METHOD AND SYSTEM FOR THE BIOLOGICAL TREATMENT OF WASTE

A method for the biological treatment of waste comprises the processes of hydrolysing the waste (1), separating the hydrolysed material stream, by screening (3), into a relatively coarse organic fraction to be discharged and a slurry stream having small particles, and converting dissolved organic components, by means of anaerobic fermentation (9), into biogas. According to the invention the said slurry stream has the sand fraction between 2 and 1000 µm separated therefrom (7) and is separated, after removal of the sand fraction (5), into a stream having a high concentration of solid fine organic material and clay-like constituents (8) and the water stream containing mainly dissolved organic components which are purified anaerobically in bioreactor (9).
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Title: Method and system for the biological treatment of waste.

The invention relates to a method for the biological treatment of waste, comprising the processes of hydrolysing the waste, separating the hydrolysed material stream, by screening, into a relatively coarse organic fraction to be discharged and having particles larger than x, where x has a value between 1 and 5 mm, and a slurry stream having particles smaller than x, and converting dissolved organic components, by means of anaerobic fermentation, into biogas.

Such a method has been described in NL-A-9100063, while reference is also made to EP-B-0142873 and NL-A-8303129.

The ability of carrying out the phase separation between the hydrolysis treatment and the anaerobic fermentation requires the controlled addition of considerable amounts of chemicals such as polyelectrolyte and flocculants. This entails considerable operational costs. Moreover, chemicals hinder the further processing of the fermenting materials. Furthermore, it has been found that domestic waste contains large amounts of sand (for example 5-12% by weight), which causes wear on the reactors and separation installations.

The object of the invention is to overcome these drawbacks, to which end it is proposed, in the first instance, that the said slurry stream has the sand fraction between 2 and 1000 μ separated therefrom and then, that the slurry stream which remains after removal of the sand fraction is separated into a stream having a high concentration of solid fine organic material and clay-like constituents and a water stream containing mainly dissolved organic components which are purified anaerobically in a bioreactor.

The removal of sand preferably takes place in a hydrocyclone. The removed sand can be reprocessed to give a reusable quality. The waste remaining after removal of sand has been considerably reduced in weight. This leads to cost savings in the remaining processes. The wear on the equipment will likewise be considerably reduced.

The step of separating into a stream having a high concentration of solid fine organic material and clay-like constituents and a stream, to be passed to the bioreactor end containing dissolved organic components, is preferably carried out in a decanter centrifuge, providing the option of avoiding the use
of chemicals, which is of great advantage for further processing.

The stream obtained having a high concentration of solid fine organic material and clay-like constituents is subjected to dewatering and secondary composting. Another possibility is that of subjecting this stream to further treatment in a RUDAD reactor.

The invention also relates to a system for the biological treatment of waste, comprising: a reactor for hydrolysing the waste, a screen installation for separating the hydrolysed material into a fraction larger than \( x \), where \( x \) has a value between 1 and 5 mm, and a slurry containing a fraction smaller than \( x \), and an anaerobic purification reactor for converting organic constituents dissolved in the slurry into biogas.

According to the invention, the system is provided with a hydrocyclone for removing from the slurry the sand fraction between 2 and 1000 \( \mu \) and also with a decanter centrifuge for separating the slurry into a stream having a high concentration of solid fine organic material and a stream containing mainly dissolved organic components.

With the aid of a dewatering and secondary composting installation, the material having a high concentration of solid fine organic material, which is produced by the decanter centrifuge, can be subjected to further treatment. Another possibility is the use of a RUDAD reactor for breaking down substances not readily degradable (especially cellulose fibres).

The invention will now be explained in more detail with reference to the flow sheet. A number of recirculation streams and bypass streams are not shown.

\[\begin{align*}
1 & = \text{hydrolysis reactor} = \text{PRETHANE reactor} \\
2 & = \text{separation installation for dividing heavy materials into glass and stone on the one hand and ferrous materials on the other hand} \\
3 & = \text{rotary screen} \\
4 & = \text{screw press} \\
5 & = \text{hydrocyclone} \\
6 & = \text{sand reprocessing installation} \\
7 & = \text{decanter centrifuge} \\
8 & = \text{composting installation or RUDAD reactor (Rumen Derived Anaerobic Digestor)} \\
9 & = \text{bioreactor for anaerobic water purification.}
\end{align*}\]
Two processes take place in the PRETHANE reactor. Heavy materials such as glass, stones and ferrous metal sink to the bottom and are removed by rakers or scrapers and passed to the processing installation 2, where the stones and the glass are separated by means of a magnet on the iron-containing waste. Organic material is hydrolysed and soured. In the process, a portion of the anaerobically degradable fraction is converted into dissolved volatile fatty acids. Mixing is preferably effected by means of compressed air, rather than by stirring. This is found to have significant technical advantages. Moreover, admixture of air will suppress the formation of methane in the PRETHANE reactor, so that said formation of methane can take place subsequently in the UASB reactor under safe and controlled conditions. The temperature is maintained at $37 \pm 3^\circ$C, by means of a warm-water system. The pH is maintained between 5 and 6.5, the solids content between 5 and 10%. The hydraulic retention time will be between 1 and 2 days. The retention time of the solids may vary between 2 and 5 days.

The hydrolysed material is conveyed to the rotary screen 3 where it undergoes dewatering. The rotating rotary drum has a pore size between 1 and 5 mm, preferably between 2.5 and 3.5 mm. The fermenting mass from the PRETHANE reactor is separated, in the rotary drum, into a coarse organic fraction (coarse fibrous material) which may either be fermented further in the PRETHANE or RUDAD reactor or is dewatered mechanically and may then be subjected to secondary composting, and a slurry stream containing only small particles.

This lastmentioned slurry stream containing small particles still contains fine sand, clay and organic material. For example, dewatering takes place from 5-10% solids content in the incoming stream to $\pm 13\%$ in the stream of solid particles. This stream of solid particles can be further dewatered in the screw press 4, prior to the aerobic composting. In the screw press, the stream of solid particles can be dewatered to give $\pm 55\%$ of dry matter. Downstream of the screw press there may be, for example, a belt conveyor which passes the material to the aerobic composting installation.

The liquid stream which still contains fine sand, clay and organic material is passed to the hydrocyclone 5 where the sand is separated. This separated sand is reprocessed in the installation 6. This reprocessed sand can be separated in a clean, reusable form.
The slurry stream which flows from the hydrocyclone and from which the sand fraction has been removed, is pumped to the decanter centrifuge 7. This stream is separated therein into a water stream containing virtually only dissolved components which are conveyed to the anaerobic water purification installation 9, and a stream with a high concentration of fine organic material and clay-like substances which may be further processed in a system 8. This may consist of a PRETHANE or RUDAD fermentation reactor, a mechanical dewatering installation and/or a drying-composting installation.

In the anaerobic purification installation 9 (for example a UASB reactor) the stream containing dissolved components is processed to give pure water and biogas.

Apart from the advantage of sand removal and the advantage of not having to use noxious chemicals, an additional advantage is obtained, namely that of the waste being separated into fractions which each have different concentrations of heavy metals and micro-contaminants. This means that one or more fractions immediately do comply with certain standards and consequently may be reused.

Studies have shown that the concentrations of heavy metals in the fractions "sand" and "coarse organic" are lower than in the incoming fresh waste.

When integral domestic waste is treated, the fermented residue contains such large amounts of contaminants (metals, organic microcontaminants, plastics) that it cannot and must not be used as a compost. It will therefore have to be dumped, or after incineration the residue has to be dumped. The sand can be separated in a clean form and thus need not be dumped.

The standards imposed on compost produced from vegetable, fruit and garden waste are stringent in many countries. This waste sometimes contains somewhat excessive concentrations of heavy metals, as a result of which the compost formed cannot comply with the standards. These metals are, in particular, adsorbed on the clay particles and the colloidal organic fraction (humic acids), rather than on the coarser organic fraction or the sand. By applying the invention, only the coarse organic fraction (and possibly the sand) from the rotary screen being reprocessed into compost, a quality can be achieved which does comply with the standards.

The following mass balances illustrate what results the
three-stage fermentation system (hydrolysis, separation and anaerobic fermentation) according to the invention achieves, in terms of the masses formed. D.M. means dry matter and O.M. means organic matter.
Example 1

Treatment of 25,000 tonnes/year of VFG waste in the three-stage fermentation system with conventional separation systems.

Vegetable, Fruit and Garden waste
25,000 tonnes of VFG
8,800 tonnes of D.M.
5,700 tonnes of O.M.

stone, glass
1,300 tonnes
900 tonnes of D.M.
50 tonnes of O.M.

23,700 tonnes
7,900 tonnes of D.M.
5,650 tonnes of O.M.

→ biogas
→ waste air
→ water

→ after composting

11,700 tonnes
4,900 tonnes of D.M.
2,850 tonnes of O.M.
Example 2
Treatment of approximately 25,000 tonnes/year of VFG waste in the three-stage fermentation system with the separation system according to the invention.

Vegetable, Fruit and Garden waste
25,000 tonnes of VFG
8,800 tonnes of D.M.
5,700 tonnes of O.M.

stone, glass
1,300 tonnes
900 tonnes of D.M.
50 tonnes of O.M.

sand
700 tonnes
500 tonnes of D.M.
50 tonnes of O.M.

23,700 tonnes
7,400 tonnes of D.M.
5,600 tonnes of O.M.

→ biogas
→ waste air
→ water

after secondary composting
coarse organic fraction
7,500 tonnes
3,400 tonnes of D.M.
2,300 tonnes of O.M.

after secondary treatment
fine organic & clay
3,500 tonnes
1,000 tonnes of D.M.
500 tonnes of O.M.
Example 3
Treatment of 50,000 tonnes/year of grey domestic waste (after mechanical pretreatment) in the three-stage fermentation system with conventional separation systems.

5
Pretreated domestic waste
50,000 tonnes of
35,300 tonnes of D.M.
17,700 tonnes of O.M.

10

stone, glass,
ceramics
8,600 tonnes
7,700 tonnes of D.M.
400 tonnes of O.M.

15
41,400 tonnes
27,600 tonnes of D.M.
17,300 tonnes of O.M.

→ biogas
→ waste air
→ water

20
→ secondary treatment

34,250 tonnes
18,400 tonnes of D.M.
8,300 tonnes of O.M.
Example 4

Treatment of 50,000 tonnes/year of (grey) domestic waste (after mechanical pretreatment) in the three-stage fermentation system with the separation system according to the invention.

Pretreated domestic waste
50,000 tonnes
35,300 tonnes of D.M.
17,700 tonnes of O.M.

stone, glass
8,600 tonnes
7,700 tonnes of D.M.
400 tonnes of O.M.

sand

36,700 tonnes
24,300 tonnes of D.M.
17,100 tonnes of O.M.

⇒ biogas
⇒ waste air
⇒ water

after secondary treatment
coarse organic fraction
17,300 tonnes
11,600 tonnes of D.M.
6,500 tonnes of O.M.

after secondary treatment
fine organic & clay
12,250 tonnes
3,500 tonnes of D.M.
1,600 tonnes of O.M.
Claims

1. Method for the biological treatment of waste, comprising the processes of hydrolysing the waste, separating the hydrolysed material stream, by screening, into a relatively coarse organic fraction to be discharged or to be processed separately and having particles larger than x, where x has a value between 1 and 5 mm, and a slurry stream having particles smaller than x, and converting dissolved organic components, by means of anaerobic fermentation, into biogas, characterized in that the said slurry stream has the sand fraction between 2 and 1000 µ separated therefrom.

2. Method according to Claim 1, characterized in that the step of separating the sand fraction takes place in a hydrocyclone.

3. Method according to Claim 1 or 2, characterized in that the slurry stream which remains after removal of the sand fraction is separated into a stream having a high concentration of solid fine organic material and clay-like constituents and a water stream containing mainly dissolved organic components which are purified anaerobically in a bioreactor.

4. Method according to Claim 3, characterized in that the step of separating the slurry stream into a stream having a high concentration of solid fine organic material and clay-like constituents on the one hand and a stream containing dissolved organic components on the other hand takes place in a decanter centrifuge.

5. Method according to Claim 3 or 4, characterized in that the stream having a high concentration of solid fine organic material and clay-like constituents is subjected to dewatering and secondary composting.

6. Method according to Claim 3 or 4, characterized in that the stream having a high concentration of solid fine organic material and clay-like constituents is subjected to further treatment in a RUDAD reactor.

7. System for the biological treatment of waste, comprising: a reactor for hydrolysing the waste, a screen installation for separating the hydrolysed material into a fraction larger than x, where x has a value between 1 and 5 mm, and a slurry containing a fraction smaller than x, and an anaerobic purification reactor for converting organic constituents dissolved in the slurry into methane and carbonic acid, characterized in that the system is also provided
with a hydrocyclone for removing from the slurry the sand fraction between 2 and 1000 μ.

8. System according to Claim 7, characterized in that it contains a decanter centrifuge for separating the slurry into a stream having a high concentration of solid fine organic material and a stream containing mainly dissolved organic components.

9. System according to Claim 7, characterized by a dewatering and secondary composting installation for treating the stream produced by the decanter centrifuge and having a high concentration of solid fine organic material.

10. System according to Claim 7, characterized by a RUDAD reactor for breaking down substances not readily degradable in the material which has been produced by the decanter centrifuge and has a high concentration of solid fine organic material.
A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 C12P5/02 C12M1/107 C05F9/00

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 6 C12P C02F C05F

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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