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(73) Patenthaver: **pro agri gmbh, Burgseestraße 5, 19053 Schwerin, Tyskland**

(72) Opfinder: **Beckers, Klaus, Burgseestr. 5, 19053 Schwerin, Tyskland**

(74) Fuldmægtig i Danmark: **Plougmann Vingtoft A/S, Strandvejen 70, 2900 Hellerup, Danmark**

(54) Benævnelse: **FREMGANGSMÅDE OG APPARAT TIL FREMBRINGELSE AF BIOGAS**

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METHOD AND DEVICE FOR GENERATING BIOGAS

The invention relates to a method for producing biogas by fermentation of pumpable organic starting materials, in particular also containing solids or mixed with organic solids, in particular manure and slurry from animal husbandry, as well as residues from food processing, such as, for example whey or fruit juice remains, as well as of other organic, intermediate, residual or waste products from commercial production or processing. The invention also relates to a device for producing biogas by fermentation of pumpable mixed organic starting materials, in particular also containing solids or mixed with organic solids, in particular those as mentioned above.

The production of biogas on a large scale as a source of alternative, CO_2-neutral energy has already been used for several years. Corresponding biogas plants are situated in particular in rural areas, where they serve to generate both electric power and useful heat, often in cogeneration of heat and power. As a rule, they are connected to combined heat and power plants that burn the resulting biogas in biogas engines and thereby drive a generator to produce electricity. The simultaneously resulting exhaust gas and cooling water heat of the biogas engine is coupled out as useful heat. The existing agricultural biogas plants obtain their biogas mainly from specially cultivated plant biomass, in particular from silage maize. If manure from animal husbandry is present, it is co-fermented in the silage maize biogas plants.

As a rule, however, only large arable farms have sufficient arable land resources to produce the required plant biomass. The majority of small and medium-sized family farms do not have these resources. but it is precisely in the many small and medium-sized farms with animal husbandry, but also in pure commercial animal husbandry farms without arable land, that, overall, a very high amount of manure and dung will accumulate. This quantitatively significant, free substrate potential that accumulates anyway to generate renewable energy is often unused because:

– no sufficiently powerful and therefore no economically competitive biogas method exists for the fermentation of manure alone or substrates with a high manure content,

– no suitable, sufficiently powerful and therefore no economically competitive plant technology exists in the field of small and medium-sized biogas plants (in particular 25 to 250 KW electric).

DE202004010707 U discloses a device for simultaneous anaerobic treatment of wastewater and organic solids. The device for fermentation according to D1 comprises an outer chamber (1),

which is connected to the inner chamber (2) by a separator, preferably designed as a perforated plate. As a result, the solid particles of the biomass to be fermented are retained in the outer chamber.

The present invention devotes itself to this gap and has as its object the provision of a method and a device for producing biogas by the fermentation of pumpable organic starting materials, possibly containing solids or mixed with organic solids, which allow the operation of high-performance, compact plants for biogas production that can be prepared with low investment costs.

This object is achieved in respect of the method aspect by a method for producing biogas by fermentation of pumpable, organic starting materials, in particular manure or slurries from animal husbandry, having the features of claim 1. Advantageous developments of this method according to the invention are indicated in dependent claims 2 to 8. The device aspect of the solution according to the invention is recorded in claim 9. Advantageous developments of the device according to the invention are cited in claims 10 to 13.

The method according to the invention for producing biogas by fermentation of pumpable organic starting materials, in particular manure or slurries from animal husbandry, distinguishes itself by the following features and method steps:

– an inflow of the organic starting material, which typically also contains a substantial proportion of coarser organic solids, is separated into a thin-liquid thin matter fraction, which contains solid particles to a lesser extent in relation to the starting material and, as a rule, predominantly smaller particle sizes, and, as a rule, also has a much lower dry substance content (here, as hereinafter, the dry substance content indication always refers to a proportion of dry substance per unit of volume or mass), and into a thick matter fraction, which compared to the starting material, therefore also to the thin matter fraction, contains a much higher proportion of solid particles, thereby as a rule also those with larger particle sizes, then also has, as a rule, a much higher dry substance content, and which typically has a higher viscosity, compared to the starting material, and in the process has a more pulpy to semi-solid consistency. In terms of mass and volume the thin matter fraction is regularly substantially greater than the thick matter fraction. The thin matter fraction is a fine suspension and thin. In this case, the thin matter fraction is determined by the proportion which a separation device, having passage openings of a particular opening width, allows to pass. The proportion retained by the separation device then forms the thick matter fraction. In the application provided within the scope of the invention, the separation device, which can be equipped for example with one or more screen insert(s) typically

has passage openings with opening widths of 20 μm to 2 mm. In particular, these opening widths are from 50 μm to 1 mm. Particularly preferred are opening widths of 100 μm to 500 μm. In many cases, in particular opening widths of 200 μm to 300 μm are chosen partly, sometimes even only up to 250 μm.

The dry substance content of the thin matter fraction is, as a rule, not more than 10% by weight, is often even at ≤ 5% by weight. The viscosity of the thin matter fraction is comparatively low. In contrast to the thin matter fraction, the thick matter fraction, which is substantially smaller in terms of mass and volume, is thickened compared to the starting material and contains a significantly increased solids content, in which almost all the coarser solid particles, which were present in the starting material, are included. The thick matter fraction regularly also contains a much higher dry substance content compared to the thin matter fraction. As a rule, the dry substance content of the thick matter fraction lies above 10% by weight, usually in the range of 15-25% by weight or even higher (in particular when even further organic solids are added to the thick matter fraction, the dry substance content can increase still further).

- The thin matter fraction is fed to a thin matter fermenter. In this thin matter fermenter, microorganisms are grown on growth bodies held in suspension in the filling volume, with the aid of which the thin matter fraction is fermented in the thin matter fermenter. The growth bodies can be held in suspension in the thin matter fermenter, in particular also supported by a stirring or internal circulating device, by consisting of a material which corresponds in its density, taking into account the growth, approximately to the density of water. Furthermore, an external circulation of the thin matter fraction contained in the thin matter fermenter can help to distribute the growth bodies in the volume of the thin matter fermenter (that is to say, to hold it in suspension). The thin matter fermenter is also designed as a fermenter chamber which is sealed and receives the thin matter fraction.

– Biogas produced in the thin matter fermenter is collected, for example in a biogas storage bag or a membrane gas store, and discharged for further use.

– Digestate produced in the thin matter fermenter is discharged.

In industrial wastewater treatment, the use of growth bodies suspended in wastewater to be treated that is mixed with organic load is not yet widely-used prior art, but is nevertheless basically known although more from the aerobic fermentation and denitrification of wastewater. However, in respect of quantity and quality of the organic load, manure cannot be compared with industrial wastewater. With manure, the content of organic dry substance per m^3 is not only up to 10 times higher, in particular cattle manure and fattening pigs' manure also contain relatively high

solids contents with particle-bound organic substance while the organic load in industrial wastewater is often in a predominantly dissolved form, and this is considerably easier for degradation by metabolisation. High solids contents – as in manure – always mean a high risk of blocking (clogging) of the growth bodies by the solid particles, moreover, with the result of severe limitation through to the loss of functionality of the growth bodies and therefore the entire process. In addition, high solids contents in the fermentation medium increase the viscosity of the fermentation medium, which is also detrimental to the fermentation process.

For these reasons, there is a substantial moment, enhancing the efficiency of the method, in the separation of a thin matter fraction and in the combination of a colonisation of microorganisms in the thin matter fermenter on growth bodies.

The colonisation of the microorganisms on growth bodies in the thin matter fermenter leads not only to a maximum area of contact between microorganisms and nutrients and substantially increased population density of the microorganisms; at the same time the immobilization or "fixing" of the microorganisms prevents flushing out of the microorganisms from the discharged digestate. As a result, the residence time of the fermentation medium in the thin matter fermenter can be harmlessly shorter than the duration of the regeneration cycle in particular of methane bacteria, which is usually about 15 days. In conventional biogas plants, contact area and population density are considerably lower, microorganisms are continuously flushed out there with the digestate and the residence time must necessarily be above the duration of the regeneration cycle, in particular of the methane bacteria, and this consequently means a proportionally higher fermenter volume and lower digester productivity.

For the present method, for example appropriate growth bodies from the Swedish company AnoxKaldnes can be used. Also, for example, the growth bodies offered by Multi Umweltechnologie AG from Aue/Sachsen, Germany under the brand name Mutag Biochip® can be used or equivalent growth bodies that ensure retention of the microorganisms by colonisation and growth on the growth bodies.

Advantageously, the thick matter fraction accruing in the separation can be fed to a thick matter fermenter, and also be fermented in part there in any case. In such a thick matter fermenter, the thin matter fraction is also – as a rule, predominantly – hydrolysed and acidified, however. Before the thick matter fraction is introduced into the thick matter fermenter, it can, or the solids contained therein can, be comminuted, broken up and/or homogenised, for example in a ball mill. Here, for example, additional solids such as, for example dung, grass, straw or other biomass, and/or process aids, such as hydrolysis-promoting enzymes, trace elements and the like,

and/or a recirculate from the thick matter or from the thin matter fermenter can added to the thick matter fraction and be comminuted, broken up and/or homogenised too. Pre-heating can also occur already, for example by a ball mill that is being used being heated. A proportion hydrolysed after a certain period of time, when a thick matter fermenter is used in the manner described above, is removed from the thick matter fermenter and – after passing through a comminution and/or breaking up and/or homogenising step, in an electrokinetic disintegration – is fed to the thin matter fermenter or added to the thin matter fraction or added to the inflow of organic starting material. Biogas produced in the thick matter fermenter is likewise collected and removed for further use, if necessary, fed to a biogas store. In this case, in particular the biogas produced in the thick matter fermenter can be combined with the biogas produced in the thin matter fermenter. Such separate and simultaneously conducted treatment of the thick matter fraction in a thick matter fermenter further contributes to increased efficiency of the method. Although the duration of the treatment of the thick matter fraction in the thin matter fermenter should be set to be longer than the residence time of the thin matter fraction in the thin matter fermenter, the thick matter fraction is significantly smaller in terms of volume, so the thick matter fermenter also requires only a comparatively small volume. The hydrolysed and acidified proportion from the effluent from the thick matter fermenter can now be fermented very efficiently for biogas production, like the previously separated thin matter fraction in the thin matter fermenter, with a short residence time.

A proportion of the filling volume of the thin matter fermenter is subjected to a treatment for comminution, breaking up and/or homogenising of the solids contained therein, to an electrokinetic disintegration, and, after this treatment again fed to the volume fermenting in the thin matter fermenter. This can be done once for a particular treatment period, in batches or at time intervals, but also – and this advantageously – continuously or semi-continuously. Such a continuous or semi-continuous volume flow can also be used for (external) circulation of the thin matter fraction contained in the thin matter fermenter. After treatment for comminution, breaking up and/or homogenising of the solids contained in the volume flow, that is to say, after electrokinetic disintegration, the proportion of the filling volume treated in this way is returned to the thin matter fermenter. In this procedure, the growth bodies are retained by means of a retaining device, for example retention rakes or screens, in the thin matter fermenter, therefore preventing even these from passing through the treatment, through the electrokinetic disintegration. Therefore, locating the microorganisms on the growth bodies and the retention of the growth bodies, and therefore of the microorganisms colonised thereon from the treatment,

electrokinetic disintegration, prevents the microorganisms that are crucial for the fermentation process from being killed in this process step. Electrokinetic disintegration mentioned here as a potential appropriate treatment is taken to mean comminution or breaking up of existing structures by means of an electrical high voltage applied by an electrode around which the disintegrating medium washes. The electrical forces in the high-voltage field occurring in the process deform and destabilise the cell walls and membranes. If the deformation exceeds the elastic resistance of the cell walls or membranes, they become permeable and the cell contents are liberated, then are immediately exposed or present for metabolisation by the microorganisms and therefore the biogas production. Even relatively large agglomerates of solid particles are hereby broken up and "cracked". Corresponding electrokinetic disintegration devices are already commercially available, for example the BioCrack® system belonging to Hugo Vogelsang Maschinenbau GmbH, Essen/Oldenburg, Germany. It is important to emphasize here that the treatment for comminution, breaking up and/or homogenising the entrained solids can also occur in other ways, for example mechanically in a mill or a blade macerator. At this point is important to emphasize that the treatment described above does not require arrangement of a corresponding device outside the thin matter fermenter. The treatment can take place for example also in a portion of the fermenter volume of the thin matter fermenter itself, which can be separated, for example by a cage, from the region with the growth bodies.

Precisely such a combination with the optional and advantageous treatment for comminution, breaking up and/or homogenising the solids content in the content of the thin matter fermenter, in the form of electrokinetic disintegration, now ensures, however, that the potential of significantly increased breakdown intensity in the thin matter fermenter can be exploited further. The, in particular continuous or semi-continuous, also multiple, "cracking" of the comparatively high particle loads in the case, for example, of manure ensures that after the corresponding treatment, by electrokinetic disintegration, the valuable organic components can be better recycled and also exist in a greater total mass and therefore can be metabolised by the microorganisms more easily, with higher biogas yields and faster. The more the solid particles (agglomerations) are smashed and crushed by the treatment, by the electrokinetic disintegration, and at the same time the more the viscosity of the fermentation medium is reduced, the less high the risk of blocking of the growth substrate simultaneously is – a highly favourable point for the long-term process stability. Precisely the fact that the microorganisms, which are colonised on the growth bodies, can be efficiently retained inside the thin matter fermenter, here allows the implementation of a relatively large volume flow by the treatment for comminution, breaking up

and/or homogenising, by an electrokinetic disintegration, which is well above a volume flow, which could be achieved in a fermenter in which the microorganisms float are freely suspended in the suspension. This is because this treatment, for example the electrokinetic disintegration, not only macerates the organic load of the organic starting material (what is referred to as the substrate) to be metabolised by the microorganisms organic better, but also the cells of the useful microorganisms that are also basically desired in the fermenter are broken up and destroyed so, if there is no possibility of retention of the microorganisms, killing of an excessively large proportion of the microorganisms, and therefore a slackening through to stoppage of the fermentation process, would occur here.

The above-described – in particular continuously or semi-continuously performed – treatment for comminution, breaking up and/or homogenising the solids content in the content of a thin matter fermenter populated with microorganisms colonised on growth bodies, in particular by electrokinetic disintegration, can also be carried out in its own right in an independently inventive manner and without a separation of the starting material into thick and thin matter fractions, in particular if the organic starting material is already thin enough per se, and contains only a small amount of coarse particles load in order to be classified as "thin matter" (for example whey, breeding sows' manure, manure from aquaculture or the like).

In order to save fermenter heating energy required for heating to the temperature usually increased compared to a normal ambient temperature, at which fermentation occurs, the inflow of organic material is advantageously preheated by way of heat exchange with outflowing digestate. Conventional heat exchangers, in particular counterflow heat exchangers, can be used for this purpose.

While some organic starting materials, such as breeding sows' manure, fish and crustacean manure from aquaculture and possibly also whey, as a rule, predominantly contain only fine solids particles of small size and only a comparatively small amount of coarse particulate load, and therefore can be treated as a whole as a thin matter fraction, the conventional, agricultural starting materials occurring in significant quantities, in particular bovine manure and pig manure, do not satisfy this requirement. Since these can contain significant quantities of coarse and overall more solids particles, they cannot usually be conclusively treated as a thin matter fraction, so the separation performed at the beginning of the method is necessary. If the starting material should already be in a form that can be completely qualified as thin matter, the separation can be omitted, the treatment of all of the starting material can be performed exclusively in the thin matter fermenter.

As mentioned above, it is possible in principle to add further organic solids to the inflow of organic starting material, for example dung, grass, straw, dry chicken manure and others. These additional solids can be added to all of the organic starting material, the thin matter fraction or else – if present – thick matter fraction. These organic solids are typically purposefully pre-comminuted and can be slurried optionally by adding liquid or adjusted in their viscosity to make them pumpable. The pre-comminution can occur, for example, in a solids storage tank and be continued as a fine comminution in a ball mill in which recirculate from the process or, for example, also water can also be added to the material for slurrying or to lower the viscosity.

To increase the rate of fermentation, and to present the organic material to the microorganisms in a better conditioned form, the inflow of the organic starting material can, for example before the division into the thick matter fraction and the thin matter fraction, but also in the form of an already initially only given thin matter fraction, be subjected to a treatment for comminution, breaking up and/or homogenising, by electrokinetic disintegration. In this way the starting components of the organic material are treated accordingly as early as at this point, in particular disintegrated: agglomerations are dissolved, cell contents are liberated, which then exist as nutrients for the microorganisms in a more easily and quickly accessible manner, and the viscosity is reduced. In this way, the thin matter fraction to be fermented most efficiently can also be increased.

Furthermore, it is also possible to subject at least a proportion of the discharge from a possibly available thick matter fermenter to a treatment for comminution, breaking up and/or homogenising, for example an electrokinetic disintegration, and then to feed the proportion thus particularly disintegrated to the thin matter fermenter or introduce it into the inflow of organic starting material. In this way, a further fermentation of the discharge from the thick matter fermenter can occur, so an increase in efficiency and an increase in the biogas yield and an acceleration can also be achieved here. For the potential treatment for comminution, breaking up and/or homogenising, for example an electrokinetic disintegration, of the content of the thin matter fermenter on the one hand, and the appropriate treatment to be optionally performed, for example electrokinetic disintegration, of the organic starting material and/or also appropriate treatment to be optionally performed, for example electrokinetic disintegration, of the discharge from the possibly present thick matter fermenter, one and the same plant part, for example one and the same electrokinetic disintegration device, can be used. For this purpose, appropriate pipe systems and distributors must be provided that allow via appropriate valve switching a corresponding connection to the treatment device, for example electrokinetic disintegration

means. In such a case, the treatment, for example electrokinetic disintegration, of the content of the thin matter fermenter is then of course not carried out continuously, but at best only semi-continuously, by, in any event at the times at which the treatment device, for example electrokinetic disintegration device, is switched into the other pipe runs in each case (the inflow of organic starting material and/or the discharge from an optionally present thick matter fermenter), the appropriate treatment, for example electrokinetic disintegration, of the content of the thin matter fermenter being temporarily interrupted.

The method configured in this way in the combination of inventive steps and measures permits in particular a significant acceleration of the thin matter fraction that is regularly much larger in terms of volume. The residence time is reduced here to a duration of up to less than 1 day, compared with a residence time of at least 20 to 30 days of the unseparated starting material in a conventional agricultural biogas plant. For starting materials with a high water content useless for biogas production, such as, in particular manure and slurries, this is essential. Due to the special embodiment, the method is also highly efficient in terms of the degraded dry substance, the biogas yield and the residual dry substance content of the digestate.

Since, on the one hand, the thin matter fraction that is much larger in terms of volume can be fermented with a significantly shorter residence time, and on the other hand the thick matter fraction requiring a longer residence time is limited in terms of volume to the necessary degree, the fermentation can therefore be employed and implemented even in very compact and small-sized devices.

The initially configured separation of the inflow of the organic starting material into thin matter fraction and thick matter fraction and the separate treatment of these fractions in separate fermenters or fermentation chambers, the thick matter fermenter (also a thick matter fermenter chamber) and the thin matter fermenter (also a thin matter fermenter chamber) allow specific division and treatment with appropriate microorganisms, adapted to the respective output conditions, and a corresponding design of the fermenter, in particular the type of colonisation with the microorganisms and also of the respective agitator or mixing device, with which the respective fraction (thick or thin matter fraction) located in the associated fermenter is homogenised.

Here, the method according to the invention differs significantly from the methods executed in the conventional biogas plants in which, as a rule, all of the biomass is always treated en bloc.

The method according to the invention for generating biogas is suitable and intended in particular for the use of manure and slurry as a starting material (substrate). Owing to the high efficiency with which this method works, it is suitable even for the use of pure pig manure as the substrate, a starting material which, as a single substrate, presents major difficulties in conventional plant technology in the conversion to biogas and can only be admixed or has to be stretched further organic starting material in order to then be processed and fermented.

While it is possible in principle to operate the method according to the invention with mesophilic microorganisms at a temperature of 37 °C to 42 °C, it is preferred that thermophilic microorganisms are used, with the operating temperature of the appropriately equipped fermenter preferably being set at temperatures of 55 °C to 60 °C. It is also possible, however, if both a thin matter fermenter and a thick matter fermenters are used to set different temperatures for these two different fermenters. Therefore, in such a case, for example the thin matter fermenter can be operated mesophilically whereas the thick matter fermenter can be operated thermophilically to reduce the required use of heat to heat up the thin matter fermenter volume. This difference in temperature can be adjusted, for example, by targeted heat supply at different locations of the device or at different parts of the plant.

With the method according to the invention, the residence time in the thin matter fermenter is, as already mentioned, at very low levels of up to less than 1 day. Such a short residence time, and therewith a correspondingly high and fast throughput of organic starting material, is possible in particular since the method according to the invention has proven to be highly efficient in implementing the organic starting material into biogas. The high digester productivity and short residence time permit extremely compact fermenters. Conventional biogas plants rely on much larger fermenters. The residence time for manure in conventional biogas plants is in the range of at least 20 to 30 days.

In a further aspect the invention discloses a device according to claim 9 for producing biogas by fermentation of pumpable organic starting material, in particular also containing solids. According to the invention this device contains:

– a separation device for dividing incoming organic starting material into a thin liquid thin matter fraction having a low and predominantly finely divided proportion of solid particles and typically a relatively low dry substance content and into a rather pulpy to semi-solid thick matter fraction having a higher solid particle content, including in particular also coarse solid particles, and with typically relatively high dry substance content. The thin matter fraction, to which reference is made in the device description, corresponds in its properties generally to that as has

been explained in more detail in the context of the above method description. In particular, its properties (as well as the properties of the thick matter fraction) are obtained substantially by the separation made in the selection described above with the separation device with predetermined opening widths.

– a thin matter fermenter for fermenting the thin matter fraction. According to the invention, growth bodies are arranged in the thin matter fermenter for the growth of microorganisms, in particular they are freely suspended in the volume of the thin matter fraction contained in the thin matter fermenter in an approximately uniform distribution. Furthermore, the thin matter fermenter can have a stirrer and/or circulation device for homogenising the filling volume of the thin matter fermenter and for holding the growth bodies in suspension.

Advantageously, a thick matter fermenter for hydrolysing, acidifying and fermenting the thick matter fraction can be provided in the device, wherein the thick matter fermenter can in particular have a mixing device for mixing the filling volume received in the thick matter fermenter. The thick matter fermenter can in particular have a plurality of outlets, preferably positioned at different heights, to be able to respectively purposefully remove floating layers, settling layers and substrate liquid from the thick matter fermenter.

The device also has the following elements:

– a treatment device for comminution and/or breaking up and/or homogenising solids contained in the thin matter fraction, as an electrokinetic disintegration device, which has a feed connected to the thin matter fermenter via which a content contained in the thin matter fermenter can be fed from the thin matter fermenter to the treatment device, and a discharge connected to the thin matter fermenter, via which the content subjected to a corresponding treatment, for example an electrokinetic disintegration, can be fed to the filling volume in the thin matter fermenter again, and

– a retaining device, arranged in the region of the supply pipe, for preventing penetration of the growth bodies into the treatment device.

The treatment device, as an electrokinetic disintegration device, can be arranged outside the thin matter fermenter and be connected to the interior of this fermenter by pipes. but it can also be arranged in the volume of the thin matter fermenter itself, then can be separated from the remaining volume, for example by way of a cage surrounding the treatment device.

The device according to the invention can also in particular have a modular construction with a fermenter module, which contains the thin matter fermenter and, if such is provided, the thick matter fermenter and in particular has the maximum edge dimensions of

4 m (width) x 4 m (length) x 18 m (height), and in a technical module, which has the optionally provided treatment device, for example an electrokinetic disintegration device, at least a pump and a controller for controlling the automated operation of the device and is accommodated in particular in a 40-foot container or a housing of the same or smaller size.

The device according to the invention is therefore constructed to be able to perform the method according to the invention. The fermenter – optionally, fermenters – (thin matter fermenter and optionally thick matter fermenter) can be advantageously accommodated as vertically aligned fermenter chamber(s) in a separate housing which, due to the dimensions of a maximum of 4 m x 4 m x 18 m, for example about 3.65 m x 3.65 m x 15.00 m, can be accommodated and transported by a heavy goods transportation vehicle (HGV). It follows already from the basic dimensions that the corresponding fermenter chamber(s) have only low volume(s) and consequently for efficient biogas production is/are dependent on a high efficiency and a high throughput of organic material, as is permitted by the method according to the invention. The preferred modular construction of the corresponding device allows rapid transfer of the same by means of, for example, lorries, so a corresponding device can be easily transported to an installation site, for example to a location of a farm. There, the corresponding modules, the, as a rule, largest fermenter module and in any case the technical module preferably configured in a container size or size comparable to a housing, are installed and accordingly connected to each other with the pipe connections, in order to then obtain a functional device for generating biogas (a biogas plant).

Such devices can therefore be manufactured at a manufacturing site by completion of the modules and merely have to be installed at the installation site, for example a farm with livestock, connected to each other in the modules and possibly connected to further infrastructure facilities, for example a supply pipe to the mains. The device according to the invention also remains mobile, however, because it can be quickly dismantled in the same way. This then allows another calculation basis for the relevant potential operator in each case by being able to rent or lease for example, appropriate biogas plants and being able to sell them again to an appropriate business in the event of a loss of interest, for example after the removal of livestock on the farm. It is also possible to purchase a corresponding modular plant or device, then sell it again as a used device since it can be easily dismantled and moved. This possibility is foremost, which allows the relevant potential operators to acquire such a device and the investment therein since they do not have to worry about being burdened with a biogas plant permanently erected in situ as an “failed

investment", for example because of an economic decision against the previously existing livestock.

When the starting material can be treated as thin matter fraction as whole, however, that is to say the solid particles load is not too coarse, or the solids content is sufficiently low, the device according to the invention can be implemented without separation device, and in particular also be without an otherwise preferably provided thick matter fermenter.

Furthermore, the device can advantageously comprise a ball mill or a similarly acting device, which, – for example with running separation and simultaneous supply of the thin matter fraction into the thin matter fermenter – receives the thick matter fraction, temporarily stores it, optionally mixes it with other solids, excipients, or recirculate from the process, or also water and others, comminutes, homogenises and, if necessary preheats it. Therefore, the thick matter fraction is further processed for faster decomposition (hydrolysing) in the optionally provided thick matter fermenter. If further substrates are fed to the process in addition to the starting material, the device can still comprise, that is to say in addition to the components already described above, a solids storage tank for further solids, optionally with integrated pre-comminution, and a storage tank for further liquids.

It should be noted here that the immediate device technology combination of a separation device with a solids storage tank, optionally with integrated pre-comminution, and a ball mill can represent an independent solution to the problem and an invention separate to the previously illustrated process engineering purposes in the case of biogas production.

Both with a separation of the starting material as well as a supply of additional solids as a substrate, in addition to the thin matter fermenter (the thin matter fermenter chamber), the fermenter module can, for example, in particular also contain the thick matter fermenter, which is then constructed in particular as a second fermenter chamber in the module. With such a solution the fermenter module therefore includes the thin matter fermenter and the thick matter fermenter as separate, vertically aligned chambers in a shared housing.

In addition to the two modules necessarily present in a modular configuration of the device: fermenter module and technical module, the device according to the invention can comprise further modules, therefore, for example a biogas storage module having at least one gas storage element and which is also preferably accommodated in a 40-foot container or a housing of the same or smaller size, so this module can also be transported by road by a lorry, and a combined heat and power module in which a biogas combustion engine and a generator are arranged, as a rule for the generation of electrical power and for the recovery of useful heat.

The method according to the invention and the device according to the invention can thereby be used not only as a "stand-alone" solution and charged with its own substrate; they are also particularly suitable for use to increase efficiency and/or expand capacity in existing agricultural biogas plants, in biowaste biogas plants or in sewage gas plants by fermenting liquid from the fermenter or from the post-fermentation tank of a conventional biogas plant, even from what is known as a dry fermentation tank, being treated in an device according to the invention according to the inventive method. The device and the method are then used to optimize the existing biogas plants equally as an "extension module" and integrated into an existing plant and the associated method control. In this case, for example, the separation can be carried out as early as in a process of the fermenter or of the secondary settling tank of an existing biogas plant, the retained thick matter fraction can then be left in the fermenter or the secondary settling tank.

Further advantages and features of the invention will become apparent from the following description of an exemplary embodiment with reference to the accompanying figures. In the drawings:

Fig. 1 shows a method flow diagram illustrating the method according to the invention and the interaction of the individual components of a device for producing biogas carrying out this method;

Fig. 2 schematically shows the construction of a device according to the invention comprising different modules; and

Fig. 3 shows a schematic interior view of the fermenter module to illustrate the two vertically aligned fermenter chambers arranged side by side therein: the thick matter fermenter chamber and the thin matter fermenter chamber.

The figures, which are purely schematic outline illustrations, show on the one hand the procedure of an exemplary embodiment of the method according to the invention for generating biogas, on the other hand they schematically show the construction of a device according to the invention for producing biogas in a possible substantiated embodiment example.

Firstly, one embodiment of the method according to the invention shall be explained hereinafter on the basis of the method flow diagram schematically illustrated in Fig. 1 which specifically and by way of example makes reference to the processing of manure as a starting material:

From a manure storage tank 1, which does not have to be considered part of a device according to the invention for carrying out the method, a manure feed pump 2 pumps manure used as starting material for the production of biogas sequentially through a counterflow heat

exchanger 3, a manure pipe 4, a multi-way valve 5, a treatment device for comminuting, breaking up and/or homogenising a solids content, here in the form of an electrokinetic disintegration device 6, a heat exchanger 7 and a multi-way valve 8 to a separation device 9. This separates the inflow of manure into a thin matter fraction, which flows off through the effluent thin matter discharge pipe 10 flows to a suction-side distributor 11 upstream of a pump 12, and a thick matter fraction which is introduced via a retentate thick matter output 13 into a ball mill 14. Further organic – optionally pre-comminuted – starting material, for example dung, dry chicken manure, straw, grass, other plant biomass, and others from a solids storage tank 15, which can include integrated solids comminution, and/or for example hydrolysis-promoting enzymes, trace elements and others from a dosing unit for processing aids 16, and/or via a distribution pipe 17, recirculate from the process can optionally be added into the ball mill 14. The thick matter, including its possible admixtures, flows from the ball mill 14, via a discharge pipe 18 likewise to the suction distributor 11 upstream of the pump 12. A heat exchanger 19 and a pressure-side distributor 20 adjoin the pump 12 downstream of the pump 12. The pump 12 pumps the thin matter fraction sequentially through a distribution pipe 21, the multi-way valve 8, and a distribution and circulating return pipe 22 into a thin matter fermenter 23, which, for example, can be formed as a thin matter fermenter chamber in a multi-chamber system. The pump 12 pumps the thick matter fraction with the possible admixtures via a distribution pipe 24 into a thick matter fermenter 25, which can be formed, for example, as thick matter fermenter chamber in the multi-chamber system. The thick matter fermenter 25 can optionally be fed via another distribution pipe 26 at an alternative location, inter alia also with recirculate from the process. If the thin matter fermenter 23 and the thick matter fermenter 25 are to be operated at different temperatures, then instead of a single heat exchanger 19 for heating of the different fractions (thick matter fraction and thin matter fraction), in each case separate heat exchangers appropriately designed for adjusting the temperature to the desired process temperatures can be provided. Alternatively, further heating means can also be arranged in the further pipes (for example, in the distribution pipes 21 and/or 21a and or 24).

The thin matter fermenter 23 contains growth bodies 27 on which microorganisms are colonised, which metabolise the organic load of the fermenting liquid, formed by the thin matter fraction, in the thin matter fermenter 23 into biogas. With its agitator blades 30 an agitator 28, which is rotated by an agitator motor 29, homogenises the content of the thin matter fermenter 23 and holds the growth bodies 27 freely suspended and distributes them uniformly over the entire height of the thin matter fermenter 23.

A circulating discharge pipe 31 from the thin matter fermenter 23, which is protected with the aid of a retaining screen 32 against the penetration of growth bodies 27, leads via the multi-way valve 5 to the electrokinetic disintegration device 6. During the (external) circulation, fermenting liquid then flows via the heat exchanger 7, the multi-way valve 8 and the distribution and circulating return pipe 22 back into the thin matter fermenter 23 again.

The thick matter fermenter 25 contains a mixing device 33, which is rotated by a mixing device motor 34, and with mixing device blades 35 mixes the contents of the thick matter fermenter 25. From the thick matter fermenter 25, chamber contents can be withdrawn via three different outlets positioned primarily at different heights, namely above a floating layer outlet 36, a sinking layer outlet 37, and a substrate liquid outlet 38. All three outlets open into a distribution pipe 39 leading to the suction-side distributor 11 upstream of the pump 12. Due to the different outlets of the thick matter fermenter 25 and the specific system of the distribution pipes, various operations can be carried out, namely, in particular, content of the thick matter fermenter 25 that has liquefied (hydrolysed) can be transferred via the electrokinetic disintegration device 6 into the thin matter fermenter 23 , but also floating layers can be discharged from the thick matter fermenter 25 and, if necessary, be introduced into the ball mill 14 again, or sinking layers can be discharged from the thick matter fermenter 25 and be transferred either via the electrokinetic disintegration device 6 into the thin matter fermenter 23 or, if required, can be removed completely as digestate.

The digestate of the process in the thin matter fermenter 23 is discharged regularly from the thin matter fermenter 23 via a digestate outlet 40. The growth bodies 27 are thereby retained by a retaining screen 41 and are not discharged too. The digestate exits the process via a digestate pipe 42, the suction-side distributor 11 and the pump 12 via a digestate pipe 43 into a digestate store 44, which is not necessarily to be regarded as a component of a plant or device carrying out the method according to the invention, but can also be provided externally. In the process, the digestate passes through the countercurrent heat exchanger 3 in order to thus use its residual heat for preheating the slurry newly fed through the manure pipe 4.

The method Illustrated in Fig. 1 for the production of biogas operates as follows:

The inflowing manure is pre-heated in the counterflow heat exchanger 3 by absorbing residual heat of the digestate flowing off through the digestate pipe 43 and then disintegrates electrokinetically in the electrokinetic disintegration device 6. In the process, due to the electrical high-voltage, particle agglomerations are disintegrated and comminuted, cell walls are smashed and cell contents dissolved and made more readily available for fermentation. The viscosity of the

liquid is also noticeably reduced. After further heating in the heat exchanger 7, the material passes into the separation device 9. This separates the thin and relatively low-viscosity thin matter fraction, which compared to the manure initially fed in contains a reduced solids content with predominantly finer solid particles and comparatively little dry substance, of a more pulpy to semi-solid and relatively viscous thick matter fraction, which compared to the manure initially fed in contains an increased solids content and predominantly the coarse solid particles while having a comparatively large amount of dry substance. This separation is effected by a sieve insert in the separation device 9 or a similar separation means with passage openings of predetermined opening width. This opening width can be from 20 μm to 2 mm, will, as a rule, be from 50 μm to 1 mm, in particular from 100 μm to 500 μm, and most preferably from 200 μm to 300 μm, in particular from 200 μm to 250 μm.

After it has passed through the sieve insert or the comparable separating means of the separation device 9, the thin matter fraction flows via the effluent thin matter discharge pipe 10 to the suction-side distributor 11 upstream of the pump 12. The pump 12 pumps the thin matter fraction via the further heat exchanger 19, which brings the fermentation substrate to the desired, preferably thermophilic, process temperature, the pressure-side distributor 20 and the distribution pipes 21, 22, into the thin matter fermenter 23, where the inflow of organic nutrient load of microorganisms is metabolised and degraded to biogas. The microorganisms are mainly localised on the growth bodies 27 freely suspended in the fermenting liquid of the thin matter fermenter 23. The growth bodies 27 are held in the thin matter fermenter 23 so as to be continuously freely suspended and largely uniformly distributed by the agitator 28. The growth bodies 27 allow the microorganisms a multiple of population density as well as constant best possible spatial proximity to food and thereby ultimately a drastically increased intensity of degradation of the organic load to biogas. To very significantly reduce the start-up time of the thin matter fermenter 23 at the start of commissioning of the process, the fermenter will be filled at the beginning of the process with growth bodies 27 pre-inoculated with bacteria. Provided that the electrokinetic disintegration device 6 is not occupied by supplying new manure (or other new starting material), or by transferring substrate from the thick matter fermenter 25 into the thin matter fermenter 23, a continuous (external) circulating flow of the fermentation substrate contained in the thin matter fermenter 23 circulates via the retention screen 32 and the circulating discharge pipe 31 through the electrokinetic disintegration device 6 and then via the distribution and circulating return pipe 22 back into the thin matter fermenter 23. The flow of the (external) circulating flow is maintained by the vertical lift effect in the thin matter the fermenter

23 generated by the agitator 28 and, if necessary, is supported by a circulation pump (not shown in Fig. 1). The continuous, apart from interruptions, circulation makes it possible that, within a short time, a large volume flow, subjected (possibly also repeatedly) to electrokinetic disintegration and therefore a maximum digestion of the substrate for an optimally complete and optimally quick degradation of the organic load, can be achieved in the thin matter fermenter 23. The retention screen 32 ensures that the growth bodies 27 do not co-circulate with the fermenting liquid. Otherwise, the microorganisms seated on the growth bodies 27 would be disintegrated too and therefore killed by the electrical high voltage in a counter-productive manner.

The thick matter fraction retained in the separation device by the sieve insert or the comparable separation means, is discharged via the retentate thick matter output 13 from the separation device 9 into the ball mill 14. Further – if necessary, pre-comminuted – solids, for example, such as dung, dry chicken manure, straw, grass, other plant biomass, and others, and/or, for example hydrolysis-promoting, enzymes, trace elements and others from the dosing unit for processing aids 16 and/or via the distribution pipe, recirculate 17 from the process can also be added from the solids storage tank 15 to the ball mill 14 , which are then incorporated in the fermentation process.

The thick matter fraction, including its possible admixtures, is finely comminuted homogenised, and – if the ball mill is heated 14 – heated further in the – preferably heated – ball mill 14. Via the discharge pipe 18 from the ball mill 14, the suction-side distributor 11, the pump 12, the heat exchanger 19, which brings the fermentation substrate to the preferably thermophilic process temperature, the pressure-side distributor 20 and the distribution pipe 24 the thick matter fraction passes into the thick matter fermenter 25. The fermenter contains the mixing device 33, which with its mixing device blades 35 mixes the content of the thick matter fermenter 25 at specified time intervals. The thick matter fraction is hydrolysed, acidified and partially (pre-)fermented in the thick matter fermenter 25 by corresponding microorganisms. Biogas is already produced here too. Gradually, the solids dissolve in the thick matter fermenter 25; the pulpy content liquefies increasingly. The liquefied portion mainly settles in the lower part in the thick matter fermenter 25. It still entrains a significant proportion albeit mainly smaller, particulate matter, and is removed from the thick matter fermenter 25 via the substrate liquid outlet 38 and then transferred via the distribution pipe 39, the suction-side distributor 11, the pump 12, the heat exchanger 19, the pressure-side distributor 20, a distribution pipe 21a, the electrokinetic disintegration device 6 and the distribution and circulating return pipe 22 into the

thin matter fermenter 23, so the contents ferment definitively and almost completely there. The passage through the electrokinetic disintegration device 6 takes place in order to disintegrate the remaining particles electrokinetically and therefore optimally digest them for an optimally complete and optimally quick degradation in the thin matter fermenter 23. Digestate is taken regularly from the thin matter fermenter 23. The retention screen 41 arranged in the digestate outlet 40 prevents the flushing-out of growth bodies 27, and therewith microorganisms. The digestate exits the process via the digestate pipe 42, the suction-side distributor 11 and the pump 12, via the digestate pipe 43 into the digestate store 44. In this case, the digestate passes through the counterflow heat exchanger 3 so as to use residual heat of the digestate for preheating the manure newly fed via the manure pipe 4.

The particular feature in the method shown in an exemplary embodiment in Fig. 1 consists in that the inflowing pumpable organic material is first divided by the separation device 9 into a thin matter fraction and a thick matter fraction. Therefore, the thick matter fraction can be liquefied, acidified and (pre-)fermented in the thick matter fermenter 25. The thin matter fraction is brought to the thin matter fermenter 23, where it experiences its special treatment. In this case, the fact that growth bodies 27 are used in the thin matter fermenter 23 is also special, so – in particular in combination with the electrokinetic disintegration continuously performed with a large volume flow – any agglomerations in the thin matter fermenter can be dissolved, in addition due to the disintegration, the biomass present for conversion by the microorganisms can be digested even better and accordingly efficiently metabolised by the microorganisms.

It should again be emphasised that the method according to the invention, when the starting material already satisfies the conditions to be placed on the thin matter fraction, in particular in respect of particle size (such as, for example in the case of breeding sows' manure, fish or crustacean manure from aquaculture or optionally also whey), a separation into thin and thick matter fractions can be omitted and only a treatment of the thin matter fraction carried out. The device too can then be simplified by omitting the corresponding elements and mechanisms provided for the separation and treatment of the thick matter fraction.

For a further consideration of the effectiveness and efficiency of the method according to the invention, comparative considerations have been made for a farm, in which, daily, for example, approximately 32 m^3 cattle manure accumulates, containing about 7.5% by weight dry substance. If this quantity of cattle manure is fed into a conventional biogas plant with en bloc fermentation of cattle manure, it stays there for about 30 days. A fermenter volume of 30 x 32 m^3 is to be provided therefore, in other words 960 m^3. If, according to the inventive procedure, this

amount of cattle manure (32 m^3) is firstly separated into a thin matter fraction and a thick matter fraction, then approximately 27 m^3 thin matter fraction are obtained, having a dry substance content of about 5% by weight and correspondingly about 5 m^3 thick matter fraction, which then has a dry substance content of about 21% by weight. Transferred into the advantageously provided thick matter fermenter, the thick matter fraction remains there for about 20 days while the thin matter fraction can be fermented in the thin matter fermenter within one day already. If the discharge from the thick matter fermenter that is also to be fermented in the thin matter fermenter is also taken into account, this results nevertheless in only a required digester volume overall (therefore for thick matter fermenter and thin matter fermenter taken together) of 132 m^3, and therefore a very significant reduction. The digester productivity (m^3 of biogas per m^3 available digester volume) of the method according to the invention is therefore several times higher than in conventional biogas plants.

Fig. 2 schematically shows in an embodiment the basic structure of a device according to the invention for the production of biogas. This structure is modular with a fermenter module 45 that is vertically installed during operation, as well as a technical module 46 having the dimensions of a conventional 40-foot container. The fermenter module 45, as described below with reference to the Fig. 3, accommodates the two fermenters provided here, thick matter fermenter and thin matter fermenter, designed as fermenter chambers. The technical module 46 includes most of the further technical equipment and piping, in particular the elements provided in Fig. 1 with the reference numerals 3 to 22, 24, 26, 31, 39, 42 and 43. The piping of the technical module 46, which enters or leaves the module, ends at flanges, which are each coupled to a mating flange of the fermenter module 45 or to mating flanges of on-site devices, and/or on-site piping. The technical module 46 also includes an openable and height-adjustable roof 47. This openable and height-adjustable roof 47 can be variably extended in height by means of a cable pull device (not shown in Fig. 2) or hydraulically or with another drive, so as to correspond to the respective fill level of a biogas storage bag 48 likewise integrated in the technical module 46. Height-adjustable side limits 49 on the two longitudinal sides of the technical module 46 limit the expansion of the biogas storage bag 48. The biogas storage bag 48 has a recess 50, which is used to be able to fill the solids storage tank 15, located in the technical module 46, for example by wheel loaders, from above, past the biogas storage bag 48. Alternatively, the biogas storage bag 48 can be accommodated in a further, separate gas storage module (not shown here), which also has the dimensions of a conventional 40-foot container and can optionally be stacked on the technical module 46.

In this context it should be noted that the above-described construction of a receiving module for a biogas storage bag, having an openable and height-adjustable roof, in order to take account of the expansion of the biogas storage bag with an increasing filling level (fill volume),can be regarded as an independent problem solution and therefore as a separate invention. This is particularly true for the combination of these features with a technical module or another module, having the dimensions of a conventional 40-foot container and can have, for example, an outer shell made of steel.

Fig. 3 again shows the fermenter module 45 and the inner workings located therein. It can be seen here that the thin matter fermenter 23 and the thick matter fermenter 25 are received therein as fermenter chambers arranged side by side with the respective agitator 28 and mixing device 33 and their drive motors 29 and 34. The respective width and therewith the respective capacity of the two chambers can be completely different. The fermenter module 45 includes a finished foundation 51 which with special foundation bolts 52 (for example, such as those sold by the company Krinner Schraubfundamente GmbH from Strasskirchen, Germany) can be simply bolted to the ground rapidly and efficiently. This not only allows installation of the fermenter module 45, without extensive preparations, within the shortest possible time, but also simple and rapid dismantling. The fermenter module 45 is fitted, moreover, with a leak detection system integrated in the foundation area (not shown in Fig. 3). The fermenter module 45 outlined here in reality has a height H of about 15.00 m, a width B of approximately 3.65 m and a length L identically corresponding to the width of likewise approximately 3.65 m (each without a usually still applied exterior insulation and without a likewise still applied weatherproof skin and without finished foundation).

A special feature of the device according to the invention outlined in Figs. 2 and 3 is in particular that it is portable and can be erected at an installation site, but can also be easily dismantled again and is thereby movable. This enables the respective installers and users a different form of use, for example the possibility to rent or lease corresponding plant for certain periods or even to purchase and then resell it in the event of discontinued use. Transportation to the installation site can be carried out with a conventional heavy goods vehicle, it being possible for the modules: technical module 46 and optional gas storage module (not shown), to be freighted using normal container transport lorries. Only the fermenter module 45 with excess width has to be transported by a special vehicle, for example, a specially equipped low loader.

The foregoing description of the exemplary embodiments once again clearly demonstrates the special feature of the method according to the invention and device according to the invention with respect to the prior art. The associated advantages can be clearly read from this.

LIST OF REFERENCE CHARACTERS

1	manure storage tank
2	manure feed pump
3	counterflow heat exchanger
4	manure pipe
5	multi-way valve
6	electrokinetic disintegration device
7	heat exchanger
8	multi-way valve
9	separation device
10	effluent thin matter discharge pipe
11	suction-side distributor
12	pump
13	retentate thick matter output
14	ball mill
15	solids storage tank
16	dosing unit for processing aids
17	distribution pipe
18	discharge pipe
19	heat exchanger
20	pressure-side distributor
21	distribution pipe
21a	distribution pipe
22	distribution and circulating return pipe
23	thin matter fermenter
24	distribution pipe
25	thick matter fermenter
26	distribution pipe
27	growth bodies
28	agitator
29	agitator motor
30	agitator blades
31	circulating discharge pipe

32	retention screen
33	mixing device
34	mixing device motor
35	mixing device blades
36	floating layer outlet
37	sinking layer outlet
38	substrate liquid outlet
39	distribution pipe
40	digestate outlet
41	retention screen
42	digestate pipe
43	digestate pipe
44	digestate store
45	fermenter module
46	technical module
47	roof
48	biogas storage bag
49	side limits
50	recess
51	finished foundation
52	foundation bolt
B	width
H	height
L	length

Patentkrav

1. Fremgangsmåde til frembringelse af biogas ved fermentering af pumpedygtige organiske udgangsmaterialer, især af gylle og ajle fra husdyrhold, ved hvilken

- en tilstrømning af det organiske udgangsmateriale opdeles i en tykstoffraktion med i forhold til udgangsmaterialet højere faststofandel og en væskedomineret tyndstoffraktion med i forhold til udgangsmaterialet lavere faststofandel,
- tyndstoffraktionen tilføres en tyndstoffermenter (23), i hvilken mikroorganismer er vokset op på i tyndstoffermenterens (23) fyldevolumen i suspension holdte dyrkningslegemer (27), og fermenteres der,
- i tyndstoffermenteren (23) dannet biogas opfanges og udtømmes til anden anvendelse,
- fermenteringsrester, der dannes i tyndstoffermenteren (23), fjernes,
- en andel af fyldevolumenet fra tyndstoffermenteren (23) behandles til findeling og/eller opbrydning og/eller homogenisering af en faststofandel ved elektrokinetisk desintegration og tilsættes efter denne behandling atter tyndstoffermenterens (23) resterende fyldevolumen, idet dyrkningslegemerne (27) tilbageholdes af en tilbageholdeindretning i tyndstoffermenteren (23), således at de holdes borte fra behandlingen.

2. Fremgangsmåde ifølge krav 1, **kendetegnet ved, at** tykstoffraktionen tilføres en tykstoffermenter (25) og der hydrolyseres og evt. til dels allerede fermenteres, og at en andel, der er gjort flydende ved hydrolyse i tykstoffermenteren (25), udtages af tykstoffermenteren (25) og overføres til tyndstoffermenteren (23) og/eller iblandes tyndstoffraktionen og/eller tilføres tilstrømningen af organisk udgangsmateriale, idet biogas, der dannes i tykstoffermenteren (25), fortrinsvis opfanges og udtømmes til anden anvendelse.

3. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** tilstrømningen af organisk udgangsmateriale behandles til findeling og/eller opbrydning og/eller homogenisering af de faste stoffer før opdelingen i tykstoffraktion og tyndstoffraktion.

4. Fremgangsmåde ifølge krav 3, **kendetegnet ved, at** behandlingen af tilstrømningen af organisk udgangsmateriale til findeling og/eller opbrydning og/eller homogenisering af de faste stoffer før opdelingen i tykstoffraktion og tyndstoffraktion foregår ved elektrokinetisk desintegration.

5. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** tilstrømningen af organisk material forvarmes ved varmeveksling med udstrømmende fermenteringsrester.

6. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** tyndstoffraktionen er effluentet fra adskillelsesindretningen, og at tykstoffraktionen er retentatet fra adskillelsesindretningen, idet adskillelsesindretningen har en sigteindsats eller et sammenligneligt adskillelsesmiddel med gennemgangsåbninger med åbningsvidder fra 20 μm til 2 mm.

7. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** der målrettet sættes i forvejen findelte faste organiske stoffer til tilstrømningen af organisk udgangsmateriale.

8. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** der som organisk udgangsmateriale anvendes en fermenteringssuspension fra en fermenter eller en efterfermenterinsbeholder, også en tørfermenteringbeholder fra et bestående, konventionelt bigasanlæg.

9. Apparat til frembringelse af biogas ved fermentering von pumpedygtige, eventuelt faste stoffer indeholdende organiske udgangsmaterialer, især af gylle eller ajle fra husdyrhold, med

- en adskillelsesindretning (9) med mindst en sigteindsats eller et sammenligneligt adskillelsesmiddel med gennemgangsåbninger af forudbestemt åbningsvidde til opdeling af tilstrømmende organiske udgangsmaterialer i en som retentat fra adskillelsesindretningen udvunden tykstoffraktion og i en som effluent fra adskillelsesindretningen udvunden væskedomineret tyndstoffraktion,

- en tyndstoffermenter (23) til fermenteing af tyndstoffraktionen, idet der i i tyndstoffermenteren (23) er anbragt dyrkningslegemer (27) til vækst af mikroorganismer,
- en behandlingsindretning (6) i form af en elektrokinetisk desintegration til findeling og/eller opbrydning og/eller homogenisering af i tyndstoffraktionen indeholdte faste stoffer, idet behandlingsindretningen (6) til overføring af i tyndstoffermenteren (23) indeholdt indhold står i forbindelse med tyndstoffermenterens (23) fyldevolumen,
- en tilbageholdeindretning (32) til at hindre dyrkningslegemerne (27) i at trænge frem til behandlingsindretningen (6).

10. Apparat ifølge krav 10, **kendetegnet ved, at** tyndstoffermenteren (23) har en røre- eller cirkulationsindretning (28) cirkulation af tyndstoffermenterens (23) fyldevolumen og til at holde dyrkningslegemerne (27) i suspension

11. Apparat ifølge et af kravene 9 eller 10, **kendetegnet ved** en tykstoffermenter (25) til hydrolyse, syrning og fermentering af tykstoffraktionen.

12. Apparat ifølge krav 11, **kendetegnet ved, at** tykstoffermenteren (25) har en blandeindretning (33) til gennemblanding af sit fyldevolumen.

13. Apparat ifølge et af kravene 9 til 12, **kendetegnet ved, at** gennemgangsåbningerne har åbningsvidder fra 20 μm til 2 mm, fortrinsvis fra 50 μm til 1 mm, især fra 100 μm til 300 μm.

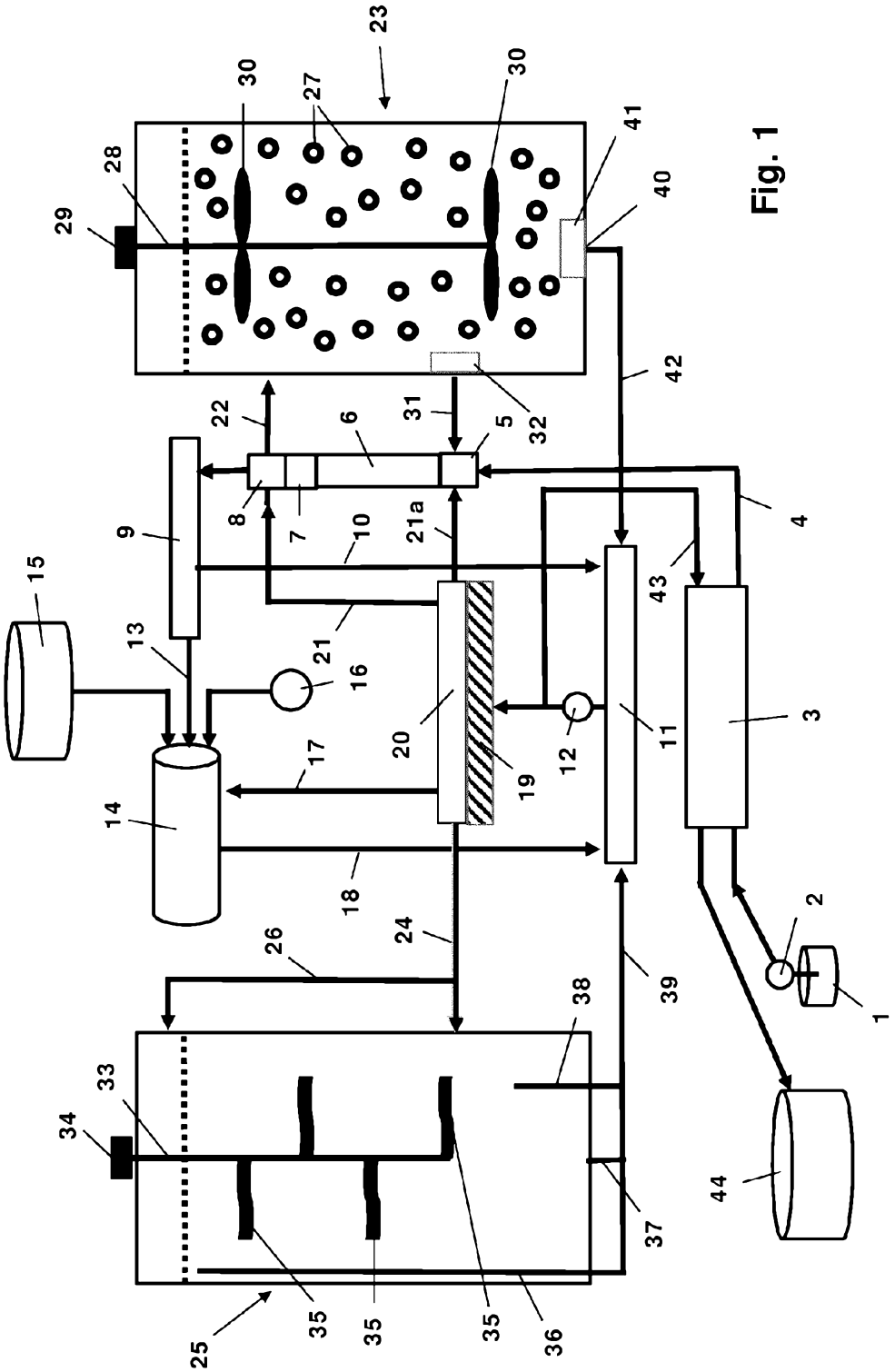

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Fig. 1

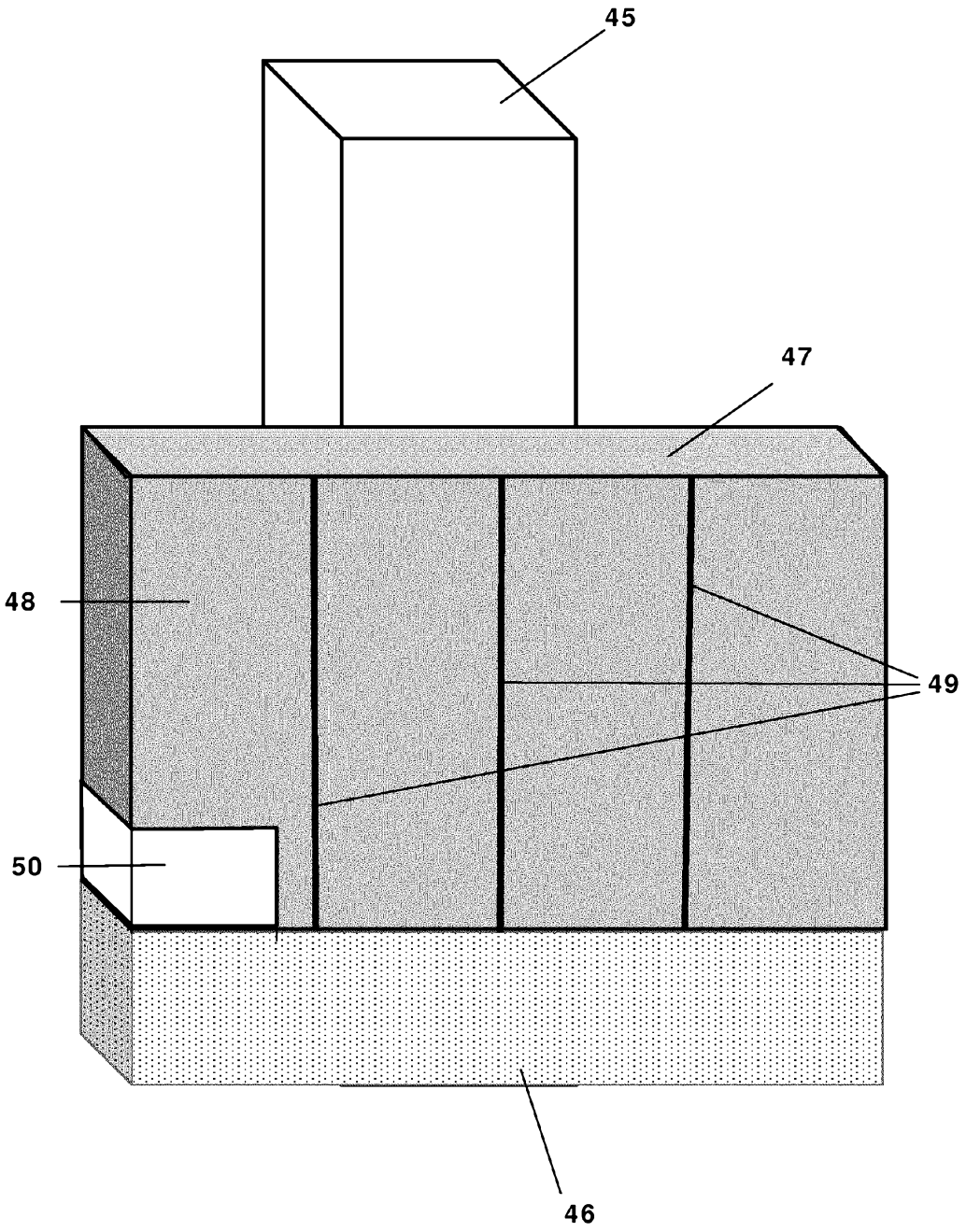


Fig. 2

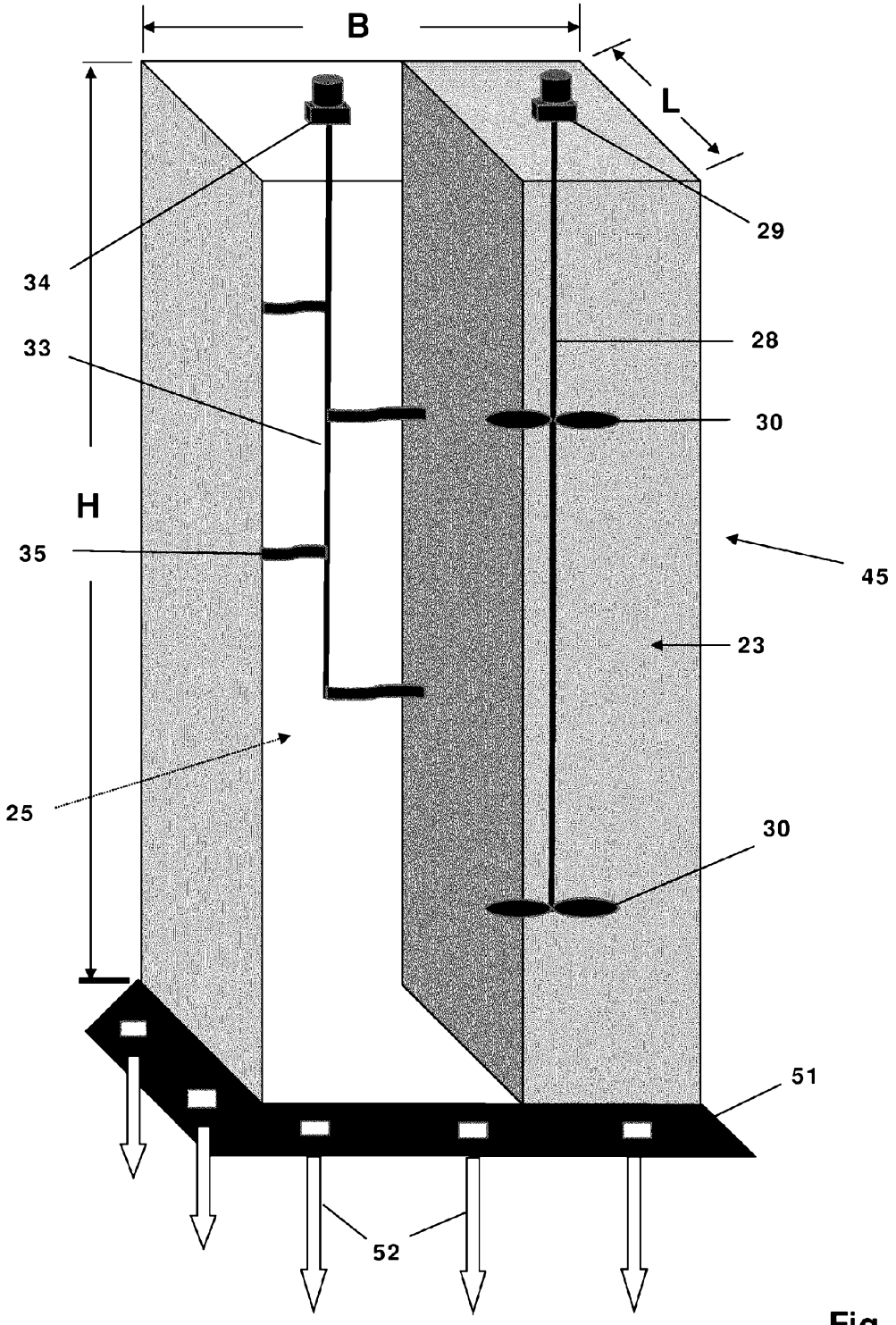


Fig. 3