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Description

The invention relates to a waste water treatment installation for processing urea-containing waste water, in particular waste water heavily contaminated with urea, as well to a waste water treatment method for treating such waste water.

It is known to treat or process urea-containing waste water in three steps, wherein in a first step urea is converted into ammonia and carbon dioxide in the course of the ammonification. Ammonium ions arise in the water from the ammonia and these in a second step become nitrite by way of feeding oxygen and can be further oxidised into nitrate. In a third step, the nitrate in the course of denitrification can be converted into nitrogen by way of suitable bacteria and bacterial enzymes amid the exclusion of oxygen. Such a method combines aerobic and anaerobic method steps which are to be carried out separately from one another. Thereby, it is difficult to optimally [closed-loop] control the individual method steps in a manner such that all substances are converted in the desired manner, in order at the end to obtain sufficiently treated water having no undesirable substances. WO 2010/030181 A1 and US 5,268,049 describe a bioreactor or a tank in which all process steps are carried out.

With regard to this problem, it is the object of the invention, to improve a waste water treatment installation, to the extent that as a whole, it can be better closed-loop controlled, so that an optimal treatment of the waste water can be achieved with an as low as possible energy consumption.

This object is achieved by a waste water treatment installation with the features specified in claim 1 as well as by a waste water treatment method with the features specified in claim 9. Preferred embodiments are to be deduced from the associated dependent claims, the subsequent description as well as the attached figure.

The waste water treatment installation according to the invention serves for treating urea-containing waste water, in particular waste water greatly contaminated with urea. The waste water treatment installation for this comprises at least one first treatment container which comprises a waste water feed. The installation is designed in order for the urea-containing waste water to be introduced through the waste water feed into the first treatment container, on operation of the waste water treatment installation. The waste water treatment installation for this is provided for converting urea into ammonia in the first treatment container on operation. This is preferably effected by way of urease or urease enzymes which are preferably formed by bacteria. Thereby, it is preferably the case of urolytic bacteria or urease-positive bacteria. Amino acids can also be converted in the first step, apart from urea, wherein the amino acids are firstly converted into urea in the presence of carbon dioxide and subsequently by urease enzymes in a corresponding manner into ammonia. Ammonium ions then preferably arise from ammonia dissolved in water.

According to the invention, the at least one first treatment container is designed in a manner such that it comprises an oxygen feed device, via which oxygen can be fed to the contents of the treatment container. For this, the oxygen feed device can be arranged directly on or in the treatment container. Alternatively, the oxygen feed device can also be arranged on or in the waste water feed or connected to the treatment container in another manner. It is only essential that oxygen can be fed or supplied to the waste water which is led into the treatment container or is located in the treatment container. With regard to the oxygen feed device, it can be the case of a device which introduces pure oxygen but also air into the inside of the treatment container. Thus in particular, it can be the case of an aeration device. The oxygen feed device or aeration device can be provided with a compressor or blower which are arranged outside the treatment container, in order to be able to introduce oxygen and/or air under pressure into the water in the treatment container. Preferably, suitable nozzles or openings which permit the introduction of the gas into the container and preferably a distribution at least in a section of the container are provided in the treatment container.

The waste water treatment installation moreover comprises a control device, via which the oxygen feed device or the aeration device can be switched on and off. Thus the supply of oxygen or air into the waste water can be controlled. The control device can activate the oxygen feed device or aeration device, so that air or oxygen is led to the waste water, or switch these off, so that no air or oxygen is introduced into the waste water. By way of this, one can succeed in the conversion of urea into ammonia or ammonium being able to be selectively carried out aerobically or anaerobically. I.e. the process can be varied in one and the same installation via the control device, such that the conversion of urea into ammonia is carried out in an aerobic manner, i.e. amid the supply of oxygen, or anaerobically without the supply of oxygen. This has the advantage that it is possible to be able to simultaneously carry out a further water treatment step in the same treatment container, depending on the condition, in which the first treatment container is operated, wherein this thus can selectively be a treatment step which is effected amid the supply of oxygen or amid the exclusion of oxygen. This permits a flexible use or a flexible control of the waste water treatment installation, since the first treatment container can be switched from the one operating condition into the other operating condition via the control device.

According to the invention, at least one first sensor which is connected to the control device and which is designed for detecting the concentration of an ammonium or ammonia concentration is present in the waste water treatment installation. The control device thereby is designed such that it switches the oxygen feed device in the first treatment container on and off in dependence on the concentration detected by the first sensor. Thus the process in the first treatment container can be operated either aerobically or anaerobically depending on the detected substance concentration, so that the method variant, with which an optimal water treatment with a simultaneously low as possible energy expense can always be effected. Ammonium or ammonia concentrations in the treated waste water which are too high are particularly undesirable, so that the installation can be controlled or regulated (closed-loop controlled) in dependence on the residual ammonium in the waste water, so that an optimal waste water processing or treatment is achieved, in order to keep the ammonium or ammonia concentration as low as possible. An aerobic or anaerobic operation can be selectively applied in the first treatment container for this.

Moreover the control device according to the invention is designed in a manner such that it switches on the oxygen supply or aeration in the first treatment container when a concentration detected by the sensor exceeds a predefined limit value, in particular when an ammonium or ammonia concentration which is detected by the sensor exceeds a predefined limit value. If the ammonium or ammonia concentration in the treated waste water is below the specified limit value, no oxygen is added to the first treatment tank. A violation of the limit value is an indication that the breakdown of the ammonium in the waste water is not effected rapidly enough. The ammonium in the waste water treatment installation is converted into nitrate and/or nitrite by way of nitrification, preferably in the known manner, as described above. This too is preferably effected with the help of suitable bacteria. Such a method step is effected aerobically, i.e. amid the supply of air or oxygen. If such a process is not effected sufficiently quickly, it is advantageous to carry out the treatment process in the first treatment container in an aerobic manner, so that apart from the conversion of urea into ammonia, a conversion of ammonium into nitrate can also be effected in the first treatment container with the help of nitrification bacteria. Thus two method steps can simultaneously take their course in the first treatment container. However, such an expensive aeration in the first treatment container is not necessary if the ammonia or ammonium concentration in the treated water is low, so that this aeration can be switched off by the control device, so that the energy consumption can be reduced. The nitrification can then be preferably effected in a further, subsequently connected or arranged container, as is described hereinafter.

The first sensor is preferably arranged at an exit side of the waste water treatment installation and detects the an ammonium concentration in the treated waste water, i.e. in the waste water which leaves or is to leave the waste water treatment installation.

According to a further preferred embodiment, at least one circulation device which can be switched on and off by the control device is arranged in the first treatment container. Such a circulation device for example can be pump or a stirrer. The control device is further preferably designed such that the circulation device is switched on when the oxygen feed device in the first treatment container is switched off and vice versa. The circulation device is switched off when the oxygen feed device or aeration device is switched on, since an adequate circulation is then achieved by way of the gas which flows in. However, a circulation by way of the circulation device is useful if no gas is fed.

According to the invention at least one second treatment container is arranged connected subsequently to the first treatment container. This means that waste water exiting from the first treatment container is introduced into the second, subsequent treatment container. For this, both are connected via at least one suitable overflow conduit, and a pump could also be provided as the case may be, in order to deliver the waste water out of the first treatment container into the second treatment container. The second treatment container comprises an oxygen feed device, in particular in the form of an aeration device, wherein in the second treatment container, ammonia and/or ammonium in the waste water is converted into nitrite amid the supply of air, on operation of the waste water treatment installation. I.e. here the nitrification process as has been hitherto described is effected. Such a process must always be effected aerobically, which is why the oxygen supply or air supply via an oxygen feed device or aeration device is necessary. This is therefore preferably designed for constant operation. If such a second treatment container is envisaged, then its effect can however be supported by the first treatment container, if this is operated in the aerobic condition, since then a nitrification can already be additionally effected in the first treatment container. This permits the second treatment container to be designed in a correspondingly smaller manner, since the processing taking its course there, as the case may be, can be supported by the operation of the first treatment container in the aerobic condition, preferably in a manner depending on how high the ammonium concentration in the treated waste water is.

Preferably, an oxidation of the ammonium into nitrate is firstly effected with the help of suitable bacteria with the conversion of ammonium into nitrate. In a second step which can take place in parallel in the same treatment container, the nitrite is then preferably oxidised into nitrate, and this is also effected with the help of suitable microorganisms.

Further preferably, the second treatment container is connected to the first treatment container via a circulation conduit, in which a pump activated by the control device and/or a valve activated by the control device is arranged. The recirculation from the second treatment container back into the first treatment container can be controlled or regulated by the control device by way of activation of the pump and/or of the valve with the help of the control device, and in particular the recirculation can be completely interrupted for example by way of switching off the pump and/or closing a valve, and be switched on again. The recirculation permits a part of the waste water treated in the second treatment container in a second treatment step to be led back into the first treatment container, in order there, to carry out a third treatment step, as described hereinafter. Thereby, it is particularly the case of waste water, in which the ammonium has already been converted into nitrate by way of the oxygen feed in the second treatment container.

Further preferably, the control device is designed in a manner such that it initiates a recirculation from the second treatment container into the first treatment container by way of a suitable activation of the valve and/or of the pump, when the oxygen feed device in the first treatment container is switched off, and a conversion of urea into ammonia takes place under anaerobic conditions in the first treatment container. In this condition, it is possible to let a further anaerobic method step, which in the known manner can be a denitrification step, take its course simultaneously in the first treatment container. Such a denitrification as a rule is effected in an anaerobic manner, i.e. without the feed of oxygen, by way of suitable bacteria, which convert the nitrate into nitrogen, as the case may be amid the feed or supply of carbon, wherein CO_2 can additionally occur. Such a process can take its course in the first treatment container, preferably with the help of carbon which is introduced into the first treatment container by way of the fed waste water via the waste water feed.

According to the invention, it is possible to simultaneously either carry out a nitrification or a denitrification in the first treatment container by way of switching the operation of this first treatment container from an aerobic into an anaerobic operating condition. A flexible utilisation and in particular an improved closed-loop control ability of the complete waste water treatment installation is achieved in this manner. The energy requirement can simultaneously be reduced, since a feeding of air or oxygen in the first treatment container only needs to take place when it is indeed necessary. The carbon which is present in any case in the waste water, can simultaneously be optimally utilised by way of the denitrification in the first treatment container, so that an additional feed of carbon can be reduced or avoided

Regarding the conversion of urea into ammonia and ammonium, it has been found that this process essentially takes its course equally well aerobically as well as anaerobically, in particular amid the use of bacterially produced urease enzymes, so that this process is essentially not influenced by way of the switching-over.

According to a further preferred embodiment, at least one third treatment container is arranged connected subsequently to the second treatment container. This means that the waste water treated in the second treatment container is transferred via a suitable connection conduit or a suitable overflow into the third treatment container. At least one pump for delivering the waste water can also be provided between the second and the third treatment container as the case may be. The third treatment container is provided with a carbon feed device, via which carbon, organically bonded carbon can be fed. The carbon feed device is preferably controllable by the control device, so that the carbon feed device can preferably be switched on and off, further preferably however can be controlled and regulated such that the quantity of the fed carbon can be varied via the control device. On operation of the waste water treatment installation, a conversion of nitrate into nitrogen, i.e. a denitrification amid the feed of carbon is effected in the third treatment container, wherein simultaneously carbon dioxide is released as the case may be. This too is effected with the help of suitable bacteria which decomposes the nitrate in an anaerobic environment, i.e. amid the exclusion of oxygen, so that nitrogen is released. If such a third treatment container is present, then the process taking its course in the third treatment container can additionally or alternatively also be carried out in the first treatment container, if this is an in anaerobic operating condition and the waste water e.g. via the described recirculation conduit is led back from the second treatment container into the first treatment container. Thus the feed of carbon in the third treatment container can be reduced or switched off as the case may be, should a carbon share which is adequately high for this denitrification process in the first treatment container be present in the waste water. A carbon feed device could alternatively also be present on the first treatment container.

According to a further preferred embodiment, a sludge separation device separating sludge or sewage sludge from the treated waste water can be arranged at the exit side of the treatment containers, i.e. preferably at the exit side of the treatment container which is last in the series. The treated waste water can then be led away or discharged, e.g. into a collection container or be led away in another suitable manner. The sludge can be disposed off, treated or reused.

Particularly preferably, the sludge separation device is connected to the first treatment container via a sludge return feed. This serves for reusing the activated sludge or sewage sludge and keeping it in the process. Thus for example the bacteria cultures which are present in the sludge can be retained and be resupplied to the process at the beginning in the first treatment container.

The control device of the waste water treatment installation, apart from the described functions can comprise further control functions. This for example can be the control of existing pumps, for example in the sludge return feed or also in the conduits between the treatment containers and a sludge separation device as the case may be. These can be switched on and off by the control device or, as the case may be, be controlled in their speed, in order to be able to control or regulate the media transport in quantity and speed. The control device can moreover be designed for the control of the described carbon feed and, as the case may be, the air feed or oxygen feed into the first treatment container and/or the second treatment container, wherein the oxygen feed or air feed preferably not only can be switched on and off, but can be closed-loop controlled in its quantity. The control device is moreover designed for pH value control, in order for example to maintain the pH value in the system, in particular in the first treatment container, in a desired range, for example in the neutral range, i.e. between 6.6 and 8.5. The control device can moreover be connected to suitable sensors for this, wherein these sensors detect oxygen concentrations, ammonium as well as nitrate concentrations and/or the pH value and lead them as input variables to the control device for the described control or regulation.

Apart from the described waste water treatment installation, the subject-matter of the invention is a waste water treatment method for treating urea-containing waste water, in particular waste water heavily contaminated with urea. This waste water treatment method in particular is suitable for being carried out whilst using the previously described waste water treatment installation. It is to be understood that method courses or method features described by way of the waste water treatment method, in a preferred design can also be applied with the subsequently described waste water treatment method. Inasmuch as this is concerned, the previous description is referred to with regard to these features.

According to the waste water treatment method according to the invention, urea is converted into ammonia in a first method step, wherein this is preferably effected by way of urease or urease enzymes which are further preferably formed by bacteria, as has been described above. According to the invention, this first treatment step can be selectively carried out aerobically or anaerobically, i.e. the method is designed such that the first treatment step can be changed from aerobic into anaerobic operation or vice versa, so that this treatment step can be changed or adapted, in order to be able to better control or regulate the complete waste water treatment process and, to achieve an optimal waste water treatment with an minimal expense of energy, as described above. The change-over between aerobic and anaerobic operation has the advantage that a further treatment step can take place simultaneously with the conversion of the urea into ammonia, specifically a treatment step which selectively takes its course in an aerobic or anaerobic inner, as has been described above.

According to the invention the first treatment step is carried out aerobically if an ammonium or ammonia concentration in the treated water, i.e. preferably at the exit side of the complete treatment process exceeds a predefined limit value. It is possible to carry out a nitrification in parallel in the same treatment container due to the aerobic design of the first treatment step, in order to break down the ammonium and convert it into nitrite or nitrate, as has been described above.

The method according to the invention is further designed such that in a second treatment step, a conversion of ammonium and/or ammonia into nitrite or nitrate is effected amid the supply of oxygen. This second treatment step is effected subsequently to the first treatment step, in a second treatment container, in which aerobic conditions prevail, i.e. air or oxygen is fed.

If the first treatment step is carried out aerobically, then the second treatment step is preferably at least partly carried out together with the first treatment step in the same treatment container. Thus a simultaneous nitrification in the first treatment container together with the first treatment step can support a nitrification process in the second treatment container, in order to achieve a more rapid breakdown of ammonium. The above description with regard to the waste water treatment installation is referred to in this respect.

Preferably, the method comprises a third treatment step, with which a conversion of nitrate into nitrogen is effected amid the supply or feed of carbon. This, as described above, is effected under anaerobic conditions, i.e. amid the exclusion of oxygen. Preferably, a separate treatment container can be provided for this third treatment step, and this container is preferably arranged subsequently to the treatment containers, in which the previously described treatment steps are carried out.

If the first treatment step is carried out anaerobically, the third treatment step is preferably carried out at least partly together with the first treatment step in the same treatment container. Thereby, one can make do without a carbon feed as the case may be, and the denitrification can be carried out solely with the help of the carbon present in the waste water. The design of this third treatment step simultaneously to the first treatment step in the same container has the advantage that one can make do without an additional container for the denitrification or however a denitrification process in such an additional container can be supported by the denitrification together with the first treatment step. A greater closed-loop control region or an improved adaptability of the installation to changing operating conditions on operation can be achieved by way of this.

The invention is hereinafter explained by way of example and by way of the attached figure. This schematically shows a preferred construction of a waste water treatment installation.

The waste water treatment installation which is shown in the example comprises three treatment containers 2, 4 and 6 which are arranged in series. The first treatment container 2 comprises a waste water feed which is to say a waste water supply 8. The waste water flows out of the first treatment container 2 via a connection 10 into the second treatment container 4 and from the second treatment container 4 via a connection 12 into the third treatment container 6. The connections 10, 12 here are represented as simple connection conduits. However, it is to be understood that pumps for delivering the fluid from one treatment container into the other could also be arranged in the connections 10, 12 as the case may be.

An aeration device 16 which is fed by a blower or a compressor 14 is arranged in the first treatment container 2. The aeration device 16 serves for the supply of oxygen into the inside of the treatment container 2. A circulation device 18 is moreover arranged in the first treatment container 2. A pH value sensor 20 as well as an oxygen sensor 22 detecting the quantity of the dissolved oxygen in the fluid in the treatment container 2 is yet arranged on the first treatment container 2.

An aeration device 24 which is fed by a blower or a compressor 26 is likewise arranged in the second treatment container 4. The aeration device 24 serves for the oxygen supply into the inside of the second treatment container 4. An oxygen sensor 28 is moreover arranged on the second treatment container 4, in order to detect the oxygen content of the water in the inside of the treatment container 4.

A circulation device 30 is arranged in the third treatment container 6. The circulation devices 18 and 30 can be designed as stirring devices or circulation pumps for example. Moreover, a carbon feed 32, via which carbon can be metered into the inside of the treatment container 6 is arranged on the third treatment container 6.

The third treatment container 6 at the exit side is connected to a sludge separation device 34, to which the waste water exiting from the third treatment container 6 is fed via a connection to the delivery pump 36. A collection container 38, in which the treated waste water is collected before it is then discharged via an outlet 40 in a suitable manner, connects at the exit side of the sludge separation device 34. An ammonium sensor 42 which detects the ammonium concentration in the waste water in the collection container 38 is arranged on the collection container 38. A nitrate sensor 44 which detects the nitrate content or the nitrate concentration in the waste water in the collection container 38 is moreover arranged on the collection container 38.

The waste water treatment installation moreover comprises a control device 46 which controls the complete installation and for this is connected to all essential components for their control.

A sludge return feed 46 runs from the sludge separation device 34 into the first treatment container 2, wherein the sludge return feed 46 is provided with a delivery pump 48. The second treatment container 4 is moreover connected to the first treatment container 2 via a recirculation conduit 50, in which a pump 52 is arranged, in order to deliver fluid out of the second treatment container 4 back into the first treatment container 2. A pH value setting device 54, via which the pH value of the waste water flowing into the first treatment container 2 via the waste water feed 8 is set, is yet also provided.

The manner of functioning of the represented waste water treatment installation is as follows. Basically, a conversion of urea or amino acids into ammonia and subsequently into ammonium takes place in the first treatment container 2. A nitrification, with which the ammonium is converted into nitrate, takes place in the second treatment container 4. A denitrification takes place in the third treatment container 6, with which the nitrate is converted into nitrogen and carbon dioxide amid the addition of carbon by way of the carbon feed 32.

The process in the second treatment container 4 must always be carried out aerobically. The conversion of ammonium into nitrate is effected by way of suitable bacteria. The oxygen is simultaneously introduced into the second treatment container 4 via the blower 26 and the aeration device 24. The oxygen feed can be closed-loop controlled by way of the oxygen content being detected via the oxygen sensor 28, and the blower 26 being correspondingly set or adjusted. An autarkic closed-loop control device can be provided for this. Alternatively, this closed-loop control can likewise be assumed by the control unit 46.

The process in the third treatment container 6 takes place without the feed of oxygen, preferably amid the exclusion of oxygen, i.e. anaerobically. A circulation via the circulation device 30 is effected in the third treatment container 6. Carbon is moreover admetered in a suitable quantity via the carbon feed 32. The conversion of nitrate into nitrogen here is likewise effected by way of suitable bacteria. The carbon feed 32 is preferably likewise controlled or regulated via the control device 46, as the dashed line in the figure indicates.

The conversion process of urea into ammonia and then into ammonium is effected by way of urease enzymes which are produced by way of suitable bacteria. What is essential to the invention is the fact that this process can be carried out aerobically as well as anaerobically with more or less the same efficiency and that the waste water treatment installation is suitable for changing between these two operating conditions in the first treatment container 2. The aeration device 16 or its blower 14 are controlled which is to say switched on and off via the control device 46 for this. The control device 46 moreover also controls the circulation device 18 as well as the pump 52 in the recirculation conduit 50.

The aeration device 16 is put out of operation by way of switching off the blower 14, so that no air and no oxygen are fed into the treatment container 2, if the process in the first treatment container 2 is to be carried out anaerobically. The circulation device 18 is simultaneously switched on by the control device 46. The pump 52 is moreover switched on by the control device 46, so that waste water which is treated at the second treatment container 4 is led out of this at least partly back into the first treatment container 2. The waste water treated in the second treatment container 4 contains nitrate due to the conversion which is effected there, and this nitrate is led back via the recirculation conduit 50 into the first treatment container 2. The described denitrification can take place there together with the carbon which in any case is contained in the waste water fed via the waste water feed 8, due to the fact that anaerobic conditions prevail there. I.e., bacteria decompose the nitrate and convert it into nitrogen and, as the case may be, carbon dioxide, which is released into the atmosphere. This denitrification process can thus support the denitrification process in the third treatment container 6 or also completely replace it. Carbon supplied via the carbon feed 32 can be saved on account of this. The waste water treatment installation in this condition is preferably operated with the anaerobic process in the first treatment container 2, if an ammonium content which is not too high is detected in the treated water via the ammonium sensor 42, i.e. the ammonium content lies below a predefined limit value. This method variant can moreover be applied if via the nitrate sensor 44, a nitrate content which is too high is ascertained in the treated waste water, i.e. a nitrate content which exceeds a predefined limit value. In this case, the denitrification process in the treatment container 6 can be operated with maximal power or output and can be additionally supported by the denitrification which takes its course in the first treatment container 38 under anaerobic conditions. If the ammonium limit values as well as the nitrate limit values are fallen short of, then the denitrification process in the third treatment container 6 can be run down by way of throttling the carbon feed 32, in order to carry out the denitrification partly or largely in the first treatment container 2.

If an ammonium content which is too high is determined in the treated waste water by way of the ammonium sensor 42, i.e. an allowable limit value is exceeded, then the control device 46 switches over the method course in the first treatment container 2 into an aerobic operating condition, in which the circulation device 18 is deactivated and simultaneously the oxygen feed via the aeration device 16 is activated. The blower 14 is switched on for this. The pump 52 is simultaneously switched off, so that the recirculation from the second treatment container 4 into the first treatment container 2 is prevented. The oxygen content in the first treatment container can be detected in the aerobic process via the oxygen sensor 22 and can be closed-loop controlled via by the control device 46 via the setting of the fed air quantity. The blower 14 can be set in its speed for this. The conversion of urea into ammonium under aerobic conditions continues in the same manner as under anaerobic conditions. The aerobic conditions in the first treatment container 2 permit a part of the nitrification to simultaneously take its course in the first treatment container 2. I.e. a conversion of ammonium into nitrate, as the case may be via the intermediate step of a conversion into nitrite can also take place in the first treatment container 2 by way of bacteria amid the feed of oxygen. The process in the second treatment container 4 is thus supported, so that simultaneously a larger quantity of ammonium can be converted into nitrate and the quantity of the ammonium which is contained in the treated water can be reduced.

The activated sludge or sewage sludge is led back out of the sludge separation device 34 into the first treatment container 2 via the sludge return feed 46. By way of this, one succeeds in the bacteria which are necessary for the described processes being able to be retained in sufficient quantities in the waste water flow through the three treatment containers 2, 4 and 6. I.e. the sludge and its contents such as bacteria and enzymes remain at least to some extent in the installation, where it is only the treated water which is led away out of the sludge separation device 34 into the outlet 40. The sludge return feed as the case may be can be controlled or regulated by the control device 46, by way of this controlling the delivery pump 48 for example. The control device 46 could also control all other pumps in the system, such as the delivery pump 36 for example. The circulation device 30 could also be controlled or regulated by the control device 46. The same also applied to the pH value setting device.

What is essential to the invention is the fact that an improved adaptation of the waste water treatment installation to differing demands is possible by way of switching the process in the first treatment container 2 from an aerobic into an anaerobic process, in order to always achieve an adequate nitrate reduction as well as an adequate ammonium reduction with an energy and carbon requirement which is the same time is as minimal as possible. Suitable valves for the regulation can also be provided instead of setting or regulating the air feed or oxygen feed via the blowers 14 and 26, so that a common air feed, for example a common compressor could be applied for both aeration devices 16 and 24 as the case may be. An oxygen feed can also be provided instead of an air feed, via which oxygen feed pure oxygen is introduced into the second treatment container 4 and, as the case may be, the first treatment container 2 when this is operated in the aerobic condition.

List of reference numerals

2, 4, 6	-	treatment container
8	-	waste water feed
10, 12	-	connections
14	-	blower or compressor
16	-	aeration device
18	-	circulation device
20	-	pH value sensor
22	-	oxygen sensor
24	-	aeration device
26	-	blower or compressor
28	-	oxygen sensor
30	-	circulation device
32	-	carbon feed or carbon feed device
34	-	sludge separation device
36	-	delivery pump
38	-	collection container
40	-	outlet
42	-	ammonium sensor
44	-	nitrate sensor
46	-	sludge return feed
48	-	delivery pump
50	-	recirculation conduit
52	-	pump
54	-	pH value setting device

Patentkrav

1. Spildevandsbehandlingsanlæg til at behandle urinstofholdigt spildevand, med mindst en første behandlingsbeholder (2), som omfatter en spildevandstilførsel (8), som er designet til, at urinstofholdigt spildevand kan blive ledt ind i den første behandlingsbeholder (2) via spildevandstilførslen (8), hvor den første behandlingsbeholder (2) er designet til, at urinstof kan blive konverteret til ammoniak ved hjælp af ureaseenzymer i den første behandlingsbeholder (2) ved drift af spildevandsbehandlingsanlægget,
kendetegnet ved at
en oxygentilførselsindretning (14, 16), særligt i form af en iltningsindretning (16), er anbragt på eller i den første behandlingsbeholder (2) eller spildevandstilførslen (8), og spildevandsbehandlingsanlægget omfatter en styringsindretning (46), via hvilken oxygentilførselsindretningen (14, 16) kan slås til og fra på en sådan måde, at konverteringen af urinstof til ammoniak kan udføres på en aerob eller anaerob måde, og spildevandsbehandlingsanlægget skifter mellem en aerob driftstilstand og en anaerob driftstilstand i den første behandlingsbeholder (2), hvor mindst en anden behandlingsbeholder (4), som er forsynet med en oxygentilførselsindretning (24, 26), særligt i form af en iltningsindretning (24), er anbragt nedstrøms af den første behandlingsbeholder (2), hvor ammoniak og/eller ammonium i spildevandet kan konverteres til nitrat i den anden behandlingsbeholder (4) under tilførslen af luft, ved drift af spildevandsbehandlingsanlægget, hvor en første sensor (42, 44), som er forbundet til styringsindretningen (46), og som er designet til detekteringen af en ammoniumkoncentration eller ammoniakkoncentration er tilstede, hvor styringsindretningen (46) er designet på en sådan måde, at den slår oxygentilførselsindretningen (14, 16) i den første behandlingsbeholder (2) til og fra afhængigt af en ammoniumkoncentration eller ammoniakkoncentration, som detekteres af den første sensor (42, 44), på en sådan måde, at oxygen tilføres til den første behandlingsbeholder (2), når ammoniumkoncentrationen eller

ammoniakkoncentration i det behandlede spildevand overstiger en forudbestemt grænseværdi, og ingen oxygen tilføres til den første behandlingsbeholder (2), når en ammoniumkoncentration eller ammoniakkoncentration i det behandlede spildevand ligger under den forudbestemte grænseværdi.

2 Spildevandsbehandlingsanlæg ifølge krav 1, kendetegnet ved at den mindst ene første sensor (42, 44) er anbragt ved en udgangsside af spildevandsbehandlingsanlægget.

3. Spildevandsbehandlingsanlæg ifølge et af de foregående krav, kendetegnet ved at mindst en cirkulationsindretning (18), som kan slås til og fra af styringsindretningen (46), er anbragt i den første behandlingsbeholder (2), hvor styringsindretningen (46) er fortrinsvis designet på en sådan måde, at cirkulationsindretningen (18) er slået til, når oxygentilførselsindretningen (14, 16) er slået fra.

4. Spildevandsbehandlingsanlæg ifølge et af de foregående krav, kendetegnet ved at den anden behandlingsbeholder (4) er forbundet til den første behandlingsbeholder (2) via en recirkulationsledning (50), i hvilken en pumpe (52), som aktiveres af styringsindretningen (46) og/eller en ventil, som aktiveres af styringsindretningen (46), er anbragt.

5. Spildevandsbehandlingsanlæg ifølge krav 4, kendetegnet ved at styringsindretningen (46) er designet på en sådan måde, at det, ved hjælp af en egnet aktivering af ventilen og/eller pumpen (52), initierer en recirkulation fra den anden behandlingsbeholder (4) til den første behandlingsbeholder (2), når oxygentilførselsindretningen (14, 16) i den første behandlingsbeholder (2) er slået fra, og en konvertering af urinstof til ammoniak finder sted under anaerobe forhold i den første behandlingsbeholder (2).

6. Spildevandsbehandlingsanlæg ifølge et af de foregående krav, kendetegnet ved at mindst en tredje behandlingsbeholder (6) er anbragt nedstrøms af den anden behandlingsbeholder (4) og er forsynet med en carbontilførselsindretning (32), som er fortrinsvis styrbar af styringsindretningen (46), hvor en konvertering af nitrat til nitrogen finder sted i den tredje behandlingsbeholder (6) ved drift af spildevandsbehandlingsanlægget.

7. Spildevandsbehandlingsanlæg ifølge et af de foregående krav, kendetegnet ved at en slamadskillelsesindretning (34), som adskiller slam fra det behandlede spildevand er anbragt ved udgangssiden af behandlingsbeholderen (2, 4, 6).

8. Spildevandsbehandlingsanlæg ifølge krav 7, kendetegnet ved at slamadskillelsesindretningen (34) er forbundet via en slamtilbagetilførsel (46) til den første behandlingsbeholder (2).

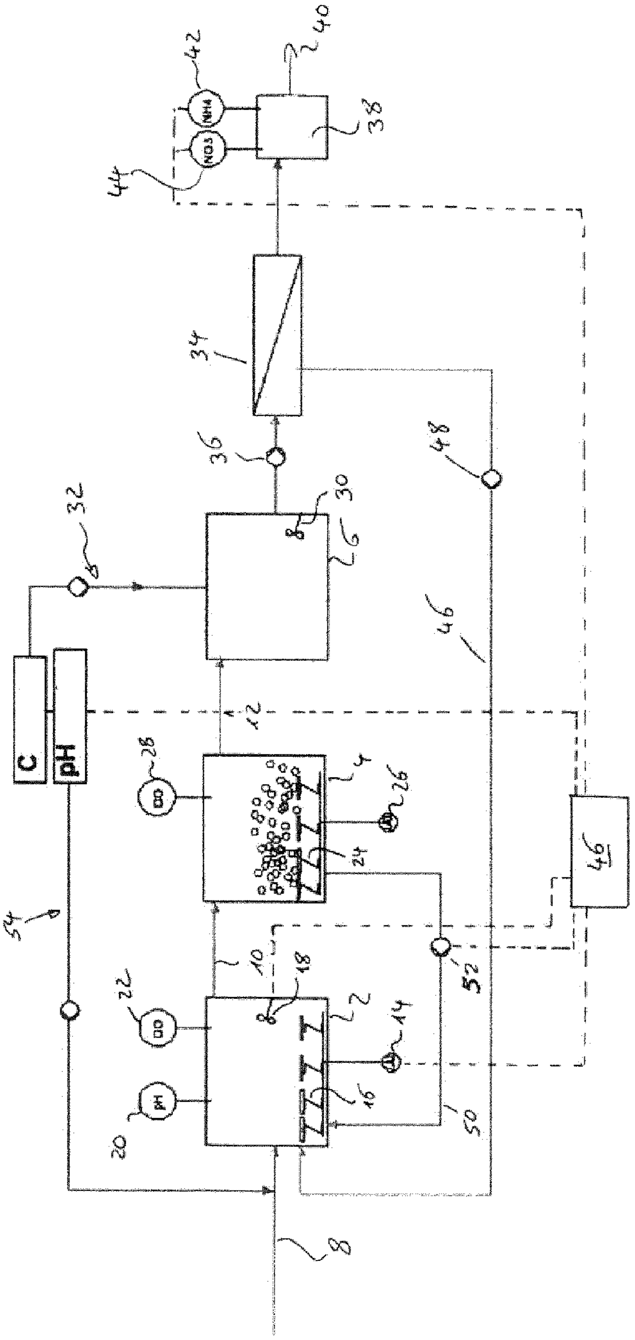
9. Spildevandsbehandlingsfremgangsmåde til at behandle urinstofholdigt spildevand, særligt til anvendelse i et spildevandsbehandlingsanlæg ifølge et af kravene 1 til 8, med hvilken urinstof konverteres til ammoniak af ureaseenzymer i en første behandlingsbeholder (2) i et første behandlingstrin, hvor det første behandlingstrin udføres selektivt på en aerob eller anaerob måde, hvor en konvertering af ammonium og/eller ammoniak til nitrat blandt tilførslen af oxygen udføres i en anden behandlingsbeholder (4), som er anbragt nedstrøms af den første behandlingsbeholder (2), i et andet behandlingstrin,
kendetegnet ved at
det første behandlingstrin udføres aerobt, hvis en ammonium- eller ammoniakkoncentration i det behandlede spildevand overstiger en forudbestemt grænseværdi, og udføres anaerobt, hvis en ammonium- eller ammoniakkoncentration i det behandlede spildevand ligger under den forudbestemte grænseværdi.

10. Spildevandsbehandlingsfremgangsmåde ifølge krav 9, kendetegnet ved at, hvis det første behandlingstrin udføres aerobt, da udføres det andet behandlingstrin delvist sammen med det første behandlingstrin i den samme behandlingsbeholder.

11. Spildevandsbehandlingsfremgangsmåde ifølge krav 9 eller 10, kendetegnet ved et tredje behandlingstrin, med hvilket en konvertering af nitrat til nitrogen gennemføres under tilførslen af carbon.

12. Spildevandsbehandlingsfremgangsmåde ifølge krav 11, kendetegnet ved at, hvis det første behandlingstrin udføres anaerobt, da udføres det tredje behandlingstrin mindst delvist sammen med det første behandlingstrin i den samme behandlingsbeholder.

Fig. 1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