



(51) International Patent Classification:

C05F 3/00 (2006.01) C02F 9/04 (2006.01)
C02F 1/52 (2006.01) C05F 7/00 (2006.01)
C02F 9/00 (2006.01) C02F 101/16 (2006.01)
C02F 9/02 (2006.01) C02F 103/20 (2006.01)

(21) International Application Number:

PCT/DK2010/050117

(22) International Filing Date:

28 May 2010 (28.05.2010)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

PA 2009 70012 28 May 2009 (28.05.2009) DK

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(81) Designated States (unless otherwise indicated, for every kind of national protection available):

AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available):

ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: METHOD AND SYSTEM FOR SEPARATION OF ANIMAL SLURRY

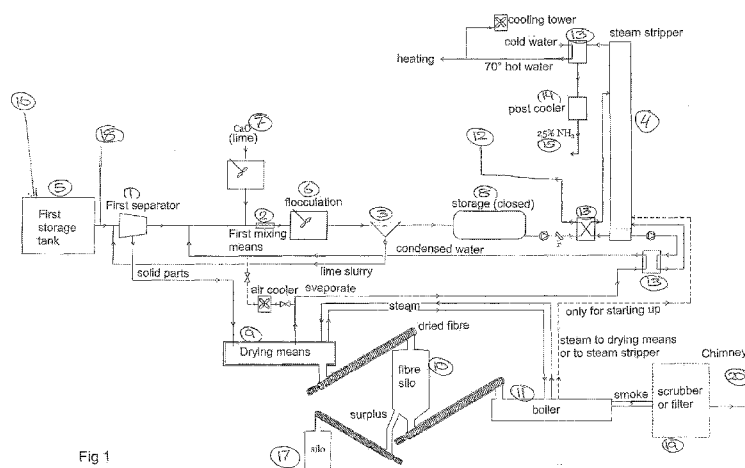


Fig 1

(57) Abstract: Described is a system and method for separation slurry into a solid phase, a reject water with a low content of nitrogen and a nitrogen fraction is described. The nitrogen fraction can be used as a fertiliser and the reject water can be spread on land. The system comprises a first separator (1) for separation raw slurry into a first liquid phase and a first solid phase, first mixing means (2) for mixing the first liquid phase with a base, a second separator (3) for separation the first liquid phase mixed with the base into a second liquid phase and a second solid phase. The second liquid phase can be further freed from ammonia by directing it to an ammonia separation means (4) in the form of a system where the second liquid phase is subjected to stirring and/or aerating and/or heating to increase the evaporating of ammonia or the second liquid phase is subjected to a steam stripping process.

WO 2010/136046 A1

Method and system for separation of animal slurry

All patent and non-patent references cited in the application, or in the present application, are also hereby incorporated by reference in their entirety.

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The present invention relates to separation of slurry into a liquid and solid phase. The separation is based on a first mechanical separation and a second chemical separation. Especially the invention relates to a process and a system for separation of slurry obtained from livestock into a liquid and a solid fraction as well as obtaining a fraction with nitrogenous compounds especially ammonia. The process and system is based on a simple process combining simultaneous coagulation, precipitation of solid compounds and phosphorous compounds and also release of ammonium by increasing the pH of the slurry, when this slurry has been subjected to a mechanical separation.

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Background of invention

When handling slurry and manures on farms raising animals it is a problem to store the entire amount of the obtained slurry and manure and deliver this to the agricultural field in the plant growth season to reduce the risk of washing out the important fertiliser compounds of the organic material. Especially loss of nitrogen, phosphor and potassium from the agricultural fields may be obtained when deliver the organic material to the agricultural field in unsuited periods. Furthermore nitrogen may also be lost as evaporating ammonia when storing and handling the organic material.

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In Denmark and other EU countries, when irrigating and/or fertilising the field with slurry obtained from domestic animals, rules regulate the amount of slurry that may be spread on a certain area. In Denmark to have the ability to release the slurry or reject water into brooks or streams the content of N may not exceed 8 g pr. ton and the content of P may not exceed 0.4 g pr. ton. Slurry or reject water with N or P contents above these limits need to be handled as fertilisers and stored until the growth season before crops are irrigated with the product. With a slurry or reject water containing max 300 g nitrogen pr. ton it is allowed in Denmark to irrigate with this at an amount of 460 ton pr. Hectare. Thus to have the opportunity to spread an increased amount of reject water on a certain area of field and at the same time play by the rules, the amount of

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nitrogen and/or phosphorous and/or potassium need to be reduced from the slurry obtained from domestic animals.

5 Prior art methods including mechanical separation of animal slurry can reduce the content of nitrogen and/or phosphor by less than 30%. This is not suitable to have the possibility to use the reject water for irrigating the crops without taking into account the fertilising effect of the compounds of the reject water. Therefore the prior art methods reducing the N and/or P content by less than 30% of the slurry are not lifting the reject water from the rules regulating the amount to be spread as fertiliser on a certain field
10 area.

The present system and method overcome the problems with irrigating fields with reject water containing too much nutrients especially in the form of nitrogen and phosphor.

15 The reject water and fertilisers obtained with the present system and method also reduces or eliminates the odour problems occurring when spreading slurry or reject water on the fields where the slurry or reject water is obtained by using prior art methods.

20 **Summary of invention**

The present invention relates to a system and method for separation slurry or slurry and manure into a solid phase, a liquid phase with a low content of nitrogen and a nitrogen fraction.

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The system for separation of slurry comprises

- a first separator (1) for separation raw slurry into a first liquid phase and a first solid phase,
- first mixing means (2) for mixing the first liquid phase with a base,
- 30 ○ a second separator (3) or sedimentation tank (3') for separation said first liquid phase mixed with said base into a second liquid phase and a second solid phase.

The first separator (1) and the second separator (3) may each be a combination of two
35 separation means e.g. settling tank, screw press, band-pass filter, drum separator,

conveyor separator, vibratory separator, curved sieve, a decanter centrifuge or other suitable separators.

5 Preferably the system is a closed system such that gas developed from the material under process is not led uncontrolled to the surroundings, the closed system comprises the units of the system from at least the second separator (3) and until the ammonia separation means (4). However, the system may be a closed system from the first separator (1) or from the first storage tank (5) and until the ammonia separation means (4).

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The method for separation of slurry into solid and liquid phases comprises

- Obtaining raw slurry comprising liquid and solids,
- Separation at least a part of said solid from said liquid, hereby obtaining a first liquid phase and a first solid phase,
- 15 ○ mixing said first liquid phase with a base,
- separation of said mixed first liquid phase mixed with said base into a second liquid phase and a second solid phase,
- hereby obtaining solid and liquid phases from said slurry.

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The slurry to be treated (raw slurry) may be any slurry, e.g. a slurry obtained from a stable for rearing animals. The slurry may be slurry from animal waste which is meant to be slurry based on animal manure and urine. The slurry also may be pre-treated before entering the system or method. A pre-treatment of slurry may be addition of a base or another chemical e.g. iron sulphate or iron chloride. A pre-treatment of slurry
25 may also be a fermentation process e.g. for the production of biogas or ethanol, or a process for cutting organic material into smaller parts. Preferred is when pre-treated slurry originate from animals e.g. livestock mentioned herein and especially from cows, pigs or mink, thus preferred is when a pre-treatment of slurry is a biogas or ethanol production based on organic material originating from animals. Most preferred the
30 organic material is manure and urine obtained from livestock, however, the organic material may also be the animals itself such as dead animals or waste from slaughterhouses which is subjected to a fermentation process.

The base added to the first liquid phase increases the pH-value and thus increases the
35 evaporation of ammonia from the liquid phase. Preferably the pH-value is increased to

above 10. The added base also performs a flocculation of at least a part of the remaining solid particles in the first liquid phase.

5 The second liquid phase can be further freed from ammonia by directing it to an ammonia separation means (4) in the form of a system where the second liquid phase is subjected to stirring and/or aerating and/or heating to increase the evaporating of ammonia or the second liquid phase is subjected to a steam stripping process. In some other systems for separation of slurry, struvite is produced and constitute a significant working problem in heat-exchangers, transport in pipes etc. However, 10 struvite is not a problem in the described process. In a preferred embodiment the process described herein does not include sedimentation, addition of compounds such as magnesium and/or phosphate for the production of struvite or removal of struvite.

15 From the system a first solid phase, a second solid phase with base, a reject water with a low content of nitrogen and a liquid phase with nitrogen can be obtained.

Description of Drawings

20 Figure 1 shows a system of the invention for separation of slurry.

Figure 2 and 3 show methods of the invention for separation of slurry.

Figure 4 to 6 illustrate different systems according to the invention.

25 Detailed description of the invention

The present invention relates to a system and a method for separation slurry and manure into a solid fraction comprising fibre parts, a fraction comprising ammonium or ammonia and a liquid fraction comprising reject water with a low content of nitrogen. 30

The method/process and system is based on a simple process combining simultaneous coagulation, precipitation of solid compounds and phosphorous compounds and also release of ammonium by increasing the pH of the slurry, when this slurry has been subjected to a mechanical separation. The method and system is especially suitable for handling manure and slurry obtained from animals such as from 35

animals living in stables e.g. livestock such as pigs. In the mechanical separation solid parts are removed from the slurry which comprises the main part of the ammonium which by a simple process can be converted into gaseous ammonia.

- 5 An aspect of the invention relates to a system for separation of slurry such as animal slurry, said system comprises
- a first separator (1) for separating a raw slurry into a first liquid phase and a first solid phase,
 - first mixing means (2) for mixing the first liquid phase with a base,
 - 10 • a second separator (3) or sedimentation tank (3') for separating the first liquid phase mixed with base into a second liquid phase and a second solid phase.

In a preferred embodiment the system is a closed system at least in respect of the first separator (1), the first mixing means (2) and the second separator (3) and/or
15 sedimentation tank (3').

In an embodiment the system comprising pH measuring means for measuring and regulating the pH of the liquid phases.

20 In another preferred embodiment the pH of the slurry is measured by pH measuring means in each process performed at least in the first mixing means (2) and the second separator (3) and/or sedimentation tank (3') and the pH is adjusted to above 9 or another value as specified elsewhere herein.

25 The pH measuring means may be connected to the first separator (1), to the first mixing means (2), to the second mixing tank (6), to the second separator (3) and/or to the second storage tank (8).

In an embodiment the pH measuring means measure the pH of the liquid and is
30 connected to the first separator (1), to the first mixing means (2), to the second mixing tank (6), to the second separator (3) and/or to the second storage tank (8) and if the pH is below a predetermined value base is added until the predetermined value is reached. The predetermined pH may be a pH selected from the group of pH-values of 9, 9.5, 10, 10.5, 11, 11.5, 12, 12.5, 13. Preferably the predetermined pH is a pH
35 selected from the group of pH-values of 10, 10.5, 11.

The system may further comprise a third mixing means (18) for mixing the raw slurry with base e.g. lime and/or polymer, the third mixing means (18) can be connected to the first storage tank (5), to the first separator (1), and/or to at least one pipe connecting the first storage tank (5) with the first separator (1).

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The system may further comprise a third mixing means (18') for mixing the first liquid phase mixed with a base with more base and/or polymer, the third mixing means (18) may be connected to the second separator (3).

10 Raw slurry to be treated in the system may be any fluid with at least 1% non-liquid material i.e. with a dry matter of at least 1%, preferably the raw slurry has a dry matter of 1-10%. Non-liquid material may be solid organic material. Solid organic material may comprise small living organisms, manure, and plant parts. In an embodiment raw slurry may be liquid with suspended solid organic material and/or suspended non-organic
15 material e.g. wastewater. In a preferred embodiment the raw slurry can be obtained from animals. In a further preferred embodiment the animals can be bred on a ground from where the slurry can be collected, such as in a stable. The stable can have a solid ground or any kind of slurry collecting means e.g. slurry basin. In a preferred embodiment the slurry to treat is obtained from a stable for livestock.

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Raw slurry may be obtained from any animals e.g. cows, cattle, pigs, mink, dogs, cats, horses, goats, sheep, chickens, ducks, turkeys, ostriches, deer, and/or animals of zoos. In an embodiment raw slurry may be obtained from animals bred for the production of milk or meat, e.g. from cows, cattle, pigs, horses, goats, sheep, chickens,
25 ducks and/or turkeys. In a further preferred embodiment the raw slurry can be obtained from animals like cows, pigs, goats, sheep, and/or chickens. The raw slurry can be obtained from a single species of animal or from more than one species of animals e.g. a combination of any of the animals mentioned herein. In another preferred embodiment the slurry is obtained from a cows, pigs and/or mink. In a most preferred
30 embodiment the slurry is obtained from a cows and/or pigs.

A raw slurry may also be obtained by obtaining manure for one or more types of the animals mentioned above. The manure can be diluted with liquid e.g. reject water obtained from the method and system described herein.

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5 A suitable raw slurry to use in the present system has a dry matter of 1-50%, e.g. below 40%, such as below 30%, e.g. below 25% dry matter, such as below 20% dry matter, e.g. below 15% dry matter, such as below 10% dry matter. Preferably the raw slurry contains between 2% and 15% dry matter, more preferably between 2.5% and 12%, even more preferably between 3% and 9%. Organic material with a dry matter higher than a preferred content e.g. higher than 10% may be diluted. A dilution of organic matter may be performed with reject water obtained from the process described herein.

10 In a preferred embodiment the raw slurry or slurry to treat by adding base is not waste water obtained from households, rainfall e.g. heavy rain or from non-agricultural industry. In another embodiment the raw slurry or slurry to treat is not sludge such as sludge from household wastewater or from biogas plants for fermentation of non-agricultural products such as biogas production based on household wastewater.

15 A raw slurry may contain about 5 kg/ton of total nitrogen, about 3,8 kg/ton of ammonia, about 1 kg/ton of phosphor, about 2 kg/ton of potassium and have a dry matter content of about 4%. A slurry to be treated according to the present may also be a slurry subjected to biogas fermentation and thus may contain about 5 kg/ton of total nitrogen, 20 about 4 kg/ton of ammonia, about 0.9 kg/ton of phosphor, about 2.8 kg/ton of potassium and have a dry matter content of about 2.8%.

Dried/separated or non-dried/non-separated manure or a slurry having a too high content of dry matter may be cut into pieces and/or diluted to obtain a suitable slurry (raw slurry) before this raw slurry enters the first storage tank (5) as described herein 25 below or the first separator (1). By diluting manure/slurry any of the dry matter content as described above may be obtained. A dilution can be performed to extract compounds from the solid phase and thus to increase the content of N, P and K compounds in the liquid phase. A dilution can also be performed to make the material 30 containing the solid phase more buoyant and thus easier to handle in the system especially in the first separator (1).

Cutting dry matter content of a slurry e.g. by treating the slurry in a cutter e.g. a rotating cutter may be a possibility to make the slurry suitable to be handled in the first 35 separator (1). The size of dry matter within the slurry to be treated in the first separator

(1) may be less than 150 mm, e.g. less than 140 mm, such as less than 130 mm, e.g. less than 120 mm, such as less than 110 mm, e.g. less than 100 mm, such as less than 90 mm, e.g. less than 80 mm, such as less than 70 mm, e.g. less than 60 mm, such as less than 50 mm, e.g. less than 40 mm, such as less than 30 mm, e.g. less than 20 mm, such as less than 20 mm, e.g. less than 5 mm. A cutter (24) may thus cut the dry matter into a predetermined size selected in respect of a dimension just described.

In an embodiment the slurry is as fresh as possible when directed to the first storage tank (5) and/or to the first separator (1). Fresh slurry is slurry which has left the stable within 1-50 hours. The total content of nitrogen in the form of ammonia may be as high as 80% in fresh raw slurry, whereas this may decrease to e.g. 60% when the raw slurry has been stored for two weeks. The ammonia which evaporate from the slurry during storage before treatment in the first separator (1) may be collected and directed to the ammonia separation means (4). Thus an alternative to use fresh slurry in the first separator (1) is to collect the evaporated ammonia during storage before treating the slurry in the first separator (1).

In another embodiment the slurry is transferred from the stable or a collection tank connected to the stable to a storage tank e.g. slurry basin and/or to the first storage tank (5) and/or to the first separator (1) at least one time each week, e.g. at least twice a week, such as at least every second day, such as at least every day, e.g. at least two times every day. The system may also function continuously such that raw slurry continuously is directed to the first separator (1).

In or in connection to the stable the slurry may be collected in a collection tank before being directed to a storage tank and/or the first storage tank (5) and/or the first separator (1). A part of the slurry collected in a collection tank, may be returned to the stable.

If the slurry is stored before treated in the first separator (1) it is possible to convert nitrogen in the urea into ammonia. If fresh slurry is mixed with older slurry enzymes of the older slurry can initiate the conversion of urea into ammonia. The slurry may be stored for at least 1 day before being diverted to the first separator, e.g. at least 2 days, such as at least 3 days, e.g. at least 4 days, such as at least 5 days, e.g. at least 6 days, such as at least 1 week, e.g. at least 2 weeks, such as at least 3 weeks, e.g. at

least 4 weeks, such as at least 2 months, e.g. at least 3 months, such as at least 4 months, e.g. at least 5 months, such as at least 6 months, e.g. at least 7 months, such as at least 8 months, e.g. at least 9 months. When being stored the slurry may be subjected to stirring and/or air treatment and/or heating to increase the conversion of urea into ammonia and/or to increase evaporation of ammonia from the slurry. When
5 being stored the pH-value of the slurry may be adjusted by addition of a base to increase the pH. Bases described elsewhere herein may be used. The pH may be increased to above 7.5, e.g. above 8, such as above 8.5, e.g. above 9, such as above 9.5, e.g. above 10. Base can also be added by directing lime slurry from the second
10 separator (3) or sedimentation tank (3') to the stored slurry e.g. stored in a first storage tank (5).

In a preferred embodiment the stored slurry is not returned to the stable or the collection tank (5).

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In an embodiment the first separator (1) and/or second separator (3) may be any separation means capable of separating solid parts from a liquid in the form of raw slurry hereby the separation can be a mechanical separation. The first and second separator (1, 3) may each be a settling tank, screw press, band-pass filter, drum
20 separator, conveyor separator, vibratory separator, curved sieve, a decanter centrifuge or other suitable separators or each may be a combination of two or more of these separation means i.e. the organic material can be treated in two or more of these separation means. A screw press or drum separator can be combined with a vibratory separator, a curved sieve, a band-pass filter or a decanter centrifuge. Preferred as a
25 first separator (1) is a combination of a screw press and a vibratory separator or a decanter centrifuge. Also preferred as a first separator (1) is a drum separator or a combination of a screw press and a band-pass filter.

The purpose of the treatment in the first separator (1) is to obtain a first liquid phase
30 with as little solid material as possible and a first solid phase with as much fibre/solid material and as little liquid as possible. The choice of separator may also be influenced by the price of the separator as well as the expenses when running the separator. When using a decanter centrifuge as the first separator (1) it may be possible to obtain a first solid fraction comprising the main part of e.g. the phosphor, the organic nitrogen,

and the sulphur in the slurry to be treated in the first separator (1) and a first liquid fraction comprising the main part of the ammonia and potassium.

5 Any separator mentioned herein may in the resulting solid phase include solid material of a dimension of at least 100 μm , such as at least 200 μm , e.g at least 300 μm , such as at least 400 μm , e.g at least 500 μm , such as at least 600 μm , e.g at least 700 μm , such as at least 800 μm , e.g at least 900 μm , such as at least 1000 μm , e.g at least, such as at least 1.1 mm, e.g at least 1.2 mm, such as at least 1.3 mm, e.g at least 1.4 mm, such as at least 1.5 mm, e.g at least 1.6 mm, such as at least 1.7 mm, e.g at
 10 least 1.8 mm, such as at least 1.9 mm, e.g at least 2 mm, such as at least 2.1 mm, e.g at least 2.2 mm, such as at least 2.3 mm, e.g at least 2.4 mm, such as at least 2.5 mm, e.g at least 3 mm.

15 In another preferred embodiment as much fibre mass is removed from the slurry before subjecting the first liquid phase to the addition of base. In the table below, information of the efficiency of different separators are presented.

Table 1. Efficiency of different separators when separating slurry

| Separation system | M ³ pr. Hour | Fibre fraction | | | |
|---------------------|-------------------------|---------------------------|---------------|-------------|-------------|
| | | Percent of the raw slurry | Dry matter, % | Nitrogen, % | Phosphor, % |
| Screw press | 10-30 | 8 | 10-40 | 8-10 | 10-30 |
| PCK/Staring® *1 | 11 | 10-16 | 20-30 | 10-20 | 30 |
| Kemira Miljø® *2 | 8-12 | 9 | 35 | 29 | 73 |
| Samson Bimatech *3 | | 8 | 40 | 13 | 10-50 |
| Decanter centrifuge | | 10 | 30 | 20 | 70 |

*1: screw press and vibratory separator

20 *2: screw press, band-pass filter and flocculation/ of P with polymer and ferro sulphate

*3: drum separator

The first separator (1) may be connected to the second separator (3). Preferred is when a first mixing means (2) is located between the first separator (1) and the second separator (3). Yet further preferred the part of the system comprising a first separator (1) and a second separator (3) is a closed system.

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The first liquid obtained from the first separator (1) may contain below 5% dry matter, such as below 4% dry matter, e.g. below 3% dry matter, such as below 2% dry matter, e.g. below 1% dry matter. In table 2 different features of fibre and liquid fractions obtained when separation pig slurry is presented.

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Table 2. Separation of pig slurry. The content in the fibre and liquid fraction followed a separation including treatment by polymer or a treatment in a decanter centrifuge

| | Fraction | Dry matter, % | N, kg/t | NH ₄ -N, kg/t | NH ₄ -N,, % | P, kg/t | K, kg/t |
|-----------------------|---------------|---------------|---------|--------------------------|------------------------|---------|---------|
| Polymer treatment | Fibre (solid) | 36 | 11.6 | 4.0 | 34 | 7.0 | 2.0 |
| | Liquid | 1.4 | 2.9 | 2.3 | 79 | 0.3 | 1.9 |
| Decanter centrifuging | Fibre (solid) | 36 | 11.8 | 5.6 | 48 | 13.0 | 2.3 |
| | Liquid | 1.4 | 4.8 | 4.0 | 84 | 0.2 | 1.9 |

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The first solid phase obtained from the first separator (1) may comprise the main part of the solid fibre parts corresponding to 50-70 % of the dry matter of the raw slurry. The fibre fraction may constitute 10-20% of the raw slurry when obtained from livestock and this part may include 10-30% of the total amount of nitrogen present in the raw slurry. The nitrogen of the fibre fraction is mainly bound as organic nitrogen, but the fibre fraction also contains ammonium and ammonia in the liquid part.

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Before diverting the first liquid phase into the first mixing means (2) and/or while the first liquid phase is within the first mixing means (2) base may be added to the first liquid phase. When a liquid containing ammonium such as slurry is mixed with a base in an amount to increase the pH-value to above 9, the amount of nitrogen of the liquid in the form of ammonia increases and the amount of ammonium is decreased. The pH of the first liquid phase may be increased to at least 9, e.g. at least 9.5, such as at least 10, e.g. at least 10.5, such as at least 11, e.g. at least 11.5, such as at least 12, e.g. at

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least 12.5, such as at least 13. Preferably the pH is increased to at least 10.5, more preferably to at least 11.

5 In an embodiment the first liquid phase which has been added base e.g. lime, is not subjected to a gas treatment where gas is directed through the material.

10 In a preferred embodiment the system is a closed system from the point where base is added to a liquid phase e.g. from the first mixing means (2) and until the ammonia separation means (4) separating ammonia from the liquid. In respect of the process ammonia evaporating from the first liquid phase after addition of base to a pH above 9 is collected. Collected ammonia can be directed to the ammonia separation means (4) for absorption.

15 In another preferred embodiment the system comprises at least one ammonia separation means (4) for separating ammonia from the second liquid phase, and wherein the ammonia separation means (4) together with the first mixing means (2) and the second separator (3) or sedimentation tank (3') is a closed system.

20 In the first mixing means (2) base and the first liquid phase can be mixed for at least 1 min, e.g. at least 2 min, such as at least 3 min, e.g. at least 5 min. Preferred is a mixing time of 1-60 min, such as 2-50 min, e.g. 3-40 min, such as 5-30 min, e.g. 6-20 min, such as 7-15 min. Preferred is a mixing time of 5-30 min, more preferred of 15-30 min. Also the addition may be a continuous process in which the first liquid phase and the base is added to the mixer at the same time.

25 In a preferred embodiment the process of mixing the first liquid phase with a base such as lime, e.g. CaO is performed with a simultaneously measurement of the pH of the mixture. Hereby the pH can be regulated e.g. increased to a pre-determined level. The pre-determined level of pH can be any pre-determined pH as described herein.

30 Preferred is a pre-determined pH of 9.5-11. More preferred is a pre-determined pH of 10-10.5 in the mixing process.

35 The system described herein may be constructed such that a loop is present between the first mixing means (2) and the second separator (3) if no second mixing tank (6) is present in the system or the loop can be located between the second mixing tank (6)

and the second separator (3). In the loop the pH can be measured and adjusted as described above. Hereby the mixture (first liquid phase mixed with base) can be returned from the loop to the second mixing tank (6) if the pH is below a pre-determined pH-level, and the mixture can be directed to the second separator (3) if the pH is at or above a pre-determined level. Addition of base in the loop may be performed by a second dosage means for adding base. This second dosage means may be connected to the dosage means (7) described elsewhere herein.

The loop can be used to secure the correct pH of the mixture and thereby secure a proper reaction between the base e.g. lime such as CaO with the compounds of the dry matter of the first liquid phase.

The base added can be any suitable base e.g. natural base products. Preferred is Na- and Ca-containing bases. Further preferred is Ca(OH)_2 , CaO, CaCO_3 , CaSO_4 , NaOH, $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$. Yet further preferred is lime. Further preferred is CaCO_3 and/or CaO. Most preferred is CaO.

The base if obtained as a liquid-free product may be added water e.g. reject water obtained from the fourth storage tank (12) to prepare a suspension of the base before adding this to the first liquid phase. Also the base can be added to the first liquid phase in a dry form.

The amount of base can be any amount increasing the pH to a value described elsewhere herein. When treating a raw slurry from pigs or cows the raw slurry can have a pH of 7-8, adding 5-10 kg Ca(OH)_2 per ton first liquid phase can increase the pH to about 11.

The base when added to the first liquid phase also may result in the formation of flocs in a flocculation process. If the base are a Ca-containing base Calcium bridges are formed between solid parts of the liquid phase when the flocs are formed. The flocculation process precipitates different phosphorous-containing compounds e.g. the orthophosphate and organic bound phosphor. Thus when performing the flocculation process P is removed from the first liquid phase as a settlement. At least 50% of the phosphor present in the first liquid phase can be removed by adding a Ca-containing base to the first liquid phase, such as at least 60% of the phosphor, e.g. at least 70% of

the phosphor, such as at least 80% of the phosphor, e.g. at least 85% of the phosphor, such as at least 90% of the phosphor, e.g. at least 95% of the phosphor. The flocs may be obtained as a settlement.

5 When removing the settlement and/or non-settled flocs of the first liquid phase in the second separator (3) a second liquid phase and a second solid phase is obtained. The second solid phase can be used as a lime product and a phosphorous fertiliser to treat agricultural land and the second solid phase may contain 8-15% dry matter with 5-10 kg/t Ca, 4-6 kg/t total-N, 3-4 kg/t NH₄-N, 0.3-1 kg/t P and 1-2 kg/t K. The second solid
10 phase can be used as a fertiliser in the form obtained from the second separator (3) or it can be dried and optionally stored before spread on land. Ash from the boiler (11) as described elsewhere herein may be added to the second solid phase before used as a fertiliser.

15 The separation performed in the second separator (3) may be electronically and based on mass flow (density) e.g. by the use of a mass flow meter or the separation may be based on optical analysis of the material to be separated. Preferably the amount of second solid phase i.e. of sediments in the second separator (3) is measured to ensure that sediment is removed from the second separator (3) when the amount reaches a
20 certain level and that only sediment in the form of the second solid phase and not slurry can be directed to a earlier sub-process of the system e.g. to the raw slurry in the first storage means (5) or to the raw slurry before this enters the first separator (1). Also the amount of slurry is measured in the second separator (3). Measurement of amount of slurry and sediment in the second separator (3) can be performed by measuring the
25 height of the slurry and/or of the sediment (second solid phase). Measuring means for measuring the height of the slurry and/or of the sediment (second solid phase) may thus be connected to the second separator (3). When a first liquid phase with about 2% dry matter is obtained from the first separator (1), a volume of about 30% of the first liquid phase is removed as a second solid phase from the second separator (3) and
30 directed to a earlier process in the system e.g. to the storage means (5) or to the raw slurry before this enters the first separator (1).

To the second separator (3) pH measuring means for measuring and controlling pH may be connected. Hereby the pH may be kept at a predetermined level throughout the
35 process being performed in the second separator (3) or sedimentation tank (3'). The

pH may be any predetermined pH as mentioned elsewhere herein e.g. about 10, or about 10.5.

5 The process and system as described herein are a simple process and a simple system where the process combines simultaneous coagulation, precipitation of solid compounds and phosphorous compounds and also release of ammonium by increasing the pH of the slurry, when this slurry has been subjected to a mechanical separation as in the first separator (1). The pH is increased to a level as described elsewhere herein.

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In an embodiment a pre-sedimentation is performed in a pre-sedimentation tank (21) located between the first separator (1) and the dosage means (7) or the first mixing means (2) or the second mixing tank (6). The pre-sedimentation tank (21) can also be located between the first mixing means (2) and the second missing tank (6).

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In a preferred embodiment the system comprises

- a first separator (1) for separating raw slurry into a first liquid phase and a first solid phase,
- first mixing means (2) for mixing the first liquid phase with a base,
- 20 • a second separator (3) or sedimentation tank (3') for separation said first liquid phase mixed with said base into a second liquid phase and a second solid phase,

wherein at least the first mixing means (2) and the second separator (3) or sedimentation tank (3') is a closed system and wherein a loop as described elsewhere for measuring and adjusting the pH of the material is located between 25 the first mixing means (2) and the second separator (3) or sedimentation tank (3').

In the system described with a first separator (1), a first mixing means (2) and a second separator (3) or sedimentation tank (3'), the slurry is separated in the first separator 30 into a first liquid phase and a first solid phase, the first liquid phase is mixed with a base in the first mixing means (2) and directed through the loop for measuring and adjusting the pH to a pre-determined pH-level as described elsewhere herein, and when the coagulation reaction has occurred at the pre-determined pH-level for a suitable time, the mixture is directed to a second separator (3) or sedimentation tank 35 (3') for separation said first liquid phase mixed with said base into a second liquid

phase and a second solid phase. In a preferred embodiment the pre-determined pH of the loop is about 10 to 10.5 or at least 10.

In another preferred embodiment the system comprises

- 5
- a first separator (1) for separating raw slurry into a first liquid phase and a first solid phase,
 - first mixing means (2) for mixing the first liquid phase with a base,
 - a pre-sedimentation tank (21) for pre-sedimentation of flocculated dry matter,
 - a second mixing tank (6) comprising a loop as described elsewhere for
- 10
- measuring and adjusting the pH of the material,
 - a second separator (3) or sedimentation tank (3') for separation said first liquid phase mixed with said base into a second liquid phase and a second solid phase,

wherein at least the first mixing means (2), the pre-sedimentation tank (21), the

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second mixing tank (6) and the second separator (3) or sedimentation tank (3') is a closed system.

In the system described with a first separator (1), a first mixing means (2), a pre-sedimentation tank (21), a second mixing tank (6) and a second separator (3) or

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sedimentation tank (3'), the slurry is separated in the first separator (1) into a first liquid phase and a first solid phase, the first liquid phase is mixed with a base in the first mixing means (2), and directed to a pre-sedimentation tank (21) for sedimentation, the liquid phase is further directed to a second mixing tank (6) and then directed through a loop for measuring and adjusting the pH to a pre-determined pH-level as described

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elsewhere herein, and when the coagulation reaction has occurred at the pre-determined pH-level for a suitable time, the mixture is directed to a second separator (3) or sedimentation tank (3') for separation said first liquid phase mixed with said base into a second liquid phase and a second solid phase. In a preferred embodiment the pre-determined pH of the loop is about 10 to 10.5 or at least 10, and the process in the

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second mixing tank (6) together with the loop is performed for about 5 to 30 min such as 15-30 min.

In an embodiment the system further comprises ammonia separation means (4) for separating ammonia from the second liquid phase. The ammonia separation means (4)

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can be connected to the second separator (3). The ammonia separation means (4) can

be a container or vessel where the second liquid phase is subjected to an air flow through the liquid phase and/or stirring of the liquid phase and/or heating of the liquid phase to help or force ammonia to evaporate from the second liquid phase. The ammonia separation means (4) can also be a steam stripper or an air stripper. The ammonia separation means (4) may be capable of heating the second liquid phase to facilitate the evaporation of ammonia. In a preferred embodiment the ammonia separation means (4) is a steam stripper.

One method to separate ammonia from the second liquid phase can be to stir the second liquid phase and optionally heating the second liquid phase to 50-90°C, such as to 60-80°C, e.g. to 65-75°C, such as to 68-72°C or about 70°C. The heating can be performed before subjecting the second liquid phase to the stirring process and/or while stirring the second liquid phase. Hereby an amount of 50-90% of the ammonia of the second liquid phase will evaporate, such as 60-80%, e.g. 65-75%, or about 70% of the ammonia present in the second liquid phase. It is expected that about 70% of the ammonia present in the second liquid phase will evaporate when stirring the second liquid phase and heating it to about 70°C. The stirring process can be an intense stirring to aerate the second liquid phase, alternatively or at the same time the second liquid phase can be subjected to an inflow of air. The stirring process optionally with aeration and/or heating of the slurry may be performed for ½-5 hours, such as for 1-4 hours, e.g. for 1-3 hours, such as for 1-2 hours, although also a longer stirring process may be performed such as at least 5 hours, e.g. at least 10 hours, such as at least 15 hours.

The ammonia obtained from the stirring process may be subjected to a process to scrub ammonia. Ammonia is scrubbed or absorbed when air saturate with ammonia is led through a counter current fog of sulphuric acid. Ammonia is bound as ammonium sulphate.

Another method to separate ammonia from the second liquid phase can be to steam stripping of the second liquid phase where a steam of 100-140°C, such as of 110-130°C, e.g. of 115-125°C, such as of 118-122°C, e.g. about 120°C is directed through the second liquid phase. The second liquid phase may be heated itself before subjected to steam stripping. The second liquid phase may be heated to 50-90°C, such as to 60-80°C, e.g. to 65-75°C, such as to 68-72°C or about 70°C before and/or while

subjecting the second liquid phase to the steam stripping. Preferred is when the second liquid phase is heated when it has entered the steam stripper. By steam stripping an amount of amount of 70-100% of the ammonia of the second liquid phase will evaporate, such as 80-99%, e.g. 90-98%, such as 93-97% or about 95% of the ammonia present in the second liquid phase. It is expected that about 95% of the ammonia present in the second liquid phase will evaporate when the second liquid phase is steam stripped with steam at a temperature of about 120°C.

The steam may be released from a steam production system at a pressure of about below 15 bar including negative pressure. Preferred is a pressure of 4-10 bar, e.g. 6-8 bar when the steam is directed through the steam stripper or through another ammonia separation means (4).

In a steam or air stripper, steam or air is directed through a vessel from the lower part of the vessel toward the top and the second liquid phase is directed from the top of the vessel and downwards. The steam and/or air will assist in the process of directing the ammonia from the liquid to the air, hereby stripping ammonia from the second liquid phase. The vessel may contain filling material to create a larger surface of the liquid passing through the vessel, this increases the amount of ammonia evaporated from the second liquid phase.

By increasing the pH of the first and/or second liquid phase ammonium is converted to ammonia: $\text{NH}_4^+_{(\text{aq})} \leftrightarrow \text{NH}_{3(\text{aq})} + \text{H}^+_{(\text{aq})}$ the pKa-value is 9.25.

By heating the first and/or second liquid phase the aqueous ammonia is converted into gaseous ammonia: $\text{NH}_{3(\text{aq})} \leftrightarrow \text{NH}_{3(\text{g})}$

The pH of the second liquid phase may be increased to at least 9, e.g. at least 9.5, such as at least 10, e.g. at least 10.5, such as at least 11, e.g. at least 11.5, such as at least 12, e.g. at least 12.5, such as at least 13.

The temperature of the second liquid phase may be increased to at least 40°C, e.g. at least 45°C, such as at least 50°C, e.g. at least 55°C, such as at least 60°C, e.g. at least 65°C, such as at least 70°C, e.g. at least 75°C, such as at least 80°C, e.g. at least 85°C, such as at least 90°C, e.g. at least 95°C, such as at least 100°C, e.g. at least 105°C,

such as at least 110°C, e.g. at least 115°C, such as at least 120°C, e.g. at least 125°C, such as at least 130°C e.g. at least 135°C, such as at least 140°C.

5 Any combination of the mentioned pH of the second liquid phase and the mentioned temperature of the second liquid can be used in the ammonia separation means (4). Preferred pH values may be at least 9.5 to at least 12 at a temperature of at least 50°C to at least 100°C.

10 The ammonia separation means (4) can be connected to an absorption unit (14) for absorbing the ammonia separated from the first and/or second liquid phase. The absorption unit (14) may also be connected to the first mixing means (2) and/or to the second separator (3) to divert evaporated ammonia to the absorption unit (14). The ammonia evaporated from the first and/or second liquid phase before the second liquid phase enters the ammonia separation means (4) may be directed directly to the
15 absorption unit (14) or through the ammonia separation means (4) to the absorption unit (14).

In the absorption unit (14) ammonia is absorbed/scrubbed in a liquid, such as in water e.g. reject water of the system or in an acid. Acid to absorb the ammonia can be
20 sulphuric acid. The amount of ammonia absorbed in the liquid is at least 5%, e.g. at least 10%, such as at least 15%, e.g. at least 20%, such as at least 25%, e.g. at least 30% (v/w) of the liquid. The liquid with ammonia obtained from the absorption unit (14) can be stored in a N-storage tank, which is connected to the absorption unit (14). The liquid with ammonia can be used as an N-fertiliser e.g. to fertilise fields for agricultural
25 crops.

In a preferred embodiment the system is partly a closed system such that the closed part of the system comprises at least the second mixing tank (6), the second separator (3) and the ammonia separation means (4). If a second storage tank (8) is part of the
30 system, this unit is included in the closed part of the system. By "closed" is meant that substantially no ammonia escapes to the surrounding from the material under process, the evaporated ammonia can be retained within the system and collected in the steam stripper (4).

In another preferred embodiment the system is a closed system in respect of the processes taking part in the first separator (1), the first mixing means (2), the second mixing tank (6), the second separator (3) and/or the sedimentation tank (3'), and the ammonia separation means (4). The first storage tank (5) may also be a part of the closed system. Hereby any ammonia evaporated from the slurry, and if the first storage tank (5) is included in the closed system also from the waste in this storage tank, can be collected. Collection of ammonia is preferred to avoid an increase of ammonia in the environment, to reduce odour around stables and systems for treatment of manure and slurry, to reduce evaporation of ammonia when spreading manure and/or slurry on fields, and the collected ammonia also constitute a source of N-fertilizer which can be sold or spread on fields e.g. fields with crops.

When ammonia has been stripped from the second liquid phase reject water is obtained, which may have a very low content of nitrogen. The reject water can be stored in a fourth storage tank (12). The reject water can be used to irrigate crops e.g. willows grown for energy production.

The reject water may contain a low amount of nitrogen (N), such as below 400 g N/t, e.g. below 300 g N/t, such as below 200 g N/t, e.g. below 100 g N/t, such as below 50 g N/t, e.g. below 40 g N/t, such as below 30 g N/t, e.g. below 20 g N/t, such as below 10 g N/t, e.g. below 8 g N/t, such as below 6 g N/t, e.g. below 4 g N/t.

In a preferred embodiment the ammonia evaporation is performed by stirring and/or heating and/or aerating the second liquid phase and the content of N in the reject water may be below 400 g N/t, e.g. below 350 g N/t, such as below 300 g N/t, e.g. below 250 g N/t, such as below 200 g N/t.

In another preferred embodiment the ammonia removal is performed by steam stripping and the content of N in the reject water may be below 30 g N/t, such as below 20 g N/t, e.g. below 15 g N/t, e.g. below 10 g N/t, such as below 9 g N/t, e.g. below 8 g N/t, such as below 7 g N/t, e.g. below 6 g N/t, such as below 5 g N/t, e.g. below 4 g N/t.

The reject water may also contain a low amount of phosphor (P), such as below 20 g P/t, e.g. below 18 g P/t, such as below 15 g P/t, e.g. below 13 g P/t, such as below 10 g P/t, e.g. below 8 g P/t, such as below 5 g P/t, e.g. c, such as below 1 g P/t, e.g. below

0.8 g P/t, such as below 0.6 g P/t, e.g. below 0.4 g P/t, such as below 0.2 g P/t, e.g. below 0.4 g P/t.

5 The reject water may e.g. contain below 30 g N/t and below 1 g P/t. Preferred is below 8 g N/t and below 0.4 g P/t. Any of the mentioned N and P content of the reject water may be combined.

10 Between the first separator (1) and the second separator (3) a second mixing tank (6) can be located. The second mixing tank (6) may thus be connected to the first mixing means (2) and the second separator (3). Within the second mixing tank the flocculation process as described elsewhere herein can be performed. The second mixing tank (6) can thus be for mixing the organic material (mixing the first liquid phase with base) and performing flocculation. In an embodiment the system comprises the second mixing tank (6) but not the first mixing means (2), hereby the mixing of the first liquid phase and the base is performed within the second mixing tank (6). In a preferred
15 embodiment the second mixing tank (6) comprises stirring means for stirring the first liquid phase with the base in the tank. Stirring of the mixture may result in an increased evaporation of ammonia in the second mixing tank (6). The evaporated ammonia is preferably collected and directed to an absorption unit (14).

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Air or oxygen can be let to the first storage tank (5) and/or to the first mixing means (2) and/or to the second mixing tank (6) to obtain aerobic conditions and an aerobic raw slurry and/or an aerobic first liquid phase. Air or oxygen can be let to the mentioned units by an air supply means.

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It may be necessary to store the raw slurry before directing it to the first separator, this storage can be performed in a first storage tank (5) connected to the first separator (1) such that raw slurry stored in the first storage tank (5) can be directed to the first separator (1).

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To the first storage tank (5) base can be directed to increase the pH-value of the raw slurry. In one embodiment no base may be added to the first storage tank (6).

35 The first storage tank (5) may comprise means for mixing the raw slurry to avoid settlement of solid parts of the raw slurry hereby the raw slurry is kept in homogenous

condition. A homogenous raw slurry compared to a non-homogenous raw slurry may be desirable when performing the separation in the first separator (1).

5 Within the first storage tank (5) the means for mixing the raw slurry can also be used to mix the raw slurry with the added base. It is possible to add base to the raw slurry e.g. for performing evaporating of ammonia from the raw slurry. The evaporated ammonia can be directed towards the system including the ammonia separation means (4) to the absorption unit (14) or the ammonia evaporated in the first storage tank (5) can be directed directly to the absorption unit (14) through a connection between the first
10 storage tank (5) and the absorption unit (14).

The raw slurry of the first storage tank (5) may be aerated to keep the raw slurry aerob. Aeration may be performed by stirring the raw slurry and/or by a supply of air through an inlet in the first storage tank (5).

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The raw slurry may be obtained from a stable (16) which is connected to the first storage tank (5) and/or to the first separator (1). Different stables are suitable to collection of slurry to limit the evaporation of ammonia, preferred is a stable system with partly or fully slotted floor or solid floor with the use of an amount of straw which
20 ensures that the mixture of urine, faeces and straw is in a condition suitable to pump. The raw slurry may also be directed from the stable (16) to a slurry tank before being directed to the first storage tank (5) or directly to the first separator (1).

The amount of raw slurry obtained from one or more stables (16) may be at least 0.5
25 ton/hour, such as at least 1 ton/hour, e.g. at least 2 ton/hour, such as at least 3 ton/hour, e.g. at least 4 ton/hour, such as at least 5 ton/hour, e.g. at least 10 ton/hour, such as at least 15 ton/hour, e.g. at least 20 ton/hour, such as at least 25 ton/hour, e.g. at least 30 ton/hour, such as at least 35 ton/hour, e.g. at least 40 ton/hour.

30 The first storage tank (5) can have any suitable size to receive the raw slurry. Examples of sizes may be at least 250 kbm, e.g. at least 500 kbm, such as at least 750 kbm, e.g. at least 1000 kbm, such as at least 1500 kbm, e.g. at least 2000 kbm, such as at least 2500 kbm, e.g. at least 3000 kbm, such as at least 3500 kbm, e.g. at least 4000 kbm, such as at least 4500 kbm, e.g. at least 5000 kbm.

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In an embodiment the system comprises a third mixing means (18) for mixing the raw slurry with base and/or polymer before directing the raw slurry to the first separator (1). The third mixing means (18) can be connected to the first storage tank (5) and/or the stable (16) and to the first separator (1). The third mixing means (18) may also be
5 incorporated in the first separator (1).

Polymers to be added to the raw slurry can be anionic, non-ionic or cationic and are preferably with a high molecular weight. Preferably the polymer is cationic. The polymer connects to particles in the raw slurry and constitutes bridges between the
10 particles, hereby performing flocs. The flocs are separated from the raw slurry in the first separator (1) and become part of the first solid phase.

However, in an embodiment polymer is not added to the raw slurry. In another embodiment polymer is not added to the first liquid phase. In yet another embodiment
15 polymer is not added to the first liquid phase mixed with a base. Thus polymer addition may be omitted from the method as described herein.

In an embodiment the raw slurry can be added polymer before being separated in the first separator (1) in the form of a screw press followed by separation of the liquid in a
20 vibratory separator.

The polymer e.g. together with adding base can also be added to the raw slurry when being stored in the first storage tank (5). The types and amounts of polymers used may be any of the polymers and amounts mentioned in respect of the treatment of the raw
25 slurry before separation in the first separator (1). The first storage tank (5) may be used as a settlement tank and may have an exit port in the lower part of the tank to remove the material settled out in the tank. If base is to be added to the first storage tank (5) to increase the pH to a value above 9, the system from the first storage tank (5) and to the ammonia separation means (4) is preferably a closed system.

30 Polymer may also be added to the first liquid phase before this phase enters the second separator (3). The types and amounts of polymers used may be any of the polymers and amounts mentioned in respect of the treatment of the raw slurry before separation in the first separator (1).

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In another embodiment the system further comprises dosage means (7) for handling base before directing base to said first mixing means (2) or said third mixing means (18). Dosage means (7) may also handle polymer to be added to the first storage tank (5) or to the third mixing means (18).

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Multiple dosage means (7) may be connected to the first storage tank (5), to the first mixing means (1) and/or to the third mixing means (18) for handling different types of base and/or polymer. Also one dosage means (7) for each base and/or polymer can be connected to the first storage tank (5), to the first mixing means (1) and/or to the third

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In a further embodiment the system further comprising a second storage tank (8) for storage of the second liquid phase obtained from the second separator (3). The second storage tank (8) can be connected to the second separator (3) and the ammonia separation means (4) to collect the second liquid phase from the second separator (3) before diverting the second liquid phase to the ammonia separation means (4). The second storage tank (8) can also be connected to the absorption unit (14) to divert evaporated ammonia to the absorption unit (14).

15

In a preferred embodiment the system of the second mixing tank (6) and/or the second separator (3) and/or the second storage tank (8) and/or the ammonia separation means (4) and/or the absorption unit (14) constitute a closed system from where ammonia can not evaporate.

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The second solid phase may be composted.

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In another embodiment the system comprises drying means (9) for drying the first solid phase and/or the second solid phase. The first separator (1) may be connected to the drying means (9) for directing the first solid phase to the drying means (9). The second separator (3) may be connected to the drying means (9) for directing the second solid phase to the drying means (9).

30

In a preferred embodiment the second solid phase is returned to the raw slurry in the first storage means (5) or it is delivered to the raw slurry before this enters the first separator (1). If the second solid phase is delivered to the first storage means (5) any remaining base of the second solid phase may be included in a pre-coagulation

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process, where a portion of suspended substances of the material in the first storage means (5) coagulate. However, the presence of the second solid phase in the first storage means (5) may not include an amount of base e.g. lime to increase the pH to a level where the major part of ammonia in the liquid part of the material evaporates from the material. The base e.g. lime present in the second solid phase may increase the pH level of the material in the first storage means (5) to about 7.5, e.g. to about 8, e.g. to about 8.5. Preferably the amount of base in the second solid phase is such that the pH in the first storage means (5) is increased to a pH at or below 8.5.

10 When heating the first solid phase and/or the second solid phase in the drying means (9) ammonia may evaporate from the solid phase. This ammonia can be directed to the first separator (1), the first mixing means (2), the second mixing means (6), the second separator (3), the second storage tank (8), the ammonia separation means (4) or the absorption unit (14) to finally be a part of the liquid containing ammonia.

15 Steam from the boiler (11) may be superheated and be directed to the drying means (9) where the steam is used for drying the first solid phase and/or the second solid phase. The superheated steam may have a temperature of 130-155°C at a pressure of 2-6 bar, such as a temperature of 135-150°C and a pressure of 3-5 bar, e.g. 143°C and 4 bar. The superheated steam may be recirculated through the drying first solid phase. Steam removed from the drying means (9) at about 100°C may be condensed e.g. in a heat exchanger (13) of the system and the condensed liquid may be collected or reintroduced into the system before adding base to the first liquid phase. The steam can also be directed to the ammonia separation means (4) e.g. a steam stripper.

25 The steam which after drying the solid phase may comprise ammonia may be directed from the drying means (9), to the first separator (1), or to the first mixing means (2), or to the second mixing means (6), or to the second separator (3), or to the second storage tank (8), or to the ammonia separation means (4) or to the absorption unit (14) to finally be a part of the liquid containing ammonia.

30 The dried solid phase obtained from the drying means (9) may contain less than 40% water, e.g. less than 35% water, such as less than 30% water, e.g. less than 25% water, such as less than 20% water, e.g. less than 15% water, such as less than 10% water, e.g. less than 5% water.

The dried solid phase comprising the fibre of the raw slurry and/or lime from the base addition to the first liquid phase can be stored in a third storage tank connected to the drying means (9) or be transferred to a sixth storage tank (17) or be burned in a boiler (11) to produce electricity and/or heat. The boiler (11) can be connected to a filter (19) for filtering the smoke or directly to a chimney (20). The first solid phase and/or the second solid phase and/or the dried solid phase may be composted, spread on land as a material improving the structure and/or conditions of the farmland or it can be used as a product for fermenting to produce ethanol and/or biogas. The dried solid phase may be used as a soil improvement product.

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From the boiler (11) the obtained ash can be washed with sulphuric acid to reclaim the phosphor. The acid with the phosphor can be used as a fertiliser.

15

In the system heat exchangers (13) may be located whenever possible. A heat exchanger (13) may be located between the second storage tank (8), and the ammonia separation means (4) such that hot water from the ammonia separation means (4) can be directed through the heat exchanger (13) and further to a fourth storage tank (12) for reject water with a low content of ammonia. Another heat exchanger (13) may be located between the ammonia separation means (4) and the stable (16) or other buildings to be heated. A further heat exchanger (13) may be located between the drying means (9) and the ammonia separation means (4) in a way such that steam from the drying means (9) is directed through the heat exchanger (13) and further to the first separator (1), the first mixing means (2), the second mixing means (6), the second separator (3), the second storage tank (8), the ammonia separation means (4) or the absorption unit (14).

25

In a preferred embodiment the system does not comprise means for performing a treatment of the second liquid phase and/or of the reject water with activated carbon. Likewise the method in a preferred embodiment does not comprise the step of performing a treatment of the second liquid phase and/or of the reject water with activated carbon.

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The system as described herein may comprise the following units:

- First separator (1), first mixing means (2) and second separator (3).

- First separator (1), first mixing means (2), second mixing tank (6) and second separator (3).
- First separator (1), first mixing means (2), second separator (3) and ammonia separation means (4).
- 5 • First separator (1), first mixing means (2), second mixing tank (6), second separator (3) and ammonia separation means (4).
- First separator (1), first mixing means (2), second separator (3), second storage tank (8) and ammonia separation means (4).
- First separator (1), first mixing means (2), second mixing tank (6), second separator (3), second storage tank (8) and ammonia separation means (4).
- 10 • First separator (1), dosage means (7), first mixing means (2), second separator (3) and ammonia separation means (4).
- First separator (1), dosage means (7), first mixing means (2), second mixing tank (6), second separator (3) and ammonia separation means (4).
- 15 • First separator (1), dosage means (7), first mixing means (2), second separator (3), second storage tank (8) and ammonia separation means (4).
- First separator (1), dosage means (7), first mixing means (2), second mixing tank (6), second separator (3), second storage tank (8) and ammonia separation means (4).
- 20 • Third mixing means (18), first separator (1), dosage means (7), first mixing means (2), second separator (3) and ammonia separation means (4).
- Third mixing means (18), first separator (1), dosage means (7), first mixing means (2), second mixing tank (6), second separator (3) and ammonia separation means (4).
- 25 • Third mixing means (18), first separator (1), dosage means (7), first mixing means (2), second separator (3), second storage tank (8) and ammonia separation means (4).
- Third mixing means (18), first separator (1), dosage means (7), first mixing means (2), second mixing tank (6), second separator (3), second storage tank (8) and ammonia separation means (4).
- 30 • The above mentioned possibilities may further be combined with at least a first storage tank (5), an absorption unit (14), N-storage tank (15), heat exchangers (13) and/or stable (16).

- The system may also comprise drying means (9), fibre silo (10), boiler (11), filter (19) and/or silo (17) as well as other units mentioned in Figure 1 or in the “List of features shown in the Figures”.

5 The process as described herein may by any combination of sub-processes performed in the units as described above. Especially any of the combinations mentioned in the list may be combined with the systems comprising the loop as described above.

10 The units of the system as mentioned herein is connected by pipes, valves or other connection means to make it possible to perform the process as described. In a preferred embodiment the system and process is performed in a single location i.e. without transport in lorries and the like at least from the step where the raw slurry is directed to the first separator (1). Preferably the entire system and process is performed at a single location e.g. a location such as a farm with one or more stables.

15 However two or three farms located close to each other may use the same system for the separation process.

The method

20 In another aspect the invention relates to a method for separation of slurry into solid and liquid phases, said method comprises

- Obtaining raw slurry comprising liquid and solids,
- Separating at least a part of the solid from the liquid, hereby obtaining a first liquid phase and a first solid phase,
- 25 • mixing the first liquid phase with a base,
- separating the first liquid phase mixed with the base into a second liquid phase and a second solid phase,
- hereby obtaining solid and liquid phases from said slurry.

30 In an embodiment the method comprises

- Obtaining animal raw slurry comprising liquid and solids,
- Separating at least a part of the solid from the liquid, hereby obtaining a first liquid phase and a first solid phase,
- mixing the first liquid phase with an amount of a base which lead to flocculation and/or precipitation of solid compounds,
- 35

- separating the first liquid phase mixed with the base into a second liquid phase and a second solid phase,
- removing ammonia from said second liquid phase, and

hereby obtaining solid and liquid phases from said slurry and ammonia.

5

In a preferred embodiment the method as described above is performed in an at least partly closed system at least in respect of the steps comprising mixing the first liquid phase with an amount of a base, separating the first liquid phase mixed with the base into a second liquid phase and a second solid phase, and removing ammonia from the

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second liquid phase.

In a preferred embodiment of the method ammonia evaporating from the first liquid phase and from the second liquid phase is collected. In another preferred embodiment of the method ammonia evaporating from the first solid phase, from the first liquid

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phase and from the second liquid phase is collected. In a further preferred embodiment of the method ammonia evaporating from the raw slurry, from the first liquid phase and from the second liquid phase is collected. Collected ammonia of gaseous phase can be absorbed in liquid e.g. liquid acid as described elsewhere herein.

20

The method may also be described as a method comprising

- Obtaining animal raw slurry comprising liquid and solids,
- Performing mechanical separation or at least a part of the solid from the liquid, hereby obtaining a first liquid phase and a first solid phase,
- mixing the first liquid phase with an amount of a base to obtain a chemical

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reaction resulting in flocculation and/or precipitation of solid compounds,

- separating the first liquid phase mixed with the base into a second liquid phase and a second solid phase,
- thermally removing ammonia from said second liquid phase, and

hereby obtaining solid and liquid phases from said slurry and ammonia.

30

The method can thus include a mechanical separation of the fibre and liquid, and a chemical and thermal separation of the liquid phase into a phase of residue fibre and reject water as well as a solution comprising ammonia. The reject may comprise less than 300 g N per ton and less than 20 g P per ton. The ammonia released from the

liquid phase may be absorbed in a liquid phase e.g. an acid and this liquid may be e.g. a 25 % solution of ammonia.

The method of the present invention may also be described as a method comprising

- 5 • Obtaining organic material from at least one stable for rearing animals such as cows, pigs and/or mink, said organic material comprises manure, urine, and optionally litter,
- Optionally storing said organic material,
- Optionally diluting said organic material with a liquid,
- 10 • Directing at least a part of said organic material in the form of animal raw slurry comprising liquid and solids and with a dry matter of between 3% and 12% to a mechanical separation process,
- Performing mechanical separation of the raw slurry, to separate at least 50% of the solid material from the liquid of the raw slurry, hereby obtaining a first liquid
15 phase and a first solid phase,
- mixing the first liquid phase with an amount of a base such as lime to obtain a pH of at least 9.5 hereby inducing a chemical reaction resulting in flocculation and/or precipitation of solid compounds and evaporation of ammonia,
- separating the first liquid phase mixed with the base such as lime into a second
20 liquid phase and a second solid phase,
- thermally removing ammonia optionally by steam stripping from said second liquid phase,
- absorbing evaporated ammonia in a liquid such as an acid liquid and hereby obtaining at least one solid phase, a liquid phase with a reduced amount of
25 ammonia and a liquid rich in ammonia.

The solid phases and liquid phases of the method as described just above may be subjected to any processes as described elsewhere herein.

- 30 In a preferred embodiment the process described above is performed in a closed system at least from the point where base is added to increase the pH to at least 9.5 and until a liquid phase with a reduced amount of ammonia leaves the step where ammonia is removed optionally by steam stripping. However evaporated ammonia is kept in the closed system until it is absorbed in a liquid to produce a liquid rich in
35 ammonia. This liquid may contain 5-30% of ammonia.

The coagulation process of the process described herein is preferably performed in a single step.

5 In the description of the system as presented above, different information in respect of the method for separation of slurry into solid and liquid phases is presented. This information applies as well to the method as described here and below.

10 In an embodiment the second liquid phase is subjected to a step where nitrogen in the form of ammonia and/or ammonium is separated from the second liquid phase.

In another embodiment the separated nitrogen when being in the form of ammonia is absorbed in a liquid.

15 In a further embodiment the base is selected from CaO, Ca(OH)₂, CaSO₄ and/or a natural base product.

In an embodiment the base is added to the first liquid phase in an amount to increase the pH to at least 9.

20 The process as described herein may reduce the amount of solid parts of a raw slurry such that if the raw slurry contains 3% to 9% of dry matter, the first separation step can reduce the dry matter to between 1% and 2% in the first liquid phase. By addition of base e.g. lime inducing coagulation and followed by settlement or removal of the coagulated substances, the dry matter content of the second liquid phase may be
25 below 1%. The ammonia separation step only reduces the dry matter content very little such as about 10% reducing the dry matter content of a 1% second liquid phase to about 0.9%.

30 If focusing on the N-content of the material, a raw slurry from animal stables usually contains 3-5 kg N per ton (N is meant as the total amount). The amount of N in the liquid obtained when ammonia is evaporated in the ammonia separation step may be reduced to 0.3 kg N per ton or less.

The amount of phosphor can be reduced from 1-2 kg P per ton in the raw slurry to 0.03 kg P per ton or less in the reject water obtained after the evaporation of the ammonia in the ammonia separation step.

5 The pH of the obtained reject water is lower than the pre-determined pH, as the ammonia stripping process in the ammonia separation means (4) results in a decrease of the pH of the reject water. Preferably the pH of the reject water is below 9, such as below 8.5, e.g. below 8, such as below 7.5, e.g. below 7.

10 In yet another embodiment the raw slurry is added base and/or polymer before the raw slurry is separated into a first liquid phase and a first solid phase.

In a preferred embodiment of the method separation of the mixed first liquid phase mixed with the base into a second liquid phase and a second solid phase is performed at a constant predetermined pH.

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In the method the pH may be kept at a constant level of a predetermined pH from the time of adding the base and until the second liquid phase is subjected to the step where nitrogen in the form of ammonia and/or ammonium is separated from the second liquid phase. The predetermined pH can be a pH selected from the group of pH-values
20 of 9, 9.5, 10, 10.5, 11, 11.5, 12, 12.5, 13. Preferably the predetermined pH is a pH selected from the group of pH-values of 10, 10.5, 11.

In an embodiment the second solid phase is directed to the raw slurry.

25 In the method the separation of the mixed first liquid phase which is mixed with base into a second liquid phase and a second solid phase can be based on mass flow or it can be based on an optical method.

30 In the method a base and/or a polymer may also be added to the first liquid phase mixed with said base at the time just prior to separating it into a second liquid phase and a second solid phase.

In a preferred embodiment the method does not include settlement of solid parts or of residue of solid parts by the use of Al- or Fe-salts.

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Use

The system as well as the method can be used for separation slurries containing nitrogen such as slurry obtained from animals.

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The first liquid phase may with the method described herein be reduced in the content of nitrogen with about 80% when using 5-10 g Ca(OH)_2 pr ton of first liquid phase followed by stripping ammonia by simple evaporation with agitation once each hour except in the night.

10

Use of the system as described herein may be performed for separation of animal slurry. Especially the use is performed with animal slurry originating from livestock such as cows, pigs, and/or mink.

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The use of the system as described herein may be performed with any of the methods described herein.

Detailed description of the drawings

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Figure 1 shows an embodiment of the invention. From a stable (16) the slurry and manure is directed to a first storage tank (5) for storing the manure and slurry. The slurry and manure i.e. the raw slurry is directed from the first storage tank (5) to a first separator (1) where the output is a first solid phase and a first liquid phase. The first solid phase is directed to drying means (9), and from the drying means (9) the dried solid phase is directed to a third storage tank (10) and can be burned in a boiler (11).
25 The first liquid phase is added lime from a dosage means (7) and the first liquid phase and lime is mixed in a first mixing means (2) before or while being diverted to a second separator (3) or sedimentation tank (3') from which second separator (3) or sedimentation tank (3') a second solid phase can be obtained and e.g. directed to the first separator (1). From the second separator (3) or sedimentation tank (3') a second liquid phase is obtained which can be stored in a second storage tank (8) before
30 diverted to an ammonia separation means (4) for removing ammonia e.g. by stripping with air. From the ammonia separation means (4) reject water is obtained and is directed to a fourth storage tank (12) or directed to a drain e.g. connected to a
35 wastewater treatment plant or the reject water is directed to a field for irrigating the

field. From the ammonia separation means (4) also stripped ammonia is obtained. The stripped ammonia is absorbed in an absorption unit (14) and directed to a N-storage tank (15). Heat exchangers (13) can be located between different features of the system e.g. between the drying means (9) and the ammonia separation means (4),
5 between the boiler (11) and the ammonia separation means (4), between the second storage tank (8) and the separation means (4), between the ammonia separation means (4) and the stable (15).

Figure 2 shows an embodiment of the method of separating slurry into a solid and a liquid phase. Raw slurry is separated into a first solid phase and a first liquid phase.
10 The first solid phase is dried to obtain a dried solid phase and a steam which may contain ammonia. The first liquid phase is added a base and separated into a second liquid phase and a second solid phase. The second solid phase can be returned to the raw slurry or be added to the first solid phase. From the he second liquid phase
15 ammonia is removed to obtain reject water and ammonia, which can be absorbed in a liquid to obtain a liquid with ammonia. The steam with ammonia obtained when drying the first solid phase can be directed to the second liquid phase before removing ammonia from the liquid. In the end the solid phase is obtained as a dry phase. Reject water with a low content of nitrogen and a liquid with a higher amount of nitrogen are
20 obtained.

The method illustrated in Fig 2 for slurry separation may be performed with the following elements of the system. Raw slurry can be obtained from a stable (16) and may be stored in a first storage tank (5). In a first separator (1) the raw slurry can be
25 separated into a first solid phase and a first liquid phase. The first solid phase can be dried in a drying means (9) to obtain a dried solid phase and steam with ammonia evaporated from the first solid phase. The first liquid phase can be added base from a dosage means (7) and mixed in a first mixing means (2) or a second mixing means (6) before separated in a second separator (3) to obtain a second solid phase and a
30 second liquid phase. The second liquid phase can be stored in a second storage tank (8) before ammonia in the second liquid phase can be evaporated and/or stripped in an ammonia separation means (4). Evaporated/striped ammonia can be absorbed in an absorption unit (14).

Figure 3 illustrates an embodiment of the method where slurry is obtained from a stable (16). . Raw slurry which can be a slurry obtained directly from the stable, or it can be stored for an unspecified period and can be with or without the treatment by base, is separated into a first solid phase and a first liquid phase. The first solid phase is dried to obtain a dried solid phase and a steam which may include ammonia. The first liquid phase is added base, mixed and subjected to a separation into a second liquid phase phase and a second solid phase. The second solid phase is directed to the raw slurry or to the first solid phase. The second liquid phase is subjected to struvite formation before performing a separation into precipitated struvite (third solid phase) and a third liquid phase. The precipitated struvite may be directed to the first solid phase. The process of struvite formation is preferably not included in the process. Steam with ammonia obtained when drying the first solid phase may be directed to the second liquid phase or to the third liquid phase. The third liquid phase is stripped for ammonia to obtain reject water and stripped ammonia, which can be obtained in liquid.

15

Figure 4 illustrates an embodiment of the system according to the invention. In a first sprarator (1) slurry is treated to obtain a first solid phase and a first liquid phase. The first solid phase is dried in a drying means (9) to obtain a dried solid phase and steam with ammonia. The dried solid phase is stored in a third storage tank (10) before it can be burnt in a boiler (11). The first liquid is directed to mixing means (2 and/or 6) where also base is added from a dosage handling means (7). The mixed material obtained from the mixing means (2 and/or 6) is separated in a second separator (3) to obtain a second solid phase and a second liquid phase. The second solid phase can be directed to the first separator (1) or to the drying means (9). The second liquid phase is directed to a second storage tank (8) before being separated in separation means (4) to obtain ammonia which can be absorbed in an absorption unit (14) and further stored in a N-storage tank (15). To the separation means (4) steam with ammonia from drying means (9) can be directed to separate ammonia from this steam too. From the separation means is also obtained reject water which may be stored in a fourth storage tank (12).

30

Figure 5 illustrates another embodiment of the system of the invention. When compared to the system of figure 4, the second liquid phase is directed to a second storage tank (8) and/or a struvite reactor (23) before directing it to a third separator (21) from where a third solid phase comprising struvite is obtained. The process of struvite

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formation is preferably not included in the process. The third solid phase may be directed to the drying means (9). From the third separator (21) also a third liquid phase is obtained. The Third liquid phase is directed to separation means (4) wherein it is treated as described in the legend to figure 4.

5

Figure 6 illustrates another embodiment of the system for treating slurry. The figure is much like figure 5 although possibilities before performing the first separation in the first separator are indicated. The indicated possibilities may also be combined with other embodiments of the system e.g. the one shown in figure 4. In figure 6 it is shown that from a stable (16) slurry is obtained which may comprises lumps of faeces (manure) and/or straw and/or other solid materials mainly of plant origin. The organic material (slurry) obtained from the stable (16) may be directed to a cutter (24), to a first storage tank (5) and/or to a first separator (1). In or when being directed to the first storage tank (5) the organic material (slurry) may be treated with base. From the first storage tank (5) the organic material (slurry) may be directed to the cutter (24), to a third mixing means (18) or to a first separator (1). From the cutter (24) the organic material (slurry) may be directed to the first storage tank (5), to the third mixing means (18) or to the first separator (1). From the third mixing means (18) the slurry is directed to the first separator (1).

20

List of features shown in the Figures:

- First separator (1) for separating raw slurry and/or pretreated slurry
- First mixing means (2) for mixing the first liquid phase with a base
- Second separator or sedimentation tank (3) for separating the first liquid phase mixed with a base
- Ammonia separation means (4) for separating ammonia from the second liquid phase
- First storage tank or collection tank (5) for collecting slurry from a stable and/or for pretreating a slurry
- Second mixing tank (6) for performing flocculation
- Dosage means (7) for dosage of base
- Second storage tank (8) for storage of second liquid phase
- Drying means (9) for drying solid phases
- Third storage tank (10) for storage of dried solid phase
- Boiler (11) for burning dried solid phase

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- Fourth storage tank (12) for storage of reject water
 Heat exchanger (13)
 Absorption unit (14) for absorption of ammonia
 N-storage tank (15) for storage of liquid with absorbed nitrogen
 5 Stable (16) for rearing animals
 Sixth storage tank (17) for storage of dried solid phase or fibre fraction
 Third mixing means (18) for mixing the raw slurry with base and/or polymer
 Filter (19) for filtering the gas developed in the boiler
 Chimney (20)
 10 Third separator (21) for separation struvite from the liquid phase
 Seventh storage tank (22) for storage of struvite
 Struvite reactor (23) for formation and/or separation of struvite
 Cutter (24) for cutting solid matter in the slurry

15 Examples

Example 1

20 The first liquid fraction obtained by Kemira Miljø as described above in Table 1 was subjected to treatment with base in an amount of 10 gram $\text{Ca}(\text{OH})_2$ pr litre of first liquid fraction and further separation by sedimentation of the formed flocs, hereby producing a second liquid fraction and a second solid fraction.

| Fraction | Dry matter, % | Total-N, kg/t | NH4-N, kg/t | Phosphor, kg/t | Nitrogen, kg/t |
|------------------------|---------------|---------------|-------------|----------------|----------------|
| First liquid fraction | 1.13 | 3.11 | 2.63 | 0.21 | 2.25 |
| Second liquid fraction | 2.07 | 0.57 | 0.5 | 0.02 | 1.87 |
| Second solid fraction | 12.66 | 1.32 | 0.44 | 0.92 | 1.42 |

25 The second solid fraction was dried. The dry matter of the second solid fraction by itself comprises (pr. ton) about 10 kg N, about 8 kg P, about 10 kg K and about 40 kg Ca (originally added as $\text{Ca}(\text{OH})_2$).

Example 2

At a farm feeding animals e.g. pigs 20 t/h of raw slurry can be obtained. This is collected in a first storage tank (5) of 3,000 cubic metre (k³m), directed to a first separator (1) from where 3 t/h of first solid phase is obtained and 17 t/h of first liquid phase is obtained. The first liquid phase is added base in an amount of 7 kg CaO or Ca(OH)₂ per m³. After ammonia separation the output is about 17 t/h reject water and about 0.2 t/h of liquid with about 25% ammonia.

10 **Example 3**

At a farm with about 6,700 sows and a yearly production of pigs for slaughtering of about 200,000 i.a. about 8,000 AU (Animal units) in total, the following indicates the balances (the values are estimates).

| | |
|---|----------------------------|
| N, from pig at 120 kg. N pr DE (5 kg N pr ton) | 950 ton in total |
| Hereof lost | 100 ton |
| Hereof organic bound in the fibre fraction | 200 ton |
| Hereof dissolved in the fibre fraction | 50 ton |
| Hereof in the second solid phase | 100 ton |
| Hereof for stripping | 500 ton |
| | |
| P, organic bound or orthophosphate (1 kg P pr ton) | 200 ton in total |
| Hereof in the fibre fraction | 100 ton |
| Hereof in the second liquid phase (lime slurry) | 100 ton |
| | |
| K (2.5 kg pr ton) | 450 ton in total |
| Hereof dissolved in the fibre fraction | 20 ton |
| Hereof in the second liquid phase (lime slurry) | 150 ton |
| Hereof in the reject water | 280 ton |
| | |
| Second liquid phase (lime slurry) from settlement of P | 30,000 ton in total |
| Hereof water | 25,000 ton |
| Hereof dry matter with N, P and K | 5.000 ton |
| | |

| | |
|---|----------------------------|
| Fibre fraction | 20,000 ton in total |
| Hereof liquid fraction | 13,000 ton |
| Hereof dried fibre fraction | 7,000 ton |
| Hereof ash from the boiler 700 ton | |
| | |
| Gross energy in the 7,000 ton dried fibre fraction | 30 mio kWh in total |
| Hereof lost when burning | 5 mio kWh |
| Hereof used for heating | 6 mio kWh |
| Hereof used for steam production | 10 mio kWh |
| Hereof excess production excl. for heat exchanging | 9 mio kWh |

Claims

1. A system for separation of slurry from animal waste, said system comprises
- a first separator (1) for separating raw slurry into a first liquid phase and a first solid phase,
 - first mixing means (2) for mixing the first liquid phase with a base,
 - a second separator (3) or sedimentation tank (3') for separation said first liquid phase mixed with said base into a second liquid phase and a second solid phase
- wherein at least said first mixing means (2) and said second separator (3) or sedimentation tank (3') is a closed system.
2. The system according to claim 1 further comprising ammonia separation means (4) for separating ammonia from said second liquid phase, wherein said ammonia separation means (4) together with said first mixing means (2) and said second separator (3) or sedimentation tank (3') is a closed system.
3. The system according to claim 1 or 2, further comprising an absorption unit (14) for absorbing said separated ammonia.
4. The system according to any of the preceding claims further comprising a second mixing tank (6) for mixing the organic material and performing flocculation.
5. The system according to any of the preceding claims further comprising a first storage tank (5) for storing said slurry before performing the separation.
6. The system according to any of the preceding claims further comprising third mixing means (18) for mixing said first slurry (or "raw slurry") with an base before directing said slurry to said first separator (1).
7. The system according to any of the preceding claims further comprising dosage means (7) for handling said base before directing base to said first mixing means (2) or said third mixing means (18).

8. The system according to any of the preceding claims further comprising a second storage tank (8) for storage of said second liquid phase obtained from said second separator (3) or sedimentation tank (3').
- 5 9. The system according to any of the preceding claims further comprising pH measuring means for measuring and regulating the pH of the liquid phases.
- 10 10. The system according to claim 9, wherein said pH measuring means are connected to said first separator (1), to said first mixing means (2), to said second mixing tank (6), to said second separator (3) and/or to said second storage tank (8).
- 15 11. The system according to claim 10, wherein said pH measuring means measure the pH of the liquid in the said first separator (1), to said first mixing means (2), to said second mixing tank (6), to said second separator (3) and/or to said second storage tank (8) and if the pH is below a predetermined value base is added until said predetermined value is reached.
- 20 12. The system according to claim 11, wherein said predetermined pH is a pH selected from the group of pH-values of 9, 9.5, 10, 10.5, 11, 11.5, 12, 12.5, 13.
13. The system according to claim 11, wherein said predetermined pH is a pH selected from the group of pH-values of 10, 10.5, 11.
- 25 14. The system according to any of the preceding claims further comprising a third mixing means (18) for mixing the raw slurry with base and/or polymer, said third mixing means (18) being connected to the first storage tank (5), to the first separator (1), and/or to at least one pipe connecting said first storage tank (5) with said first separator (1).
- 30 15. The system according to any of the preceding claims further comprising a third mixing means (18') for mixing the first liquid phase mixed with said base with more base and/or polymer, said third mixing means (18) being connected to said second separator (3).
- 35

16. The system according to any of the preceding claims further comprising a pre-sedimentation tank (21) for pre-sedimentation of flocculated dry matter.
- 5 17. The system according to claim 16, wherein pre-sedimentation tank (21) is connected to said first mixing means (2) such that material mixed in said first mixing means (2) is directed to said pre-sedimentation tank (21).
- 10 18. The system according to any of the preceding claims further comprising a loop for measuring and adjusting pH of the first liquid phase mixed with a base.
- 15 19. The system according to claim 18, wherein said loop is located between the first mixing means (2) and the second separator (3) if no second mixing tank (6) is present in the system or the loop can be located between the second mixing tank (6) and the second separator (3).
- 20 20. The system according to any of the preceding claims further comprising drying means (9) for drying said first solid phase and/or said second solid phase.
- 25 21. A method for separation of slurry from animal waste into solid and liquid phases, said method comprises
- Obtaining raw slurry comprising liquid and solids,
 - Separating at least a part of said solid from said liquid, hereby obtaining a first liquid phase and a first solid phase,
 - mixing said first liquid phase with a base to obtain a pH value of the at least first liquid phase of at least 9,
 - separating said mixed first liquid phase mixed with said base into a second liquid phase and a second solid phase,
 - hereby obtaining solid and liquid phases from said slurry
- 30 wherein ammonia which may evaporate from the time of mixing said first liquid phase with a base and when separation said mixed first liquid phase mixed with said base into a second liquid phase and a second solid phase is collected.
- 35 22. The method according to claim 21, wherein said second liquid phase is subjected to a step where nitrogen in the form of ammonia and/or ammonium is separated from said second liquid phase.

23. The method according any of the claims 21 to 22, wherein said separated nitrogen when being in the form of ammonia is absorbed in a liquid.
- 5 24. The method according to any of claims 21 to 23, wherein said base is selected from CaO, Ca(OH)₂, CaSO₄ and/or a natural base product.
25. The method according to any of claims 21 to 24, wherein said base is added to said first liquid phase in an amount to increase the pH to at least 9.
- 10 26. The method according to any of claims 21 to 25, wherein said raw slurry is added base before said raw slurry is separated into a first liquid phase and a first solid phase.
- 15 27. The method according to any of claims 21 to 26, wherein separating said mixed first liquid phase mixed with said base into a second liquid phase and a second solid phase is performed at a constant predetermined pH.
- 20 28. The method according to any of claims 21 to 27, wherein the pH is kept at a constant level of a predetermined pH from the time of adding the base and until the second liquid phase is subjected to the step where nitrogen in the form of ammonia and/or ammonium is separated from said second liquid phase.
- 25 29. The method according to any of claims 21 to 28, wherein said predetermined pH is a pH selected from the group of pH-values of 9, 9.5, 10, 10.5, 11, 11.5, 12, 12.5, 13.
- 30 30. The method according to any of claims 21 to 29, wherein said predetermined pH is a pH selected from the group of pH-values of 10, 10.5, 11.
31. The method according to any of claims 21 to 30, wherein the second solid phase is directed to the raw slurry.

32. The method according to any of claims 21 to 31, wherein separating said mixed first liquid phase mixed with said base into a second liquid phase and a second solid phase is based on mass flow or optically.
- 5 33. The method according to any of claims 21 to 32, wherein a base and/or a polymer is added to the raw slurry before performing said first separation.
34. The method according to any of claims 21 to 33, wherein a base and/or a polymer is added to the first liquid phase mixed with said base at the time just
10 prior to separating it into a second liquid phase and a second solid phase.
35. Use of the system as described in any of the claims 1 to 20 for separating animal slurry.
- 15 36. The use according to claim 35, wherein the separation is performed according to any of the claims 21 to 34.

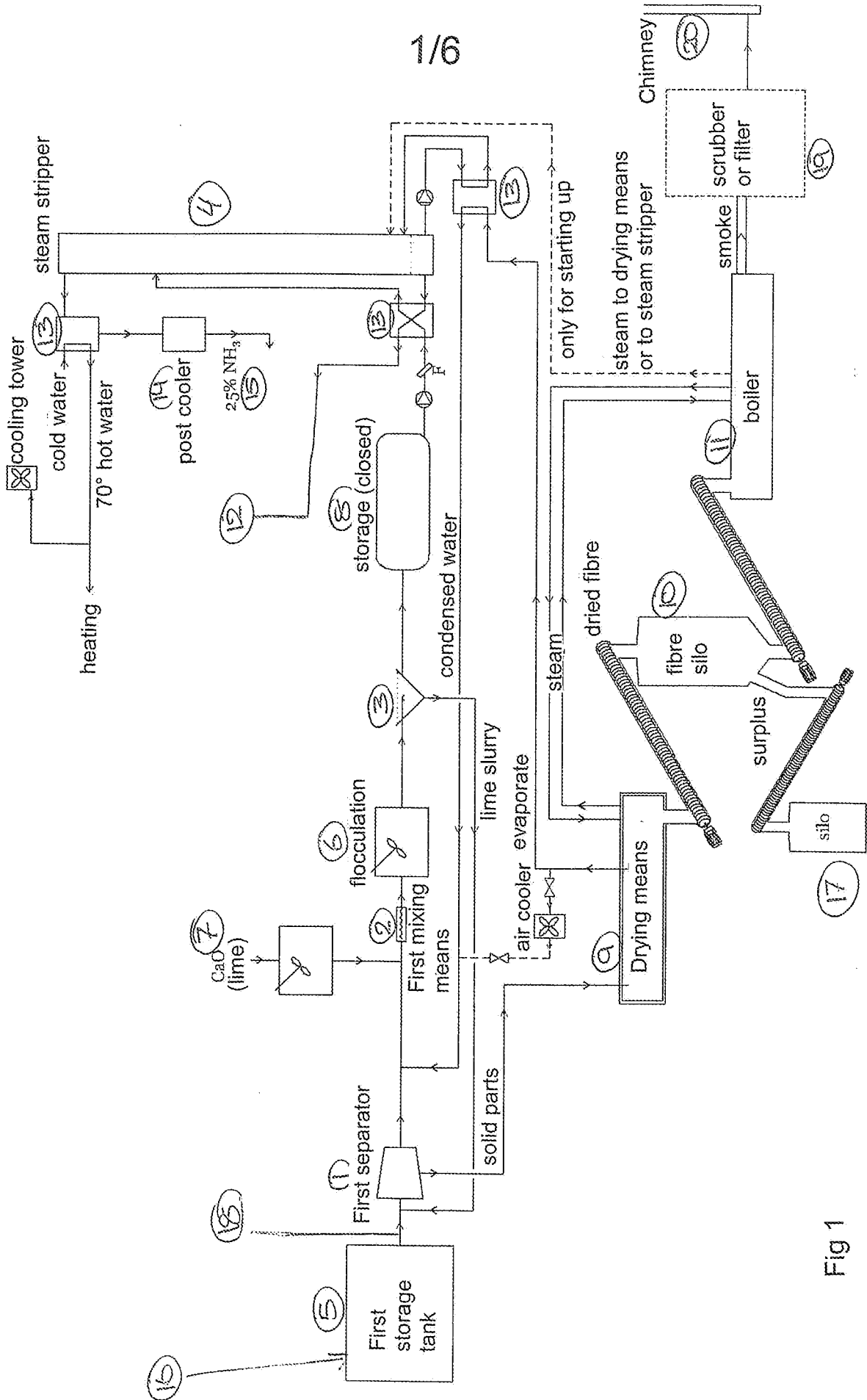


Fig 1

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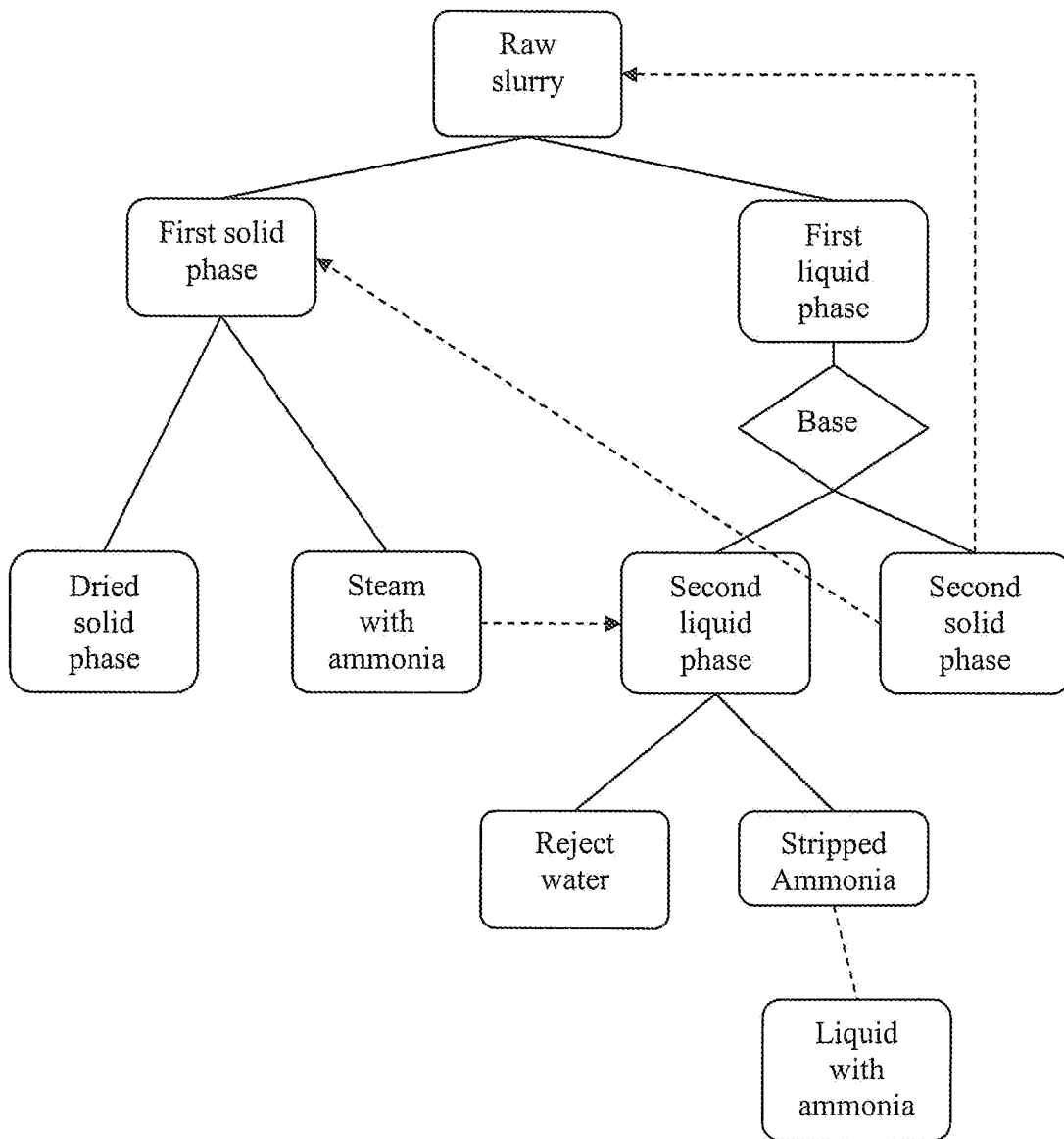


Fig 2

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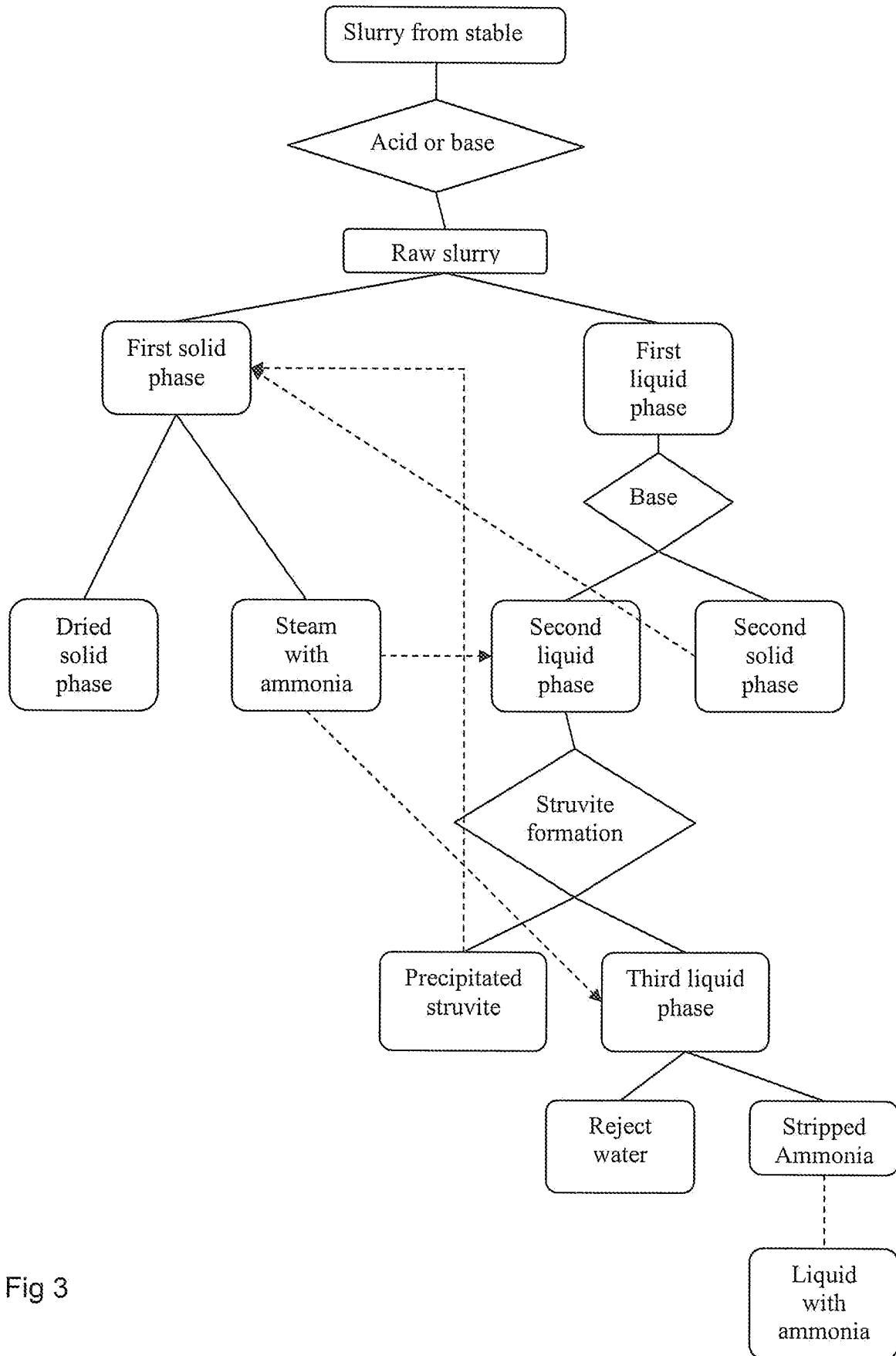


Fig 3

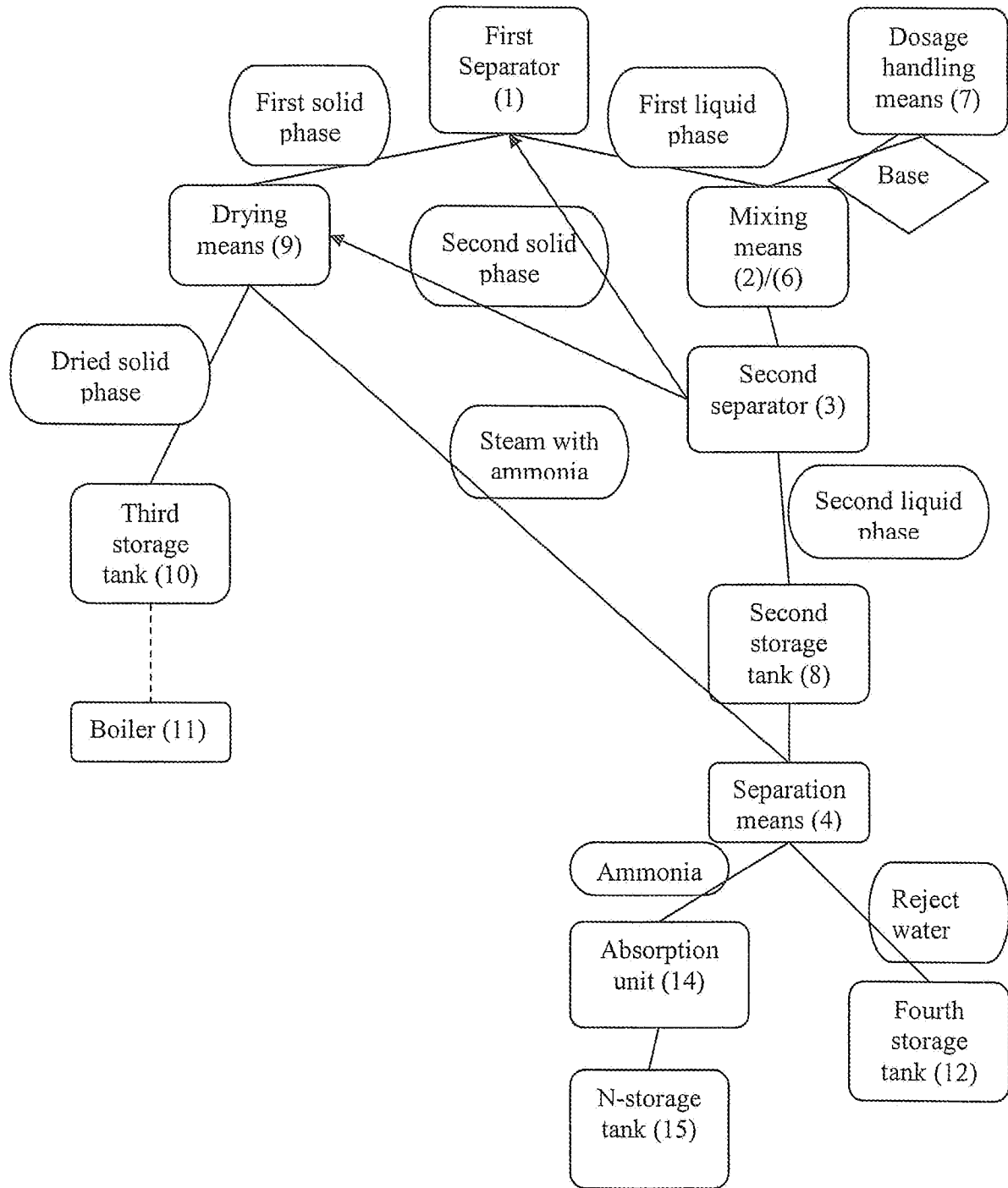


Fig 4

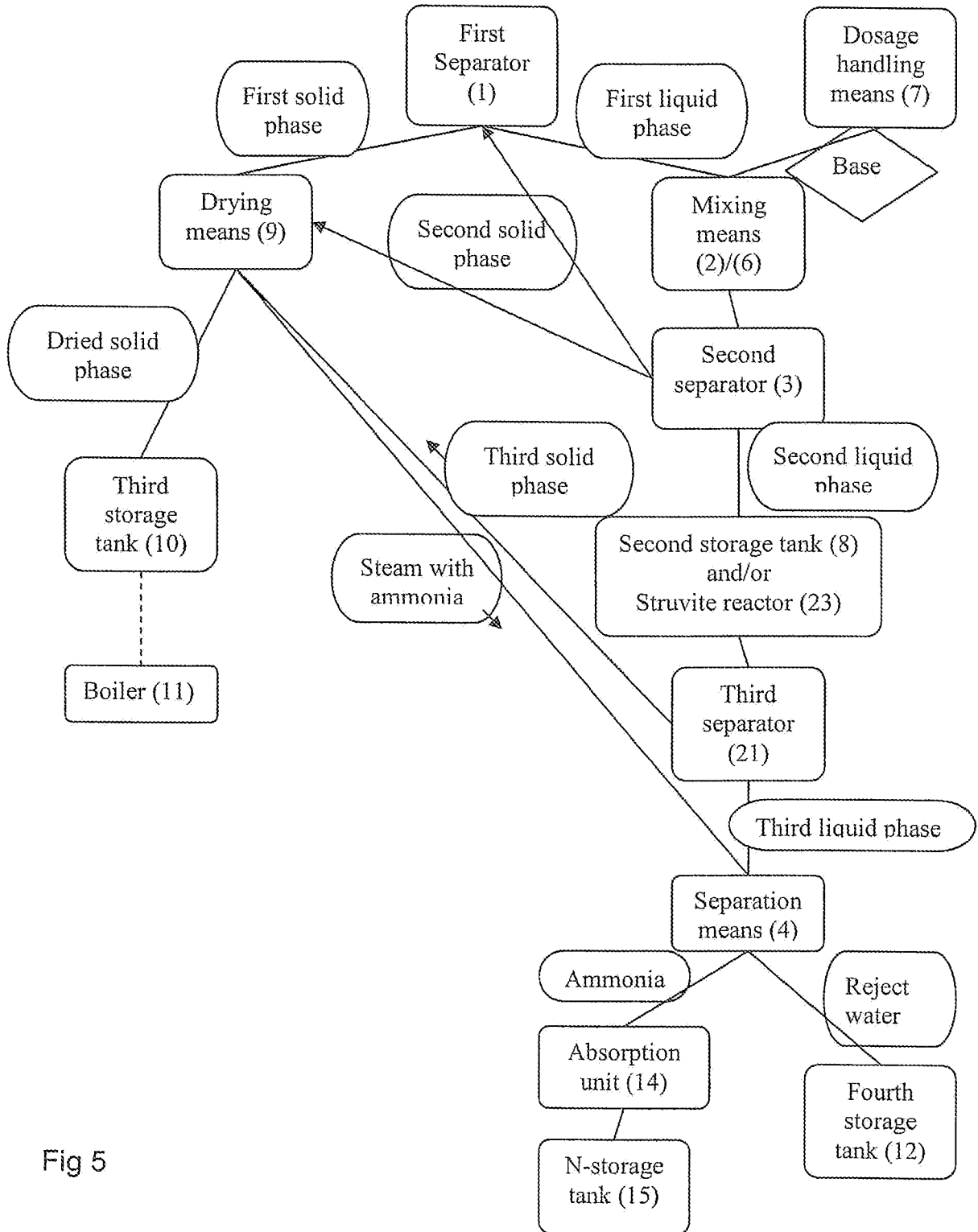


Fig 5

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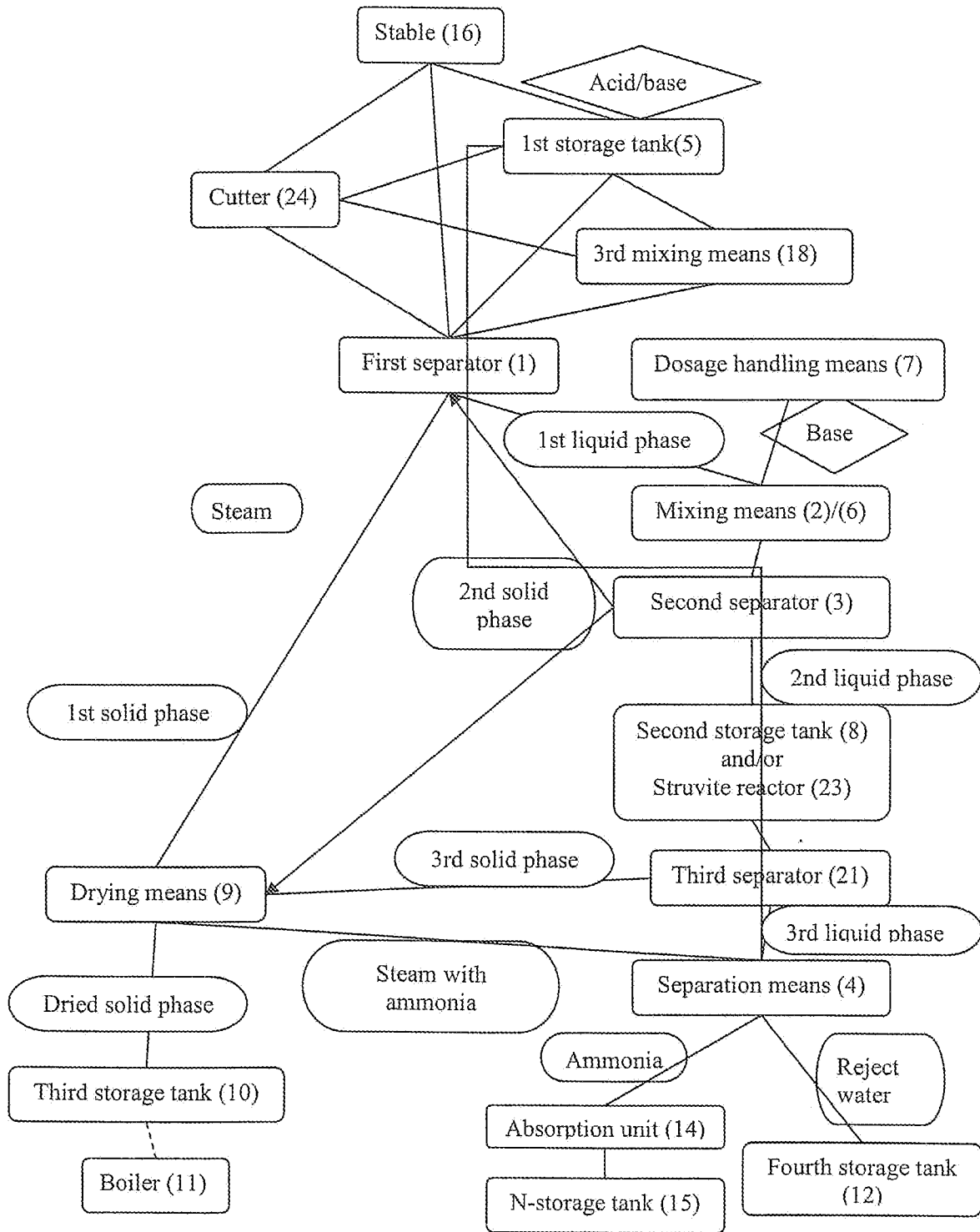


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK2010/050117

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: A01C, C02F, C05F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

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|-----------|---|-----------------------|
| X | US 20020158024 A1 (VAN SLYKE, VIKTOR ET AL), 31 October 2002 (31.10.2002), figures 1, 3, paragraphs [0031]-[0042], [0049]-[0054] -- | 1-36 |
| X | EP 0384329 A1 (HERMANN JOSEF KRUMME UND ELISABETH KRUMME GBR), 29 August 1990 (29.08.1990), column 2, line 35 - column 4, line 36; column 7, line 18 - column 8, line 55, figure 2 -- | 1-36 |
| X | EP 0351922 A1 (DRESE, JAN THEO), 24 January 1990 (24.01.1990), column 1, line 24 - column 2, line 24; column 2, line 46 - column 3, line 53, figures 1-2 -- | 1-36 |

 Further documents are listed in the continuation of Box C. See patent family annex.

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Date of the actual completion of the international search

26 August 2010

Date of mailing of the international search report

31-08-2010

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK2010/050117

| C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT | | |
|---|---|-----------------------|
| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
| X | WO 2008030234 A1 (FASSBENDER, ALEXANDER, G.), 13 March 2008 (13.03.2008), page 4, line 18 - page 11, line 11, figure 1, claims 1-32 -- | 1-36 |
| X | DE 3603739 A1 (CESKOSLOVENSKÁ AKADEMIE VED), 7 August 1986 (07.08.1986), page 10, line 7 - page 11, line 15; page 19, line 12 - page 23, line 21 -- | 1-36 |
| X | US 20040164021 A1 (LI, XIAOMEI ET AL), 26 August 2004 (26.08.2004), figure 1, paragraphs [0001], [0010] -- | 1-36 |
| A | JP 2002079299 A, MITSUBISHI JUKOGYO KK, 2002-03-19: (abstract) Retrieved from: WPI database, WEEK 20020319, AN 2002-493075; Original document: the whole document; see also the English translation -- | 1-36 |
| A | WO 9937596 A1 (TANGE, ANDERS), 29 July 1999 (29.07.1999), the whole document -- | 1-36 |
| A | WO 2004011393 A1 (LAKSHMAN, GURUNATHAN), 5 February 2004 (05.02.2004), the whole document -- | 1-36 |
| A | US 7491333 B1 (LUKE, DONALD A. ET AL), 17 February 2009 (17.02.2009), column 6, line 19 - line 39; column 8, line 5 - line 55; column 13, line 38 - column 15, line 2 -- | 1-36 |
| A | US 4657680 A (ZIBRIDA, JOHN F.), 14 April 1987 (14.04.1987), figure 1, claims 1-17 -- | 1-36 |

INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK2010/050117

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|--|-----------------------|
| P,X | US 20090206028 A1 (JIANG, ANPING ET AL), 20 August 2009 (20.08.2009), figures 1,5, paragraphs [0032]-[0034], [0037]-[0048], [0053]-[0065] -- | 1-36 |
| P,X | WO 2009116921 A1 (LINDAHL, ARNE), 24 Sept 2009 (24.09.2009), the whole document -- ----- | 1-36 |

International patent classification (IPC)

C05F 3/00 (2006.01)
C02F 1/52 (2006.01)
C02F 9/00 (2006.01)
C02F 9/02 (2006.01)
C02F 9/04 (2006.01)
C05F 7/00 (2006.01)
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INTERNATIONAL SEARCH REPORT
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International application No.
PCT/DK2010/050117

| | | | | | | |
|----|-------------|----|------------|------|---------------|------------|
| US | 20020158024 | A1 | 31/10/2002 | NONE | | |
| EP | 0384329 | A1 | 29/08/1990 | DE | 3905265 A | 23/08/1990 |
| EP | 0351922 | A1 | 24/01/1990 | NONE | | |
| WO | 2008030234 | A1 | 13/03/2008 | NONE | | |
| DE | 3603739 | A1 | 07/08/1986 | CS | 254717 B | 15/01/1988 |
| | | | | CS | 8500791 A | 11/06/1987 |
| | | | | FR | 2576741 A,B | 29/06/1990 |
| | | | | HU | 40054 A | 28/11/1986 |
| | | | | HU | 197273 B | 28/03/1989 |
| US | 20040164021 | A1 | 26/08/2004 | NONE | | |
| WO | 9937596 | A1 | 29/07/1999 | AU | 1752299 A | 09/08/1999 |
| | | | | EP | 1060153 A | 20/12/2000 |
| WO | 2004011393 | A1 | 05/02/2004 | AU | 2002317651 A | 16/02/2004 |
| | | | | CA | 2493615 A,C | 04/08/2009 |
| | | | | US | 7410589 B | 12/08/2008 |
| | | | | US | 20060108291 A | 25/05/2006 |
| US | 7491333 | B1 | 17/02/2009 | US | 7560031 B | 14/07/2009 |
| US | 4657680 | A | 14/04/1987 | NONE | | |
| US | 20090206028 | A1 | 20/08/2009 | NONE | | |
| WO | 2009116921 | A1 | 24/09/2009 | SE | 0800652 A,L | 21/09/2009 |