVIER SCIENCE PUBLISHERS, AMSTERDAM, NL, deel 127, nr. 3, 1 december 2006, bladzijden 443-451, XP005787037 ISSN: 0168-1656

D4 WO 2007/040397 A1 (WAGENINGEN UNIVERSITEIT AGROTE [NL]; ELISSEN HELLEN JOHANNES HUBERT [N) 12 april 2007

D5 HENDRICKX T L G ET AL: "The effect of operating conditions on aquatic worms eating waste sludge" WATER RESEARCH, ELSEVIER, AMSTERDAM, NL, deel 43, nr. 4, 1 maart 2009 , bladzijden 943-950, XP025962091 ISSN: 0043-1354 [gevonden op 2008-12-06]

D6 WEI Y ET AL: "Sludge reduction potential of the activated sludge process by integrating an oligochaete reactor" JOURNAL OF HAZARDOUS MATERIALS, ELSEVIER, deel 163, nr. 1, 15 april 2009, bladzijden 87-91, XP025880392 ISSN: 0304-3894 [gevonden op 2008-06-26]

2 The present application does not meet the criteria of patentability, because the subject-matter of claims 16-20 is not new.

2.1 The document D1 discloses (the references applying to this document):

A sedimentation tank (16) suitable for performing the method of claim 1 of the application and suitable for containing anoxic sludge, which can be primary sludge, secondary sludge, digested sludge, oligochaete-treated sludge, sludge derived from wastewater treatment or a combination thereof. The sedimentation tank (16) has an inlet (3) positioned at the bottom of the tank (16), suitable for filling the tank (16) with sludge. The

tank (16 has also discharge means (25, 51) for discharging water and stirring means (39) (see in particular fig. 1 and the corresponding passages in the description).

The subject-matter of claims 16-20 is therefore not new in view of D1.

2.2 The documents D2 and D3 disclose similar sedimentations tank (see D2, abstract and D3, fig. 1). The documents D2 and D3 therefore also take away the novelty of claims 16-20.

3 The present application does not meet the criteria of patentability, because the subject-matter of claims 1-15 and 21-22 does not involve an inventive step.

3.1 The document D4 is regarded as being the closest prior art to the subject-matter of claim 1, and discloses:

A method for reducing sludge, comprising holding sludge in a container (1) and bringing the sludge into contact with oligochaete- material (recirculating material from the predator reactor 6).

The subject - matter of claim 1 therefore differs from this known method for sludge reduction in that the sludge in the container (1) is anoxic. The document D4 does not mention anything about the conditions in container 1. The method is therefore new.

The anoxic character of the sludge is a result from anoxic conditions in the container. The anoxic conditions result only in the prohibition of life, growth or developement of oligochaetes. The problem to be solved may therefore be seen as how to prohibit the presence of oligochaetes in the container. It is common knowledge that oligochaetes can not survive without oxygen (see for example D5, §3.1). The solution proposed by claim 1 is therefore obvious and an inventive step can therefore not be acknowledged.

3.2 A similar reasoning can be followed for the independent use claim 21. Claim 21 is therefore also not regarded as being inventive.

3.3 The document D4 mentions also explicitly that predated waste sludge settles more effectively than non-predated waste sludge (see D4, l. 8-10). It would therefore also be obvious to choose a sedimentation tank in stead of a membrane in order to separate water from sludge. The subject- matter of claims 16-18 is therefore also not inventive in view of D4.

3.4 The subject- matter of dependent claims 2-4 and 12 is explicitly disclosed in D4 (see passages cited in the search report). The subject- matter of dependent claims 5-11, 13-15 and 22 does not appear to contribute in solving the technical problem as brought forward in the description of the application in an unexpected way. The subject-matter of dependent claims 2-15 and 22 is therefore also not regarded as being inventive.