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(54) PROCESS TO RECOVER SOLUBLE CARBON AND NUTRIENTS FROM ORGANIC WASTE

VERFAHREN ZUR KOHLENSTOFF UND NAHRSTOFF RUCKGEWINNUNG AUS ORGANISCHEN ABFALLSTOFFEN

PROCEDE DE RECUPERATION DE CARBONE SOLUBLE ET DE NUTRIMENTS A PARTIR DE DECHETS ORGANIQUES

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Description

[0001] The present invention relates to a process for separating soluble carbon and mineral compounds containing nutrients from liquid organic waste gained after hydrolysis and acidogenesis or anaerobic digestion of organic waste such as wastewater sludge, food processing waste (animal, fruit and vegetable, diary, etc.), commercial waste (grease, expired food), agricultural waste, organic municipal solid waste, animal manure, industrial by-products like Category 2 and Category 3 waste as specified in the EU regulation No 1069/2009 or a mixture thereof.

[0002] More particularly, the present invention comprises a step where the liquid organic waste is subjected to pH adjustment and another step where distillation is used to separate the valuable components of the pH-adjusted liquid organic waste into a distillate comprising soluble carbon and a residue comprising nutrients.

[0003] In the current description we refer to the following definitions:

Organic waste:

[0004] Type of waste, typically originating from plant or animal sources, which may be broken down by other living organisms in a reasonable amount of time into its base compounds; can be found in municipal solid waste as green waste, food waste, paper waste and biodegradable plastics; includes also human waste, manure, sewage and slaughterhouse waste, and digestate.

pH adjustment (acidification):

[0005] Addition of an acid to a substance such as liquid or vapor until the pH falls below 7.

Distillation:

[0006] Method of separating mixtures based on differences in boiling points (volatilities) of its components.

Soluble carbon:

[0007] Contains organic carbon compounds and low molecular weight fatty acids with a carbon chain of six carbons or less (Formic C1; Acetic C2; Propionic C3; Butyric C4; Valeric C5; Caproic C6) which are also known as volatile fatty acids (VFA), short-chain fatty acids (SCFA) or carboxylic acids and result from fermentation or hydrolysis of organic waste.

sCOD:

[0008] Chemical oxygen demand of dissolved materials, expressed in mg/l.

Nutrients:

[0009] Any organic or inorganic material of natural or synthetic origin (other than liming materials) that is added to a soil to foster the growth of plants. Important nutrient elements as identified in EU regulation N° 2003/2003 are:

- primary nutrients: nitrogen, in the form of ammonium nitrogen (NH4-N) or nitrate nitrogen (NO3-N), phosphorous, in the form of phosphates (PO4-P), and potassium,
- secondary nutrients: calcium, magnesium, sodium, sulfur and
- micro-nutrients: boron, cobalt, copper, manganese, iron, molybdenum, zinc.

Liquid organic waste, such as:

[0010]

- permeate
  a liquid product gained after firstly subjecting organic waste to hydrolysis and acidogenesis and then secondly by separating the liquid part of the hydrolyzed organic waste from the solid one by membrane filtration; comprises soluble carbon and mineral compounds including valuable nutrients;
- methanogenic digestate
  a liquid byproduct gained after firstly subjecting organic waste to anaerobic digestion to produce biogas rich in methane and then secondly separating the undigested solids from the liquid; comprises most of the residual soluble

carbon and mineral compounds including valuable nutrients.

Distillate:

[0011] A liquid condensed from vapor during distillation comprising soluble carbon.

Residue:

[0012] A matter left in a retort after evaporation or distillation comprising nutrients which might be used as fertilizers for plants after further treatment.

Total Dissolved Solid (TDS):

[0013] Combined measurement of all organic and inorganic compounds in a liquid after being filtered through a filter the pore size of 0.45 micrometer, measured in mg/l.

Vapor compression distillation (VCD):

[0014] Method for compressing and thus increasing the pressure of the vapor produced using a blower, compressor or (high pressure motive) steam ejector; combines the benefits of distillation with those of vapor compression to greatly lower the cost of distillation; if performed by a mechanically driven compressor or blower usually referred to as MVR (Mechanical Vapor Recompression), otherwise as Thermocompression or Steam Compression; MVR is used in large machines, especially when energy-efficiency is important.

[0015] Treatment of organic waste is a well-established field of research and development. In the last few years, research has focused more on trying to recover valuable matter from organic solids, e.g. compost fertilizer, biogas, nitrogen and phosphorus, as part of treating and managing organic solids.

[0016] It is known that measurement of organic acids is standardized by many authorities. The Hungarian Standard Method for examination of sludge (MSZ 318/5-1979) as well as Chapter 5560, "Standard Methods for the Examination of Water and Wastewater", American Public Health Association (1992) disclose an empirical method for determining the concentration of organic acids in wastewater or sludge using distillation and titration. The purpose of the method is to control the efficacy of anaerobic digestion. Separation of the organic part of wastewater / sludge from the inorganic one on industrial scale is not discussed therein. Furthermore, no teaching is given concerning the need for a certain distillate : residue ratio to increase the yield. pH adjustment of the sample is needed only when applying the chromatographic separation method.

[0017] It is also known from prior art that UTB Envirotec Zrt.'s Hungarian patent application N° P1200637 discloses a method and apparatus for improving efficacy and yield of hydrolysis and acidogenesis of organic waste in a reactor by removing spent solids and a permeate comprising soluble carbon and nutrients from said reactor. The permeate is separated from the organic waste after hydrolysis and acidogenesis by means of filtration. However the recovered permeate is still waste being a liquid mixture of nutrients and soluble carbon that needs further treatment to be applicable in industry or agriculture.

[0018] It is further known that the international patent application N° PCT/IL2009/000001 (WO2009083985) discloses a multistage process for treating organic waste by drying the sludge and mixing it with a solvent medium to prepare a slurry. This thermochemical liquefaction process happening at 275 to 375 °C and at a pressure of about 10 atm results in a liquid solid phase where the two separate liquid streams are oil and water. However, by subjecting the oil phase to vacuum distillation synthetic fuel is recovered instead of soluble carbon and nutrients separately.

[0019] European patent application N° EP2366679A1discloses a process for treating organic waste by means of denitrification and at the same time obtaining residues that can be used as agricultural fertilizer. Denitrification happens in the presence of a mixture comprising phosphorus pentoxide, potassium oxide, calcium oxide and magnesium oxide in the form of powder. The gaseous/vapor phase containing ammonia and the excess ammonia is taken away by evaporation or distillation. Disadvantages of the process are that (i) the only starting material useable is livestock effluent; a particular type of organic waste and (ii) the gained product is a mixture of all of the organic and inorganic parts of the livestock effluent and mineral oxides which are added in calculated quantity to make the product useful as fertilizer.

[0020] US patent N° 6 193 872 B1 discloses a process and a plant to generate a solution of an alkali metal hydroxide from an alkaline aqueous inorganic waste stream, that contains C3 to C22 carboxylic acids in the form of alcohols, ethers, ketones and aldehydes, for recycling to a chemical production plant. The waste stream is first acidified to bring the pH to about 2 to about 3.5 and then subjected to distillation. Carboxylic acids gained as a by-product are purged without further utilization. In order to minimize corrosion of the electrolysis zone used to recover said solution it is desirable not to lower the pH too far below that corresponding to the pKa of the carboxylic acid.

[0021] The aim of the current invention is to increase the yield of soluble carbon and nutrients obtained by separation from a mixture thereof on industrial scale. The mixture might be a permeate gained as a liquid product after subjecting any kind of organic waste to hydrolysis and acidogenesis, or a methanogenic digestate produced as a liquid waste stream beside biogas in biogas plants by subjecting agricultural waste to anaerobic digestion

[0022] It is sought to reach - after distillation - a distillate comprising more than 85 to 88 w/w% of the soluble carbon, less than 2 w/w% of ammonium nitrogen and less than 1 w/w% of phosphate.

[0023] The present invention solving this problem is as set out in the independent claim.

[0024] The process according to the invention is suitable for any permeate or methanogenic digestate gained from organic waste such as wastewater sludge, food processing waste, commercial waste, agricultural waste, organic municipal solid waste, animal manure, industrial by-products like Category 2 and Category 3 waste according to EU regulation N° 1069/2009, or a mixture thereof, preferably organic waste with a high content of carbohydrates, lipids and proteins.

[0025] The pH might be adjusted by adding acid continuously or batchwise to the liquid organic waste, under continuous stirring. The stirring

- homogenizes the acid and the liquid organic waste and thus prevents overacidification,
- lets the CO_2 escape thus allowing the carbonic acid to remain in the distillate,
- avoids overheating of the liquid organic waste caused by reaction heat.

[0026] Adding sulphuric and/or phosphoric acid to adjust the pH of the permeate is especially preferred.

[0027] Eventually the acid might be previously diluted with water in a 1 : 1 ratio to allow a more precise pH setting.

[0028] The amount of acid that needs to be added depends on the contents of the liquid organic waste - mainly by the volatile fatty acids and ammonium nitrogen contained therein - and on the pH value of the liquid organic waste.

[0029] To achieve the highest yield in soluble carbon (in the distillate) and in nutrients (in the residue) as much acid is added as needed to preferably set the pH to 1,9 to 2,1.

[0030] Adjusting the pH of the liquid organic waste

- enables soluble carbon to distillate out with the water steam at a lower temperature than the different volatile fatty acids would at their own individual boiling points,
- fixes the liquid organic waste's ammonium content in form of ammonium-sulphate (if sulphuric acid is used) and thus preventing the ammonium from becoming volatile.

[0031] The homogeneous mixture of the liquid organic waste and acid is then added to a distillation device wherein - depending on the device - a boiling pressure of 100 to 1000 mbar and a boiling temperature of 35 to 100 °C is maintained.

[0032] In a preferred embodiment of the invention distillation is done by means of vapor compression, optionally with polymeric heat exchangers due to the low level of pH causing corrosion. MVR compression is preferred.

[0033] Beside water the distillate gained comprises mainly soluble carbon and in traces nutrients. The residue comprises beside water mainly nutrients and the part of the soluble carbon which is not in the distillate.

[0034] In another preferred embodiment of the invention the distillation is continued until a distillate : residue ratio of about 90 : 10 v/v% (90 v/v% of distillate and 10 v/v% of residue) is reached. Measurement of the ratio is possible by measuring the TDS concentration of the liquid in the distillation device. If the TDS concentration is 10 times the concentration measured after pH adjustment of the liquid organic waste the desired ratio is reached. A 90 : 10 v/v% ratio ensures that the recovery of soluble carbon in the distillate is about 88 w/w% and the recovery of nutrients in the residue is about 98 w/w%.

[0035] Continuing the distillation process beyond a 95 : 5 v/v% ratio might cause the residue to burn up and thus to become unusable.

[0036] Distilling might be done continuously or semi-continuously.

[0037] The invented process has the following main advantages:

- it offers a solution to further treat liquid organic waste gained from organic waste subjected to hydrolysis and acidogenesis, or optionally to anaerobic digestion.
- it recovers by way of separation soluble carbon and nutrients where
    - o the soluble carbon is a valuable carbon source for use in an activated sludge plant, biofuel production, biogasification plants, bioplastics production, bio-refineries for useful chemicals production, electricity production using microbial fuel cells, and other industrial uses where carboxylic acids can be applied;
    - o the recovered nutrients may be used as organic fertilizer after further treatment.

[0038] In the following examples are presented to show some details of the process according to the present invention without the intention of limitation.

EXAMPLES

[0039] In the examples below we use the following starting material and pH adjustment means:

- starting material: permeate gained by membrane filtration from waste activated sludge of a municipal wastewater plant after subjecting the sludge to hydrolysis and acidogenesis; temperature: 15 degree Celsius;
- pH adjustment means:

  open vessel having a pH sensor, an acid dispenser with a stirring device, and an inlet and outlet opening attached

Example 1:

[0040] At first we set the pH of the permeate to 2,0 by filling 300 liters of the permeate into a feed tank and adding 1 liter of concentrated sulfuric acid previously diluted with water in a ratio of 1 : 1, slowly for 1 hour, under continuous stirring using the acid dispenser with the stirring device. The mixture obtained is a homogenous, almost CO_2-less liquid wherein the ammonium is bound as protonated non-volatile ammonium sulphate and the TDS concentration is 0,65 w/w%.

[0041] Then we feed the liquid continuously into a mobile evaporator having an evaporation capacity of 50 to 100 kg/h and a boiling temperature control of 35 to 100 degree Celsius using vacuum principle. The liquid is then circulated by a pump and heated and boiled inside a plate heat exchanger. Next we flash the liquid into a vessel, separating the liquid and the vapor. The clean vapor goes into a MVR compressor where it is compressed to a higher temperature and pressure before condensing in the heat exchanger.

[0042] Besides maintaining a boiling pressure of 170 to 220 mbar and a boiling temperature of 57 to 62 degree Celsius the distillate is continuously produced and discharged into an empty vessel at a flow rate of 70 to 90 l/h. The residue is left in the evaporator for about 3 hours from start till the TDS in the liquid reaches a concentration of 6,5 w/w%, indicating that the distillate : residue ratio is about 90 : 10 v/v%. Discharging of the residue is then started and manually adjusted in order to keep the TDS concentration at 6,5 w/w%. After 4 hours 271,8 liters of distillate (see Table 1) and 30,2 liters of residue are obtained.

[0043] Table 1 shows the characteristics of the distillate obtained under industrial scale conditions as described in Example 1:

Table 1: Industrial scale distillate

	Original permeate	Distillate	Compounds of distillate (w/w%)
sCOD (mg/l)	5340	5200	87,64
NH4-N (mg/l)	1000	17	1,53
ortho PO4-P (mg/l)	50	0,5	0,9
Conductivity (μS/cm)	12300	480	-

[0044] In Examples 2-5 below tests are run batchwise under laboratory conditions using a normal laboratory distillator with a boiling point of 100 degree Celsius under atmospheric pressure.

Example 2:

[0045] At first we add 100 ml of distilled water to 100 ml of permeate having a pH of 7,83. The pH remains unchanged (in the following referred to as Sample 1). After distillation a distillate of 177 ml has been obtained. The distillate recovery rate is 88,41 v/v%.

Example 3:

[0046] At first we add 2,6 ml of sulphuric acid diluted in a 1 : 1 ratio (with distilled water) to 100 ml of permeate having a pH of 7,83. This sets the pH to 1,97 (in the following referred to as Sample 2). After distillation a distillate of 94 ml has been obtained. The distillate recovery rate is 91,62 v/v%.

Example 4:

[0047] At first we add 100 ml of distilled water and 2,6 ml of sulphuric acid diluted with distilled water in a 1 : 1 ratio to 100 ml of permeate having a pH of 7,83. This sets the pH to 2,63 (in the following referred to as Sample 3). After distillation a distillate of 184 ml has been obtained. The distillate recovery rate is 90,9 v/v%.

[0048] Table 2 below shows the characteristics of the distillate obtained from Samples 1-3:

Table 2: Dependency on pH adjustment

Measured components	Units	Starting material	Distillate of Sample 1	Distillate of Sample 2	Distillate of Sample 3
Distillate ratio	v/v%	-	88,5	91,62	90,9
Conductivity	μS/cm	9750	1442	677	1640
Soluble carbon as sCOD (recovery in w/w%)	mg/sample	970	424	852	515
	w/w%	-	43,71	87,83	53,1
C2	mg/l	1040	416	852	515
C3	mg/l	1131	456	1061	636
iC4	mg/l	203	88	191	104
nC4	mg/l	110	67	109	74
iC5	mg/l	455	202	424	217
nC5	mg/l	167	93	165	98
iC6	mg/l	40	42	44	42
nC6	mg/l	52	48	50	48
nC7	mg/l	80	78	80	78
ortho PO4-P (recovery in w/w%)	mg/sample	11	0,35	0,02	0,1
	w/w%	-	3,22	0,18	0,9
NH4-N (recovery in w/w%)	mg/sample	133,3	42,48	0,18	1,0
	w/w%	-	31,86	0,13	0,75

[0049] It can be seen from Table 2 that the recovery of soluble carbon in the distillate is the highest in Sample 2 (sCOD = 87,83 w/w%) where the pH was adjusted close to 2. Acidifying the permeate not close to a pH of 2,0 results in a much lower soluble carbon recovery (43,71 w/w% in Sample 1 and 53,09 w/w% in Sample 3, respectively).

Example 5:

[0050] At first we add 100 ml of distilled water and 1,0 ml of sulphuric acid diluted with distilled water in a 1 : 1 ratio to 100 ml of permeate having a pH of 7,77. This sets the pH to 2,00 (in the following referred to as Sample 4). After distillation a distillate of 155 ml has been obtained.

[0051] Table 3 below shows the characteristics of the distillate and residue gained after subjecting the permeate having a pH of 7,77 to pH adjustment and distillation as described in Example 5:

Table 3: Dependency on distillate recovery

Measured components	Units	Starting material	Distillate of Sample 4	Residue of Sample 4
pH	-	7,77	2, 98	1,94
Conductivity	μS/cm	6860	394	40000
Soluble carbon as sCOD	mg/sample	1266	946	299
	w/w%	-	74,72	23,62

(continued)

Measured components	Units	Starting material	Distillate of Sample 4	Residue of Sample 4
C2	mg/l	1745	1860	2421
C3	mg/l	777	487	840
iC4	mg/l	231	33	180
nC4	mg/l	203	59	187
iC5	mg/l	507	31	383
nC5	mg/l	141	26	187
iC6	mg/l	42	39	41
nC6	mg/l	55	46	49
nC7	mg/l	80	78	79
ortho PO4-P	mg/sample	5	0,05	4,3
	w/w%	-	1	86
NH4-N	mg/sample	157	2	131
	w/w%	-	1,27	83,44
Distillate : residue recovery ratio	v/v%	-	77,11	21,9

[0052] It can be seen that the nutrients recovery (86 w/w% of ortho PO4-P and 83,44 w/w% of NH4-N) in Sample 4 of the residue reached a level of interest while the recovery of soluble carbon was only 74,72 w/w% and the distillate : residue recovery ratio 77,1 : 21,9 v/v%.

[0053] Comparing Samples 1-4 it can be seen that the recovery of soluble carbon in the distillate is the highest in Sample 2, namely 87,83 w/w%. The distillate of the same sample contains also nutrients (0,31 w/w%) and the distillate : residue recovery rate is 91,62 : 8,38 v/v%.

Claims

1. Process for separating liquid organic waste, such as a permeate or a methanogenic digestate, gained after subjecting organic waste to hydrolysis and acidogenesis or to anaerobic digestion,
where said liquid organic waste comprises

a) soluble carbon comprising the low molecular weight fatty acids including acetic acid, propionic acid, butyric acid, valeric acid, caproic acid, and heptanoic acid, and
b) nutrients comprising nitrogen in the form of ammonium nitrogen or nitrate nitrogen, phosphorus in the form of phosphates, potassium, calcium, magnesium, sodium, sulfur, boron, cobalt, copper, manganese, iron, molybdenum or zinc,

characterized by

i. a step of adjusting the pH of the liquid organic waste to 1,8 to 2,1 by adding acid;
ii. a step of subjecting the product of step i. to vapor compression distillation in a distillation device gaining a distillate and a residue while

- measuring the total dissolved solid, hereinafter referred to as "TDS", concentration of the liquid in the distillation device and
- a distillate : residue ratio in the range between 85 : 15 and 95 : 5 v/v% is maintained by measuring the TDS concentration in the distillation device.

2. The process according to claim 1 ***characterized by*** adjusting in step i. the pH to a value between 1,9 and 2,1.

3. The process according to any of claims 1 to 2 ***characterised by*** adding in step i. the acid continuously or batchwise to adjust the pH.

4. The process according to any of claims 1 to 3 ***characterized by*** adding in step i. sulphuric and/or phosphoric acid.

5. The process according to any of claims 1 to 4 ***characterized by*** distilling in step ii. the product of step i. using vapor compression with polymeric heat exchangers.

6. The process according to any of claims 1 to 5 ***characterized by*** distilling continuously or semi-continuously.

7. The process according to any of claims 1 to 6 ***characterized by*** using as liquid organic waste a permeate or a digestate gained from organic waste such as wastewater sludge, food processing waste, commercial waste, agricultural waste, organic municipal solid waste, animal manure, or a mixture thereof, preferably organic waste with a high content of carbohydrates, lipids and proteins.

8. The process according to any of claims 1 to 6 ***characterized by*** continuing the step ii. until the TDS concentration of the liquid in the distillation device reaches a value of 10 times that of the product of step i.

Patentansprüche

1. Verfahren zur Trennung von flüssigen organischen Abfällen, wie Filtrate oder methanbildende Gärreste, gewonnen während des Abbaus organischer Abfallstoffe mittels Hydrolyse und Acidogenesis oder anaerober Gärung, wobei die genannten flüssigen organischen Abfälle

    a) löslichen Kohlenstoff, der Fettsäuren mit niedrigem Molekulargewicht, einschließlich Essigsäure, Propionsäure, Buttersäure, Valeriansäure, Kapronsäure und Heptansäure umfasst, sowie
    b) Nährstoffe, die Stickstoff in der Form von Ammoniumstickstoff oder Nitratstickstoff; Phosphor in der Form von Phosphaten; Kalium, Kalzium, Magnesium, Natrium, Schwefel, Bor, Kobalt, Kupfer, Mangan, Eisen, Molybdän oder Zink umfassen,
    beinhalten,
    dadurch gekennzeichnet, dass es

        i. eine Stufe des Einstellens des pH-Wertes der flüssigen organischen Abfälle auf 1,8 bis 2,1 mittels Zugabe von Säure
        und
        ii. eine Stufe des Verdampfens des Produktes der Stufe i. mittels Brüdenverdichtung in einem Destillationsapparat unter Gewinnung eines Dampfes und eines Sumpfes
        umfasst, wobei fortlaufend

        - die Konzentration der gesamten gelösten Feststoffmenge (im Weiteren "TDS") im Destillationsapparat gemessen und
        - das Dampf-Sumpf-Verhältnis über das Messen der TDS-Konzentration im Bereich zwischen 85 : 15 und 95 : 5 v/v % gehalten werden.

2. Verfahren nach Anspruch 1, ***dadurch gekennzeichnet, dass*** in der Stufe i. der pH-Wert zwischen 1,9 und 2,1 eingestellt wird.

3. Verfahren nach einem der Ansprüche 1 und 2, ***dadurch gekennzeichnet, dass*** in der Stufe i. die Säure zum Einstellen des pH-Wertes ununterbrochen oder portionenweise zugegeben wird.

4. Verfahren nach einem der Ansprüche 1 bis 3, ***dadurch gekennzeichnet, dass*** in der Stufe i. Schwefelsäure und/oder Phosphorsäure zugegeben wird.

5. Verfahren nach einem der Ansprüche 1 bis 4, ***dadurch gekennzeichnet, dass*** in der Stufe ii. beim Verdampfen des Produktes der Stufe i. mittels Brüdenverdichtung polymere Wärmeaustauscher verwendet werden.

6. Verfahren nach einem der Ansprüche 1 bis 5, ***dadurch gekennzeichnet, dass*** die Verdampfung kontinuierlich oder

halbkontinuierlich erfolgt.

7. Verfahren nach einem der Ansprüche 1 bis 6, ***dadurch gekennzeichnet, dass*** als flüssiger organischer Abfall ein Filtrat oder Gärrest aus organischen Abfällen wie Abwasserschlamm, Nahrungsmittelherstellungsabfälle, Handelsabfälle, landwirtschaftliche Abfälle, organische feste Haushaltsabfälle, Dünger von Tieren, oder deren Gemisch, vorteilhaft aus organischen Abfällen mit hohem Gehalt an Kohlenhydraten, Fetten und Eiweiß verwendet wird.

8. Verfahren nach einem der Ansprüche 1 bis 6, ***dadurch gekennzeichnet, dass*** die Stufe ii. fortgesetzt wird, bis die TDS-Konzentration des Sumpfes im Destillationsapparat den zehnfachen Wert von der des Produktes der Stufe i. erreicht.

Revendications

1. Méthode de séparation des déchets organiques liquides, tel qu'un perméat ou un digestat, obtenu après avoir soumis les déchets à l'hydrolyse et à l'acidogénèse ou à la digestion anaérobie,
les déchets organiques liquides comprenant

    a) du carbone soluble comprenant des acides gras de faible masse moléculaire, comprenant de l'acide acétique, de l'acide propanoïque, de l'acide butanoïque, de l'acide valérique, de l'acide hexanoïque, de l'acide heptanoïque et
    b) des nutriments comprenant de l'azote sous forme d'ammonium ou de nitrate, du phosphore sous forme de phosphates, du potassium, du calcium, du magnésium, du sodium, du soufre, du bore, du cobalt, du cuivre, du manganèse, du fer, du molybdène ou du zinc,

    caractérisé par

    i. une étape d'ajustement du pH du déchets organiques liquides à une valeur entre 1,8 et 2,1, en ajoutant de l'acide ;
    ii. une étape de soumission du produit de l'étape i. à la distillation par compression de vapeur dans un dispositif de distillation, obtenant ainsi un distillat et un résidu
    en

    - mesurant la concentration des matières dissoutes totales appelées ci-après « MDT », du liquide dans le dispositif de distillation et
    - maintenant un rapport distillat: résidu dans la plage de 85 : 15 à 95 : 5 v/v% en mesurant la concentration des MDT dans le dispositif de distillation.

2. Méthode selon la revendication 1, ***caractérisé par*** l'ajustement du pH à une valeur entre 1,9 et 2,1 pendant l'étape i.

3. Méthode selon l'une quelconque des revendications 1 et 2, ***caractérisé par*** l'addition continue ou discontinue d'acide pour ajuster le pH pendant l'étape i.

4. Méthode selon l'une quelconque des revendications 1 à 3, ***caractérisé par*** l'addition d'acide sulfurique et/ou phosphorique pendant l'étape i.

5. Méthode selon l'une quelconque des revendications 1 à 4, ***caractérisé par*** la distillation du produit de l'étape i. pendant l'étape ii., en utilisant la compression de vapeur avec des échangeurs de chaleur en polymère.

6. Méthode selon l'une quelconque des revendications 1 à 5, ***caractérisé par*** une distillation continue ou semi-continue.

7. Méthode selon l'une quelconque des revendications 1 à 6, ***caractérisé par*** l'utilisation comme déchets organiques liquides d'un perméat ou d'un digestat obtenu à partir des déchets organiques tels que les boues des eaux usées, les déchets organiques solides municipaux, le fumier ou un mélange de ceux-ci, de préférence des déchets organiques avec un contenu élevé de hydrates de carbone, lipides et protéines.

8. Méthode selon l'une quelconque des revendications 1 à 6, ***caractérisé en ce que*** l'étape ii. est poursuivie jusqu'au moment où la concentration de MDT du liquide du dispositif de distillation atteint une valeur dix fois plus grande

que celle du produit de l'étape i.

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- HU P1200637 **[0017]**
- IL 2009000001 W **[0018]**
- WO 2009083985 A **[0018]**
- EP 2366679 A1 **[0019]**
- US 6193872 B1 **[0020]**

Non-patent literature cited in the description

- Standard Methods for the Examination of Water and Wastewater. American Public Health Association, 1992 **[0016]**

SZABADALMI IGÉNYPONTOK

1. Eljárás folyékony szerves hulladék elválasztására, ahol a folyékony szerves hulladék szűrlet vagy metánképződésből származó rothadék, amely savas fermentáció melletti hidrolízis vagy anaerob rothasztás útján nyert, és magába foglal

   a) oldott szenet, amely magába foglalja az alacsony molekuláris súlyú zsírsavakat, beleértve ecetsavat, propionsavat, vajsavat, valeriánsavat, kapronsavat és önantsavat, és

   b) tápanyagokat, amelyek tartalmaznak nitrogént ammónium vagy nitrát formájában, foszfort foszfátok formájában, káliumot, kalciumot, magnéziumot, nátriumot, ként, bórt, kobaltot, rezet, mangánt, vasat, molibdént vagy cinket,

   azzal jellemezve, hogy az eljárásban van

   i. egy lépés a folyékony szerves hulladék pH-értékének beállítására sav adagolásával 1.8 és 2.1 közé;

   ii. egy lépés az i. lépés szerinti termék gőz-kompressziós lepárlására egy desztillációs berendezésben, egy párlatra és egy desztillációs maradékra,

   mimellett biztosított

   - a folyadék összes oldott anyag, a továbbiakban „TDS", koncentrációjának mérése a desztillációs berendezésben és

   - a párlat : desztillációs maradék 85 : 15 v/v% és 95 :5 v/v% közötti térfogataránya a TDS koncentráció mérése által a desztillációs berendezésben.

2. Az 1. igénypont szerinti eljárás, *azzal jellemezve, hogy* az i. lépésben a pH-érték 1.9 és 2.1 közé állított.

3. Az 1. vagy 2. igénypont szerinti eljárás, *azzal jellemezve, hogy* az i. lépésben a pH beállítására a savat folyamatosan, vagy szakaszosan adagoljuk.

4. Az 1. - 3. igénypontok bármelyike szerinti eljárás, *azzal jellemezve, hogy* az i. lépésben kénsavat és/vagy foszforsavat adagolunk.

5. Az 1. - 4. igénypontok bármelyike szerinti eljárás, *azzal jellemezve, hogy* az ii. lépésben az i. lépés szerinti termék gőz-kompressziós lepárlásához polimer hőcserélőt alkalmazunk.

6. Az 1. - 5. igénypontok bármelyike szerinti eljárás, azzal jellemezve, hogy a lepárlást folyamatosan, vagy félfolyamatosan végezzük.

7. Az 1. - 6. igénypontok bármelyike szerinti eljárás, azzal jellemezve, hogy folyékony szerves hulladékként használunk szűrletet vagy rothadékat, például szennyviz iszapból, élelmiszeripari feldolgozó műveletekből, kereskedelmi hulladékokból, mezőgazdasági hulladékokból, háztartási szilárd szerves hulladékokból, állati trágyákból, vagy ezek keverékéből, előnyösen magas szénhidrát, zsir és fehérje tartalmú szerves hulladékból nyerve.

8. Az 1. - 6. igénypontok bármelyike szerinti eljárás, azzal jellemezve, hogy az ii. lépést addig folytatjuk, amig a desztillációs berendezésben lévő folyadék TDS koncentrációja eléri az i. lépés szerinti termékének 10-szeresét.