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(54) **Reduction of ammonia emission from livestock housing**

(57) The invention relates to a method for reducing emission of ammonia from a livestock housing. The method comprises applying a composition comprising a compound that restrains ammonia volatilization onto freshly excreted manure by an animal in the livestock housing. Because the compound is deposited onto freshly excreted manure, ammonia volatilization is tackled at the source, rather than at a later moment, e.g. in a manure pit, when contact of feces and urine, and therefore the conversion of urea to ammonia under the influence of urease has already led to volatilization of ammonia.

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Title: Reduction of ammonia emission from livestock housing

The present invention relates to a method for reducing emission of ammonia from a livestock housing facility.

Background Art

Livestock on farms produce a lot of manure, and therefore a lot of ammonia. For example, dairy cows on average secrete in milk about 25 to 35 percent of the nitrogen they consume, whereas the remaining nitrogen is excreted in manure (urine and feces). About half of the excreted nitrogen is in the urine, and approximately 60-80 percent of this nitrogen in urine is in the form of urea.

Nitrogen in manure can be converted to ammonia by bacterial degradation. The primary mechanism for this is by the conversion of urinary urea to ammonia. Urease, an enzyme produced by microorganisms in feces, reacts with urinary urea to form ammonia. Urease activity in feces is high and rapidly converts urea to ammonia after excretion.

Importantly, urine and feces, individually, emit minimal amounts of ammonia. It is the physical process of combining urine and feces, e.g. after excretion by an animal on a floor surface, which results in ammonia volatilization. The problem is predominantly present within buildings that house livestock, i.e. barns, stables, etc. Especially in such buildings, urine and feces contact each other extensively, as the urine cannot escape through the bottom of the floor.

Ammonia has proven to be harmful for the environment. For example, ammonia contributes to surface water eutrophication, nitrate contamination of ground water, and impaired air quality. Also, ammonia gas released into the atmosphere can react with combustion gases, i.e. nitric acid and sulphuric acid, to form ammonium nitrate or ammonium sulphate. These latter forms are the precursors for the development of fine particulate matter. These fine particulates have been shown to cause respiratory problems in humans and contribute to haze and poor visibility.

Due to the above mentioned effects, government regulations regarding ammonia emission are becoming more and more stringent. Therefore, novel ways of reducing ammonia emission by livestock, such as ammonia emission from livestock housing are sought after.

Many mechanical solutions exist, which mainly focus on separating feces and urine or at least diminishing their contact area to prevent conversion of urea to ammonia by urease. Examples can e.g. be found in US5732658A, NL2015454B1, and EP049084A1.

US5732658A discloses a stable provided with a manure collection pit with a V-shaped bottom. Urine and feces are collected within the V-shaped gutters. This reduces the contact area between the urine and feces, as well as the area from which ammonia can evaporate. Moreover, the stable and gutters are flushed to further reduce ammonia emission.

NL2015454B1 discloses a floor element which comprises a number of openings that substantially allow passage of urine and/or substantially liquid excrements while solid excrements are mainly kept on the surface. Also in EP049084A1 urine and feces are separated.

Also known are methods in which microbes or bacteria are used to reduce the presence of ammonia. EP049084A1 for example discloses covering the floor of a stable with a mixture of sawdust and bacteria for converting environmentally harmful substances to harmless substances.

The problem of ammonia emission continues when the collected manure is spread on farmland as a fertilizer. As stated in EP0424596A1, in semi-liquid manure, a large portion, mostly more than 50% of the total amount of nitrogen, is formed by ammoniacal nitrogen. Especially under alkaline circumstances, a large part of the ammoniacal nitrogen will volatize as ammonia during and after the spreading of the semi-liquid manure on the field. EP0424596A1 therefore discloses a method for processing manure, in particular for reducing nitrogen losses from manure at least after the spreading of manure on a field. In this method there is added to the manure a composition comprising at least one of the compounds calcium chloride and magnesium chloride. Particularly, this composition is added to the manure before spreading it on farmland, for example by adding the composition to the manure tank which is used to spread the manure.

In spite of the variety of solutions that are utilized in order to attempt to reduce ammonia emissions, a further reduction of ammonia emissions, especially from livestock housing is necessary. It is an objective of the present invention to reduce ammonia emissions from livestock housing facilities. It is a further objective of the present invention to reduce the ammonia emission per animal. It is an even further objective of the present invention to convert the nitrogen in ammonia from manure to solids bound nitrogen. It is an even further objective of the present invention to increase the nutritional value of manure excreted by livestock animals for use as a fertilizer. It is an even further objective of the present invention to bind phosphates in manure.

Another harmful substance present in manure is methane. Methane is a strong greenhouse gas with a global warming potential (GWP) 104 times greater than CO_2 in a 20-year time frame. A large amount of methane is excreted by livestock, especially ruminants, in the form of burps and farts. However, methane is also present in their manure. For example for cows, up to 10% of methane excreted is in the manure. It is a further objective of the

present invention to reduce methane emission from livestock housing by decreasing methane emission from manure. It is an even further objective of the present invention to reduce both methane emission as well as ammonia emission from livestock housing.

Summary of the invention

In order to reach at least one of the objectives, the present invention discloses a method for reducing emission of ammonia from a livestock housing, the method comprising applying a composition comprising a compound that restrains ammonia volatilization onto freshly excreted manure by an animal in the livestock housing.

Although it is known from e.g. EP0424596A1 to apply calcium chloride and magnesium chloride onto manure for reducing nitrogen losses at least after the spreading of manure on a field, there is no prior art that suggests use of these compounds for reducing emission of ammonia from freshly excreted manure, i.e. application of these compounds onto manure after it has been excreted by an animal and before it has been collected in a collecting means. An example of a collecting means is a manure pit, but also collection of manure in drums or other temporary storage means falls within the definition of being collected in a collecting means. Thus, there is no prior art that suggests use of a compound that restrains ammonia volatilization at the source of the manure production.

The term livestock is commonly defined as domesticated animals raised in an agricultural setting to produce labour and commodities such as meat, eggs, milk, fur, leather, and wool. The term livestock therefore encompasses, but is not limited to: poultry, cattle, sheep, pigs, goats, horses, donkeys, mules, buffalo, oxen, llamas, camels, etc.

The term livestock housing, or livestock housing facility, entails any building which is suitable for housing animals such as, but not limited to: a barn, shed, stable, stall, outhouse, dairy cow building, poultry house, etc. Such a building may have a conventional floor surface comprising or consisting of soil, sand, clay, crushed limestone, sawdust, straw, wood, concrete, brick, tiles, asphalt, etc. or the floor surface may comprise a grid or other floor element designed to separate solid and liquid manure, such as e.g. a grid according to US5732658A or comparable, or a floor element according to NL2015454B1 or comparable, or other floor elements which may be designed for reducing ammonia emissions from livestock housing.

A compound that restrains ammonia volatilization is defined as any compound that is able to engage in a chemical reaction with ammonia, urea, or any other nitrogen containing precursor formed during the conversion of urea to ammonia by urease. Examples of such compounds are e.g. magnesium salts and chloride salts, but also other compounds such as zeolites.

As opposed to the known methods to reduce ammonia emissions from livestock housing facilities, in the method of the present invention, the composition, and therefore the compound that restrains ammonia volatilization is applied directly onto manure excreted by an animal in the livestock housing. With directly is meant, that the composition is applied onto freshly excreted manure, in other words the composition is applied before collection of the manure in a collecting means, such as a container or a manure pit. Thus, other than in known methods, whereby manure is first collected, and then only after collection, compounds are added that restrain ammonia volatilization, in the present method, the composition, and therefore the compound that restrains ammonia volatilisation is added onto the manure directly after excretion of the manure, in other words onto freshly excreted manure, i.e. the compound is added to the manure after it has been excreted by the animal and before the manure is collected in a collecting means such as a container or manure pit. In other words, in the present invention, the compound that restrains ammonia volatilization is used within a livestock housing, notably on the floor and on manure that is present on the floor, rather than only in a manure collection pit or even in fertilizer equipment moments before spreading the manure on a field as fertilizer. Thus, the compound is deposited onto freshly excreted manure. Therefore, ammonia volatilization is tackled at the source, rather than at a later moment, when contact of feces and urine, and therefore the conversion of urea to ammonia under the influence of urease has already led to volatilization of ammonia, notably within the housing facility itself. In case application is performed by a manure scraper, a manure robot, or the like, it is to be understood that the manure may be actively displaced by the scraper, robot, or the like, before, during or after application of the composition. This is within the scope of the invention, as the composition is applied onto freshly excreted manure, but before collection of the manure. It is to be noted that also a manure pile, i.e. a stationary pile of manure in which the manure of different animals is collected, may be considered a collecting means.

It further is to be understood that liquid and semi-liquid manure may flow to some extent, which is passive displacement. Notably, in the case where the floor of the livestock housing comprises a floor design for separating urine and feces, such as a grit or other permeable structure, liquid and semi-liquid manure may fall or flow through the openings after excretion of the manure, in which case the compound may only be directly applied onto the part of the manure that stays on the grit or permeable structure.

In addition to the effect on ammonia emission, it has furthermore surprisingly been found that the method according to the invention does not only result in a vast reduction of ammonia emission from a livestock housing, but also in a reduction of methane emission.

Thus, with the method according to the invention, a vast reduction of ammonia emission may be achieved. Moreover, a reduction of methane emission may also be

achieved. Finally, the retained nitrogen is a slow release fertilizer making the manure more effective for soil and crops and less damaging to the environment.

Description of embodiments

In order to prevent the escape of ammonia as much as possible, the composition should be applied to the manure as quickly as possible after excretion by the animal. Preferably, application of the composition is performed at least within 8 hours, more preferably within 6 hours, even more preferably within 4 hours, such as within 3 hours, within 2 hours, or within 1 hour, still even more preferably within 30 minutes, most preferably within 10 minutes of excretion of the manure by the animal.

A study by Dai et al. (PLOS ONE 9(11): e110402) has shown that in a test setup, the total ammoniacal nitrogen concentration in a mixture of feces, urine and urease reached its final concentration after about 4 hours. In other words, in a test setup, ammonia formation appeared to be complete after about 4 hours. In a real-life setup, where feces and urine are excreted on top of each other, but are not thoroughly mixed, results may be different and conversion of urea to ammonia will likely occur more slowly. Nevertheless, in order to prevent the escape of ammonia as much as possible, the composition should be applied to the manure as quickly as possible after excretion by the animal, and notably within 8 hours, 6 hours, or 4 hours, such as within 3 hours, 2 hours, 1 hour, 30 minutes or 10 minutes after excretion.

Preferably, the composition is a liquid composition, more preferably an aqueous composition.

Preferably, application of the composition is performed by intermittently applying the composition onto a floor surface area of the livestock housing. More preferably application is performed by intermittently spraying the composition onto a floor surface area of the livestock housing, thereby being applied on any manure present on the floor surface area. Spraying achieves the best coverage of the manure by the composition with a minimal amount of composition to be sprayed, and is therefore preferred over other application methods, such as pouring. Spraying devices may also be easily incorporated in the livestock housing, for example as a fixed sprinkler installation, or on a freely moving robot. Intermittent spraying, i.e. spraying the composition onto a particular floor surface area with regular or irregular intervals provides the advantage that the manure may be treated with the composition while the livestock, i.e. the animals, are present inside the livestock housing. The composition may for example be applied onto a floor surface area when manure is present on the floor surface area, but when an animal is present on the floor surface area, application may be ceased in order not to wet the animals.

Preferably, spraying the composition onto the floor surface area is performed at regular time intervals. By using regular time intervals for spraying a floor surface area, it can be assured that the composition is applied to the manure within a preferred period after excretion, such as within 8 hours, 6 hours, or 4 hours, such as within 3 hours, 2 hours, 1 hour, 30 minutes or 10 minutes, thereby making sure that ammonia emission is reduced as much as possible. Thus, the composition may be applied onto the floor surface area every 8 hours, 6 hours, or 4 hours, such as every 3 hours, 2 hours, 1 hour, 30 minutes or 10 minutes.

Preferably, the regular time intervals are every 4 hours, more preferably every 3 hours, even more preferably every 2 hours, most preferably every 1 hour.

More preferably the spraying at regular time intervals occurs with the provision that the floor surface area to be sprayed is not occupied by an animal, human, or other object. Thus, spraying onto the floor surface area may occur when the livestock is on another surface area of the livestock housing. This prevents wetting of the animals with the composition, and avoids unnecessary use of the composition.

Suitably, application may be performed by a manure scraper equipped with a spraying device. Such a manure scraper is for example disclosed in EP2236024 A1. Thus, the manure scraper may be a device for cleaning a stable for cattle provided with at least one manure scraper blade for moving manure present on the floor to a desired location in the stable, and means for moving the manure scraper forward across the stable floor, wherein the device further comprises a spraying device. Preferably, the manure scraper is arranged in an alley in the livestock housing, for moving manure in the longitudinal direction of the alley, for example towards an opening leading to a manure collecting means, such as a manure pit. The means for moving the manure scraper forward may for example be a chain for pulling the manure scraper.

Additionally or alternatively, application of the composition may be performed by a robot which is freely moveable over the floor of the livestock housing. Preferably, the robot is equipped with spraying means. The robot may for example be a manure robot equipped with at least one spraying means, e.g. a spray nozzle, such as disclosed in EP 2183965 A1. Thus, the robot may be an unmanned manure vehicle, which vehicle comprises drive means for driving the vehicle and orientation means for following a path on a floor of a cattle shed, said manure vehicle being provided with a manure slide for moving manure present on the floor to a desired location in the cattle shed. The manure vehicle may be provided with at least one spraying means mounted on a side of the manure vehicle that faces the manure slide.

Additionally or alternatively, application may be performed by spraying means, such as a sprinkler installation, disposed above the floor of the livestock housing. The spraying means may for example be attached to the ceiling of the livestock housing, they may be attached to elements of the animal stalls or cubicles, or they may be mounted onto a

composition transportation means, such as a tube or hose. Such means may for example be provided with openings or spray nozzles, for spraying the composition onto the floor.

Preferably, spraying the composition onto the floor surface area is performed in response to excretion of manure onto the floor surface area. This may for example be realized by the presence of sensors in, on, or above the floor surface area. Suitable sensors may be urea sensors, ammonia sensors, moisture sensors, etc. When the presence of manure on a floor surface area is sensed, then in response to that presence, the floor surface area, and therefore the present manure can be covered with the composition. This is the most optimal embodiment with respect to the amount of the composition to be used, since the composition is only applied when necessary, thereby avoiding unnecessary spillage of the composition.

On the other hand, especially when the applicating means are mounted onto a robot or a manure scraper, it may be beneficial that the composition is constantly applied by the applicating means while moving the manure, e.g. towards a manure collecting means such as a manure pit. This ensures that as much of the manure as possible is covered by the composition. While the manure is being scraped forward, manure that was on the bottom of a pile of manure may be transferred to the top of the manure pile, and constant application of the composition while moving the manure ensures that this manure is contacted by the composition as well. In other words, by constantly applying the composition while moving the manure, optimal mixing of the composition and the manure is accomplished.

Preferably, the manure and the applied composition are collected in a manure collecting means, for example an underground manure pit. More preferably additional composition is applied on the collected manure within the collecting facility. Even more preferably, the collected manure, the applied composition and the additionally applied composition are stirred within the collecting facility. The addition of additional composition in the collecting facility, especially in combination with stirring of the manure, ensures that all parts of the manure contact the composition. Thereby, the emission of ammonia is reduced even further.

A known compound that restrains ammonia volatilization is for example formaldehyde. Formaldehyde may be used in the form of so-called formalin which is an aqueous formaldehyde solution. The formaldehyde present in the formalin may react with the ammonium of the semi-liquid manure in order to form hexamethylenetetramine (HMT). HMT is known as a slow release nitrogenous fertilizer. However, formalin is toxic at even low concentrations, and is therefore not a preferred compound. Other compounds that restrain ammonia volatilization, notably by engaging in a chemical reaction with ammonia, urea or another nitrogenous ammonia precursor are zeolites, magnesium salts and calcium salts.

These salts are not toxic and cause no adverse health effects to the animals, and are therefore preferred.

Preferably, the compound that restrains ammonia volatilization is chosen from the group consisting of water soluble calcium salts, water soluble magnesium salts, and/or combinations thereof. The addition of water soluble magnesium and/or calcium salts, such as their chlorides, sulphates, carbonates, hydroxides and oxides, has previously been shown to significantly reduce ammonia volatilization from fertilizer applied to the soil surface. The reaction mechanism involves the precipitation of carbonate formed during urea hydrolysis as calcium (or magnesium) carbonate.

Moreover, soluble calcium and magnesium salts present the advantage that they contain a major element, namely calcium or magnesium respectively, a sufficient amount of which has to be present in the soil to allow a favourable growth of the crop. These two elements also contribute to an improvement of the soil structure. When manure that is treated by the method according to the invention is collected and used as a crop fertilizer, a separate calcium and magnesium fertilization is no longer strictly necessary. This results in a considerable saving of time and a reduced deterioration of soil structure due to repeated riding of heavy tractors on the field.

Preferably, the compound that restrains ammonia volatilization is a magnesium salt. Magnesium salts have the additional advantage that they can bind phosphates in manure with ammonia in the form of struvite, thereby retaining phosphates. When manure that is treated by the method according to the invention is collected and used as a crop fertilizer, the retained phosphates provide additional nutrition to the soil.

Preferably, the compound that restrains ammonia volatilization is magnesium chloride and/or magnesium sulphate. Magnesium chloride has shown to be the most effective in restraining ammonia volatilization from mixtures with manure. Magnesium sulphate on the other hand has been approved for biological farming applications.

Preferably, the composition is an aqueous solution of the compound.

The composition may comprise further active ingredients. For example, in an embodiment the composition further comprises a urease inhibitor.

Preferably, the composition further comprises an acid. Reduction of the pH results in an increase of the presence of NH_4^+ ions at the expense of volatile NH_3 and therefore aids in the reduction of ammonia volatilization.

Preferably, the method of the invention is applied in combination with one or more other ammonia emission reducing measures. Examples of such measures are listed below.

- Floor designs for separating feces and urine, such as slatted floors or other floor elements, e.g. such as those disclosed in NL2015454B1.
- Scrubbing of ventilation air of the livestock housing.

- Manure scrapers.
- Manure robots.
- Controlling the manure behaviour of the livestock, i.e. reducing the area on which animals defecate. Pigs for example are naturally clean animals that prefer not to defecate where they eat and sleep. The manure behaviour can be influenced with the designs of the housing.
- Cooling of the manure. By cooling manure, the rate of the ammonia emission decreases due to the decreasing activity of urease and the reduced vapour pressure of ammonia.
- Diluting of manure, for example with water.
- Addition of acid.

Preferably, the livestock housing is equipped with a floor design for separating feces and urine and/or with scrubbers for scrubbing of ventilation air. Both of these measures, as well as the method according to the invention, can be attributed an ammonia reducing factor. The value of this factor e.g. depends on the specific floor design and/or scrubbing method used, and on the specifically used embodiment of the method of the present invention. By applying the method of the invention in combination with either of the aforementioned measures, the total emission factor of the animal housing facility can be reduced.

In the case of floor designs for separating feces and urine, such as slatted floors, a part of the applied composition will immediately flow through the openings in the floor, which is advantageous, because the composition may then flow to the collected manure, and further reduce ammonia emission of the already collected manure.

Brief description of the drawings

Fig. 1 displays a schematic top view of an animal housing facility in which an embodiment of the method according to the invention is performed.

Fig. 2 displays a schematic top view of an animal housing facility in which alternative embodiments of the method according to the invention are performed.

Fig. 3 displays a close up top view of the animal housing facility of Fig. 2.

Fig. 4 displays a close up top view of a further alternative embodiment for arrangement of applicating means.

Detailed description of the invention

Fig. 1 is a schematic overview an embodiment of the method according to the invention. A livestock housing facility 1, such as a dairy housing, houses multiple animals 2, such as cows. The animals excrete manure 3 in alleys 4. A composition applicating means 5, in this case a spray nozzle mounted onto a manure robot 6 sprays the composition onto floor

surface area 12 and onto the manure 3, after which the manure 3 is moved into the opening 7 leading to a manure collecting means, such as a manure pit, by the manure robot.

In the livestock housing facility 1' of Fig. 2, the composition is applied by applicating means 5', such as spray nozzles, mounted onto manure scraper 8 which is movable along central line 9 for moving the manure into opening 7 leading the moved manure to a manure collecting means, such as a manure pit. The composition may additionally or alternatively be applied by applicating means 5", such as spray nozzles. The applicating means 5" may be suspended above the alley 4, or they may be attached to animal stall elements 11. Furthermore, sensors 10 for sensing the presence of manure may be placed in or above the floor. The sensors may for example be suspended above the alley 4, or they may be affixed to animal stall elements 11. Also within the collecting facility, applicating means may be present.

For example, as shown in Fig. 3, in response to sensing of the presence of manure 3a by sensor 10a, both the associated applicating means 5a" suspended above the floor may be activated, thereby applicating the composition in response to excretion of the manure 3a. Alternatively, in the case the composition applicating means is mounted onto a robot such as a manure robot 6, or onto a manure scraper 8, the sensing of manure by a sensor 10 may trigger the robot or manure scraper to move towards the manure, and then activate the mounted applicating means 5 or 5' in the presence of the manure.

Shown in Fig. 4 is an embodiment in which applicating means 5"" are mounted in or onto a composition transportation means 13, such as a tube or hose located at a boundary between animal stall elements 11 and alley 4. A tube or hose may for example comprise openings for spraying the composition, or the tube or hose may be mounted with spray nozzles, for spraying the composition onto the floor.

As required, detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely exemplary of the invention, which can be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present invention in any appropriately detailed structure. Further, the terms and phrases used herein are not intended to be limiting, but rather, to provide an understandable description of the invention.

The terms "a"/"an", as used herein, are defined as one or more than one. The term plurality, as used herein, is defined as two or more than two. The term another, as used herein, is defined as at least a second or more. The terms including and/or having, as used herein, are defined as comprising (i.e., open language, not excluding other elements or

steps). Any reference signs in the claims should not be construed as limiting the scope of the claims or the invention.

The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

Example

100 L of mixed manure was collected from a dairy farm, and kept in a closed container at a temperature of about 3 °C to 6 °C for 6 days. After that period, the manure was mixed again before filling a sample drum with a diameter of 23,5 cm and a height of 58,5 cm (thus with a volume of 25 L) with 10 kg of the mixed cow manure. This led to a manure "height" of 22 cm and a headspace of 36,5 cm. 10.575 kg of $MgCl_2$ /1000L of manure was added as a 32% solution in water (25 L/1000L of manure) and thoroughly mixed with the manure before airtight closing the drum. A control drum without added $MgCl_2$ was also prepared.

The NH_3 and CH_4 concentration of the headspace were daily measured with an RAE-multigas meter: A measuring hose was connected to the drum and the measurement was performed for 5 minutes, until a constant value was reached. During 4 days, the NH_3 concentration measured for the sample drum was about 21 % lower than that of the control drum. Surprisingly, the measured CH_4 concentration was also reduced by about 34 % with respect to the control sample.

The experiment was repeated with addition of 2.115 kg of $MgCl_2$ /1000L of manure as a 32% solution in water (5 L/1000L of manure) instead of the 10.575 kg of $MgCl_2$ /1000L of manure. This experiment showed a reduction of the CH_4 concentration of 19% with respect to the control sample. Thus, the reduction in CH_4 emission was dependent on the $MgCl_2$ concentration.

CONCLUSIES

1. Werkwijze voor het reduceren van ammoniakuitstoot uit een stal, de werkwijze omvattende het aanbrengen van een samenstelling die een verbinding omvat die de vervluchtiging van ammoniak tegengaat op vers uitgescheiden mest door een dier in de stal.

2. Werkwijze volgens conclusie 1, waarbij het aanbrengen van de samenstelling ten minste wordt uitgevoerd binnen 4 uur, bij voorkeur binnen 3 uur, met meer voorkeur binnen 2 uur, met nog meer voorkeur binnen 1 uur, met nog meer voorkeur binnen 30 minuten, met de meeste voorkeur binnen 10 minuten na uitscheiding van de mest door het dier.

3. Werkwijze volgens conclusie 1 of 2, waarbij de samenstelling een vloeibare samenstelling is, en waarbij het aanbrengen wordt uitgevoerd door de samenstelling met tussenpozen op een vloeroppervlak van de stal te sproeien, waardoor deze op alle op het vloeroppervlak aanwezige mest wordt aangebracht.

4. Werkwijze volgens conclusie 3, waarbij het sproeien van de samenstelling op het vloeroppervlak wordt uitgevoerd met regelmatige tijdsintervallen, bij voorkeur elke 4 uur, met meer voorkeur elke 3 uur, met nog meer voorkeur elke 2 uur, met de meeste voorkeur elke 1 uur.

5. Werkwijze volgens een van de voorgaande conclusies, waarbij het aanbrengen wordt uitgevoerd door aanbrengmiddelen die zijn aangebracht op een mestschuif.

6. Werkwijze volgens een van de voorgaande conclusies, waarbij het aanbrengen wordt uitgevoerd door aanbrengmiddelen die zijn gemonteerd op een robot die vrij beweegbaar is over de vloer van de stal.

7. Werkwijze volgens een van de voorgaande conclusies, waarbij het aanbrengen wordt uitgevoerd door een sprinklerinstallatie die boven de vloer van de stal is geplaatst.

8. Werkwijze volgens een van de voorgaande conclusies, waarbij het sproeien van de samenstelling op het vloeroppervlak wordt uitgevoerd als reactie op uitscheiding van mest op het vloeroppervlak.

9. Werkwijze volgens een van de voorgaande conclusies, waarbij de mest en de aangebrachte samenstelling worden verzameld in een mestverzamelmiddel, en waarbij extra samenstelling wordt aangebracht op de verzamelde mest in het verzamelmiddel.

10. Werkwijze volgens een van de voorgaande conclusies, waarbij de stal is uitgerust met een vloerontwerp voor het scheiden van ontlasting en urine en/of met wassers voor het wassen van ventilatielucht van de stal.

11. Werkwijze volgens een van de voorgaande conclusies, waarbij de verbinding die ammoniak-vervluchtiging tegenhoudt wordt gekozen uit de groep bestaande uit in water oplosbare calciumzouten, in water oplosbare magnesiumzouten en / of combinaties daarvan.

12. Werkwijze volgens een van de voorgaande conclusies, waarbij de verbinding die de vervluchtiging van ammoniak tegengaat magnesiumchloride en/of magnesiumsulfaat is.

13. Werkwijze volgens een van de voorgaande conclusies, waarbij de samenstelling verder een ureaseremmer omvat.

14. Werkwijze volgens een van de voorgaande conclusies, waarbij de samenstelling verder een zuur omvat.

Fig. 1

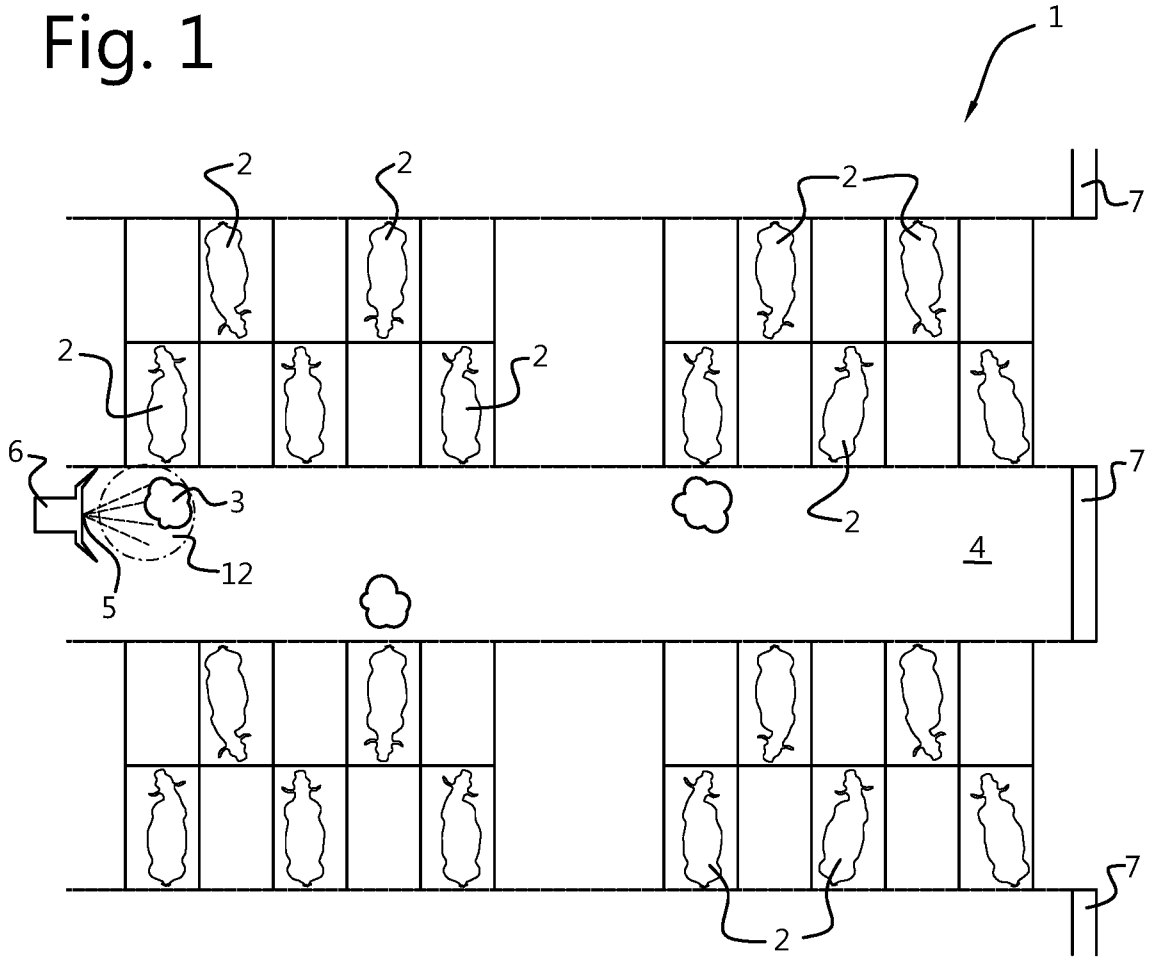


Fig. 2

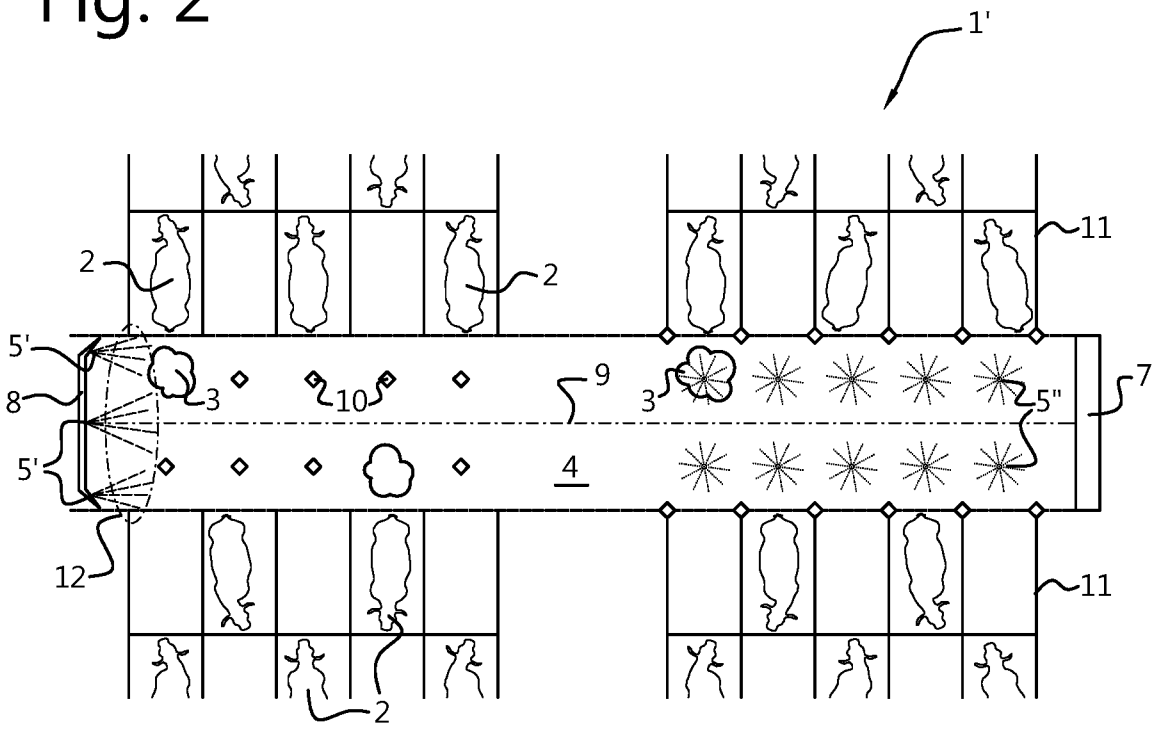


Fig. 3

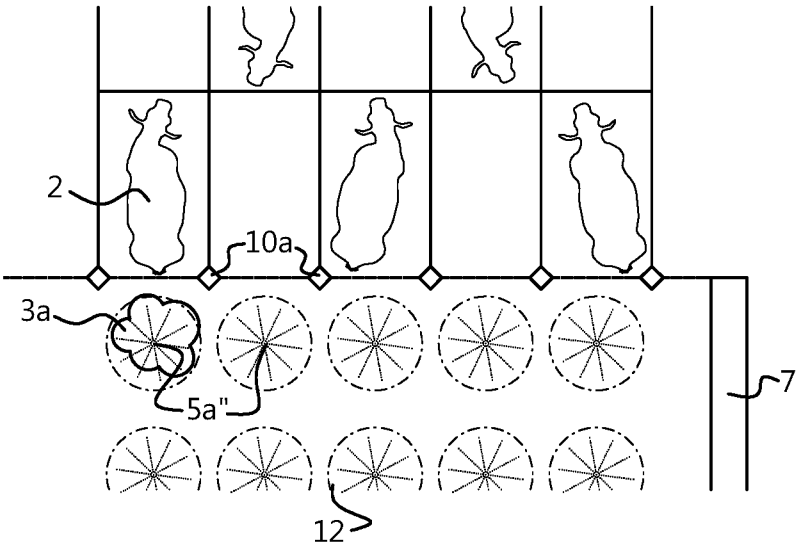
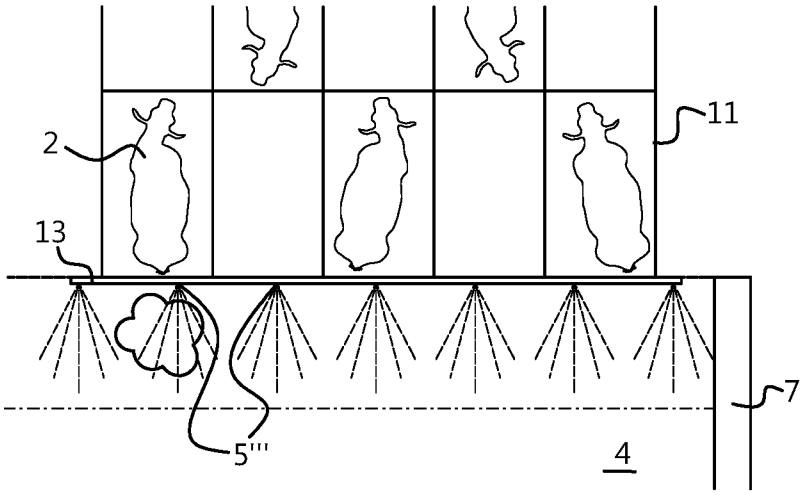


Fig. 4



SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE
	P34407NL00/WZO
Nederlands aanvraag nr. **2024904**	Indieningsdatum **14-02-2020**
	Ingeroepen voorrangsdatum
Aanvrager (Naam) **Jacobus Antonius Cornelis van Schilt**	
Datum van het verzoek voor een onderzoek van internationaal type **11-04-2020**	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. **SN75969**

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

Volgens de internationale classificatie (IPC)

Zie onderzoeksrapport

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

Classificatiesysteem	Classificatiesymbolen
IPC	**Zie onderzoeksrapport**

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 2024904

A. CLASSIFICATIE VAN HET ONDERWERP
INV. C02F1/52 C02F1/68 A01K1/00 A01K1/01
ADD. C02F101/16 C02F103/20

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

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte miminum documentatie (classificatie gevolgd door classificatiesymbolen)
C02F A01K

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

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

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	US 6 382 133 B1 (GEDNALSKE JOE V [US] ET AL) 7 mei 2002 (2002-05-07) * figuur 1 * * kolom 1, regel 4 - kolom 9, regel 8 * -----	1-14
X	US 6 530 343 B1 (LIND CHRISTOPHER B [US]) 11 maart 2003 (2003-03-11) * kolom 1, regel 5 - kolom 3, regel 55 * -----	1-14
X,D	EP 0 424 596 A1 (AEGTEN [BE]) 2 mei 1991 (1991-05-02) in de aanvraag genoemd * bladzijde 2, regel 1 - bladzijde 4, regel 34 * -----	1-14

-/--

[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
21 oktober 2020	

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	Zsigmond, Zoltán

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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 2024904

C.(Vervolg). VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X,D	EP 2 236 024 A1 (J O Z B V [NL]) 6 oktober 2010 (2010-10-06) in de aanvraag genoemd * figuur 1 * * alinea [0001] - alinea [0015] * -----	1-14

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 2024904

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
US 6382133	B1 07-05-2002	CA 2354812 A1	21-03-2002
		US 6382133 B1	07-05-2002
US 6530343	B1 11-03-2003	GEEN	
EP 0424596	A1 02-05-1991	AT 93220 T	15-09-1993
		EP 0424596 A1	02-05-1991
EP 2236024	A1 06-10-2010	EP 2236024 A1	06-10-2010
		NL 2002707 C2	05-10-2010

WRITTEN OPINION

File No.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
SN75969	14.02.2020		NL2024904

International Patent Classification (IPC)
INV. C02F1/52 C02F1/68 A01K1/00 A01K1/01 ADD. C02F101/16 C02F103/20

Applicant
Jacobus Antonius Cornelis van Schilt

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
	Zsigmond, Zoltán

Application number

WRITTEN OPINION

NL2024904

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	2, 3, 5, 6, 8-10, 13
	No:	Claims	1, 4, 7, 11, 12, 14
Inventive step	Yes:	Claims	
	No:	Claims	1-14
Industrial applicability	Yes:	Claims	1-14
	No:	Claims	

2. Citations and explanations

see separate sheet

WRITTEN OPINION

Box No. VIII Certain observations on the application

see separate sheet

Reference is made to the following documents:

D1 US 6 382 133 B1 (GEDNALSKE JOE V [US] ET AL) 7 mei 2002 (2002-05-07)

D2 US 6 530 343 B1 (LIND CHRISTOPHER B [US]) 11 maart 2003 (2003-03-11)

D3 EP 0 424 596 A1 (AEGTEN [BE]) 2 mei 1991 (1991-05-02)in de aanvraag genoemd

D4 EP 2 236 024 A1 (J O Z B V [NL]) 6 oktober 2010 (2010-10-06)in de aanvraag genoemd

Re Item V

Novelty

1. The present application does not meet the criteria of patentability, because the subject-matter of claims 1, 4, 7, 11, 12, 14 is not new.

D1 discloses a method of reducing ammonia output from a barn (column 1, lines 4-34), comprising addition of a composition comprising an ammonia suppressing agent which works on the freshly excreted feces from an animal in the barn (column 1, line 63 - column 2, line 24).

D1 also discloses the subject-matter of claim 4: column 7, line 35-50.

D1 also discloses the subject-matter of claim 7: column 7, lines 25-49.

D2 also discloses the subject-matter of claims 1, 14: column 1, line 5 - column 3, line 55.

D3 also discloses the subject-matter of claims 1, 11-12: page 2, line 1- page 4, line 34.

D4 also discloses the subject-matter of claim 1: paragraphs 1-15.

Inventive step

2. Dependent claims 2, 3, 5, 6, 8-10, 13 do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of inventive step, the reasons being as follows:

Claims 2-3, 5-6: the location of the sprinkler and being placed on a robot do not seem to bring any unexpected technical effect and in line with the general trend of automation.

Claims 8-10, 13:the skilled person would apply an additional dosage of treatment chemical in case need arises and also urease inhibitors are commonly used in similar treatment compositions.

Re Item VIII

3. The application does not meet the requirements of clarity for the following reasons:

3.1. Claim 1 refers to a method comprising a step of addition an ammonia suppressing agent. This feature is not clear because there are various agents which would suppress ammonia formation but many of those would not be suitable for use in an animal barn. Moreover, the description mentions only a few of these agents and therefore the current drafting of this feature is too broad and not supported by the description.