

The invention relates to a method according to the preamble of claim 1.

5 Moist waste presents problems both with regard to its handling and with regard to its disposal. This is particularly the case for sewage sludge from municipal and industrial sewage plants. A few years ago municipal sewage sludge from many places, after partial treatment such as putrefaction, pasteurization, sanitization etc. was
10 supplied to agriculture by discharge. This cannot be practiced in the long term. The reason for this is the unavoidable loading of the sludge with heavy metals and other problem substances, which are deposited in soils and in the ground water after the application of the sludge.

15 The following requirements can be derived from the above-mentioned problems.

20 Solution of the present problems presented by moist waste in a way that does not harm the environment and is economically justifiable.

25 Transformation of the moist waste in a cost-effective manner into a form such that it can be utilized and subsequently be converted into energy with present techniques.

30 Joint exploitation of the energy present both in the solid waste (refuse) and in the moist waste materials such as sewage sludge and agricultural and forestry waste.

Conversion of the moist waste into energy products that can be stored and transported.

35 Regional and decentralised working up of the energy products and their utilization centrally, as seems best economically.

40 It is known to process waste to compacts in order, for example, to achieve reduction in volume, improvement in the stacking or storage properties and simplification of transportation, for example, for conveyance to an incinerator. Here a distinction is to be made between pressing methods using comparatively low
45 pressure and pressing methods using comparatively high pressure. In the first case it is usual to process the compacts in a bound state, i.e. to bind them with bands, ropes or netting. In the second case it is not necessary to bind the compact because on account of the high
50 compression there is considerable consolidation of the material, resulting in solid compacts.

55 A process for the production of blocks from solid and liquid wastes is known from WO-A-8 103 029. In this process the mixed wastes are formed into blocks in a mould under low pressure. For final drying of these products an

aerobic fermentation or compacting process is carried out. The blocks made in this way have to be stored for up to 20 days in order to obtain the desired final moisture level by the biological processes and to render them combustible.

5 The production of compacts from moist waste is difficult because the moisture or the water content of the waste has to be reduced. This applies particularly to compacts which are compressed without binding, because a
10 high moisture content impairs the strength of the compact. This also applies to the afore-mentioned roped-up compacts, because considerably higher demands are made on the strength of the lashing.

15 Reduction of the moisture content of the waste can be achieved in different ways.

 A first possibility lies in dewatering the waste, which can be done during pressing. This method can only be
20 carried out with special pressing devices with drainage openings, which may give rise to difficulties on account of blockages. Moreover waste water results which must be removed and, if necessary, disposed of. Furthermore combustible constituents can escape with the waste water,
25 and this is particularly disadvantageous for compacts which are to serve as fuel.

 It is also possible to decrease the moisture in moist waste thermally in suitable devices using added heat.
30 This kind of drying is cost-intensive.

 The moisture content of waste can be determined both by the composition of the waste and by other influences, e.g. rain.
35

 The underlying object of the invention is to develop a method of the above-mentioned kind so that moist waste can be compressed to compacts without drying.

40 This object is achieved through the characterising features of claim 1.

 In the case of the two methods according to the invention the moist and possibly comminuted waste is mixed
45 with dry material (carrier material) and is thus brought without drying to a moisture content which is suitable for compression to compacts. The method according to the invention is particularly suitable for organic waste, because in the case of such waste the moisture in the
50 compacts produced by the method according to the invention is comparatively great. The compacts thus produced represent a high-grade fuel which can be used in known solid-fuel furnaces for chips or shavings and/or in hearth or coal furnaces.

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For satisfactory mixing of the moist waste with the dry material, the latter needs to have a comparatively small particle size. In the case of moist waste in small pieces the particle size of the dry material should in the main not be greater than the particle size of the moist waste. The moisture content of the dry absorbent substance should preferably amount to about 5% or less. It has been ascertained that in the case of the methods according to the invention fibre-, flake or flock- and/or lamina-like substances are particularly well suited for decreasing the moisture content. It is preferable to mix organic substances with the moist waste. It is then advantageous to use fibre-, flake or flock- and/or lamina-like substances in the form of waste, and in particular to use substances which have been obtained from waste according to claim 1 by a working-up process, such as fibre-, flake or flock- and/or lamina-like materials consisting of organic matter, paper and/or synthetic material. In this way, no added materials are required, but the compacts are produced entirely from waste, thereby taking account of the general problem of waste elimination in an advantageous manner and improving the strength and combustibility of the compacts.

The method according to the invention is also suitable for the disposal or commercial utilization of the waste or additions which are mentioned in claim 2, more particularly sewage sludge, in which case compacts can be produced which are particularly suitable for burning, in which case a certain proportion of synthetic material, which is suitable for burning, can be contained in the moist waste and/or in the dry substance.

Mixing with lime has the advantage that, in the pressing process, it acts as a braking agent inside the matrix and thus builds up additional resistance, resulting in compacts with a higher density or a higher specific gravity.

It is also advantageous to mix soda or soda lye with the waste. This acts as a softener and corrosive agent on various pieces that contain wax or resin and are brittle, so that these pieces are densified and can be bound better.

For it to be possible to compress waste without special aftertreatment to form comparatively stable compacts, the moisture content of the waste before pressing should lie, according to claim 1, in the region of about 15%, resulting after pressing in a residual or product moisture of about 7-9%. In this way comparatively stable compacts are obtained, which may only need to be thoroughly cooled and are thus available without substantial aftertreatment for further use, for transportation or directly for burning. This applies in particular to the pressing of waste to form comparatively small compacts. In a case such as this, controlled comminution should be

ensured before pressing.

5 In the case of the method according to claim 1,
a special aftertreatment of the compacts is possible after
pressing, namely an aerobic fermentation process which
results in biogenic drying by virtue of self-heating of the
compacts, fungal growth occurring in compacts. In this
way, the strength and therefore also the stackability of
the compacts is substantially increased. Compacts with a
10 moisture or water content of about 25-75%, preferably about
40-60%, are particularly suitable for aerobic fermentation.
Such water contents can be achieved by compressing the
compacts using a fairly low pressure, which should be
determined as a function of the water content. In the
15 particular case of a water content at the upper limit of
the afore-mentioned range, the strength and thus also the
stackability of the compacts is less than that of compacts,
as previously described, pressed using a greater pressure
from a body of material with a water content of about 15%,
20 yet the compacts with the higher water content obtain
sufficient strength through the biogenic drying and fungal
growth. In this way pressing energy can be saved.

25 In the first case (water content of about 25-75%)
a surface pressure of about $400 - 500 \text{ N/cm}^2$ is very
suitable. In the second case (water content of about 40-
60%) good results have been attained with a surface
pressure of about $60 - 100 \text{ N/cm}^2$.

30 On account of the lower strength of the compacts in
the second case, a parallelepiped shape of the compacts is
to be preferred in order to achieve, despite the
comparatively low strength, stackability of the compacts
for the aerobic fermentation process, for which the
35 compacts can be superimposed in up to 5 layers, a gap being
provided at least between horizontally adjacent compacts by
virtue of which the fermentation process previously
described and evaporation can take place. No water or
moisture is supplied during this process. In tests it has
40 been shown that compacts with a bottom surface size of
about $250 \times 800 \text{ mm}$ and a height of about 200 mm are very
suitable.

45 The aforementioned moist waste or the
aforementioned materials are thus processed by the method
according to the invention to give valuable compacts which
can be further used as fuel and can have the following
compositions. A few examples:

Variant 1 Wet pieces with 40% H₂O. Dry material with 2% H₂O

5	Wet pieces:	Chopped chips or bark or sawdust etc.	
	"	350 kg incl. 140 kg H ₂ O)	=15.3% pressing
	Dry material	650 kg incl. 13 kg H ₂ O)	moisture.
	H ₂ O loss on pressing:	80 kg	= 7.3% product
			moisture

10 Variant 2 Wet pieces with 25% H₂O. Dry material with 5%
H₂O

	Wet pieces:	as above		
	"	500 kg incl.	125 kg H ₂ O)	=15% pressing
	Dry material	500 kg incl.	25 kg H ₂ O)	moisture.
15	H ₂ O loss on pressing	80 kg		= 7% product
				moisture.

Variant 3 Wet pieces with 70% H₂O. Dry material with 2% H₂O

20	Wet pieces:	soft plants, grasses, residues from distilleries etc.			
	Wet pieces	200 kg	incl. 140 kg H ₂ O	) =15.6%	pressing
	Dry material	800 kg	incl. 16 kg H ₂ O	) =	moisture
	H ₂ O loss on pressing		80 kg	= 7.6%	product
25					moisture

Variant 4 Wet pieces with 80% H₂O. Dry material with 2% H₂O

Wet pieces: Sanitized sewage sludge from sewage plant
 Wet pieces 180 kg incl. 144 kg H₂O) = 16.4% pressing moisture
 Dry material 820 kg incl. 16.4 kg H₂O)
 H₂O loss on pressing 80 kg = 8.4% product moisture

35 Variant 5 Wet pieces with 78% H₂O. Dry material with 2%
H₂O

	Wet pieces:	as above, variant 4		
	"	210 kg incl. 163 kg H ₂ O)		
	Dry material	760 kg incl. 15 kg H ₂ O)	= 17.8%	pressing
40	Lime	30 kg)		moisture
	H ₂ O loss on pressing	90 kg	= 8.8%	product
				moisture

45 In all the examples (variants) shown lime can be added or mixed in. Likewise in Example 5 lime can be omitted. Lime is, as a rule, admixed in a quantity of 3% by weight, based on the mixture.

50 Instead of the afore-mentioned lime addition, a
30% soda lye can be added.

Further advantages which can be attained through the invention will now be briefly mentioned.

55 All slightly, moderately and very moist biomasses
which are suitable for heating purposes and which occur in

nature in a form which is only usable with difficulty, or not at all, can be converted into a solid heating product which is adjusted to a desired moisture level, is capable of being stored and can be exploited commercially. All wet pieces with very different moisture levels can be processed immediately the individual constituents are formed. Fine comminution of the wet pieces to the size required for pressing is rendered possible without pre-drying by mechanical equipment or prolonged storage. The pressing of wet pieces present such as sludge, sawdust etc., which are produced in a fine form, is rendered possible without their being first pre-dried. Bulky wet material can be brought to a small volume with high energy density without partial rotting. Sludge can be pressed without pre-drying, particularly to form heating products. Biomasses which easily rot can be converted into durable products which can be stored without thermal treatment. The products can be used in any solid-fuel furnace, even in fully automatic furnace plants which are operated under load control. For the first time, sewage sludge from sewage plants can be transformed into dry durable fuels without great expenditure of energy. The invention renders it possible to recover new raw material from many biomasses that have hitherto been lost, by mixing them individually with dry material or with one another and with dry material to give an aesthetic fuel which remains stable in its further use, makes an important contribution to disposal and to the saving of energy as a form of alternative energy, and thus renders notable service to the public interest. In places where appropriate heating installations are already present communities can run their own installations, such as schools, baths, administrative facilities, with alternative fuels produced according to the invention in a way that is proof against crises and is economically interesting.

The invention will now be described with reference to preferred exemplary embodiments shown in a diagrammatic drawing.

Fig. 1 shows a flow diagram or plant for producing compacts from moist organic waste;

Fig. 2 shows a flow diagram for a modified type of production;

Fig. 3 shows a table of the mixture ratios of compacts;

Fig. 4 shows in perspective a compact produced by the method according to the invention;

Figs. 5 and 6 show arrangements for stacking compacts;

Fig. 7 shows a storage arrangement for the aftertreatment of the compacts;

Fig. 8 shows a store for the finished compacts.

The coarse waste 2, such as wet wood, shrubs, bushes etc., lying on a storage place 1, is charged by means of a conveyor 3 (not shown in detail) into a primary comminuting device 4 which produces therefrom chopped chips or coarse shavings which are subsequently supplied to a bin or silo 6 by means of a conveyor 5. At the same time small-sized waste 7 from plantations and agriculture or parks can also be supplied to the silo 6, by-passing the primary comminuting device 4. The silo 6 is equipped with a discharge and metering device (not shown) which makes it possible to feed a secondary comminuting device 11 in the form of a fine mill by means of a conveyor 9 in a uniform and continuous manner.

The secondary comminuting device 11 is a commercially available hammer, beater or impact mill with a classifying sieve assembly (aperture size 8 mm in diameter). The purpose of the secondary comminuting device 11 is to bring the partly pre-broken and partly small-sized material from the silo 6 to the desired final size of about 8 mm.

A dry lamina- or fibre-like material 14 can be charged from a silo 12 into the secondary comminuting device 11 by means of a conveyor 13. The fibre material 14 is below the desired grain size and thus does not load the comminuting device 11, but has the object of absorbing, to a large extent, the water which is set free from the moist pieces during the comminution and of removing it from the comminuting device. The quantity of fibre material 14 added depends on the moisture content of the moist waste present. A moisture content in the region of about 15% is the target. With this moisture content agglutination in the comminuting device is prevented.

The fibre material 14 is preferably a material which is obtained from waste by a working-up process. Several Orfa processes are suitable for this, which are referred to in German Patent 31 05 597 and German Patent Applications P 36 14 325.1 and P 36 14 324.3 and in the second exemplary embodiment. Reference is made to these methods. The fibre material 14 has a moisture content of about 5% and is thus very absorbent.

The secondary comminuting device 11 is connected by a conveyor 15 with a charging device 16 for a pellet and/or briquette press 17, 18. The charging device 16 can be in the form of a feeding worm.

Between the silo 12 and the charging device 16 there is a direct conveyor 19, which makes it possible to compress the fibre-like material 14 directly and alone when no or few wet pieces are present in the waste.

Arranged before the charging device 16 there is a bin 21 for receiving thickened sewage sludge from sewage plants, this bin being connected through a conveyor 23 with the charging device 16. Arranged in the conveyor 23 there is a mixer 24 which is also connected through a conveyor 25 with the silo 12. Sewage sludge and the drying agent from the silo 12 are mixed together in the mixer 24 and conveyed to the charging device 16. The mixer 24 is an appliance which is available commercially and is capable of operating continuously. A metering device (not shown) is associated with the conveyors, for example, 9, 13, 15, 19, 23, 25, respectively, for example at 26. It is thus possible to supply metered amounts of all the constituents, namely the waste from the silo 6, the fibre material from the silo 12, the sewage sludge from the bin 21, the mixture from the secondary comminuting device 11 and the mixture from the mixer 24, individually or mixed, to the charging device 16, which also mixes in additives such as lime and/or soda which may be supplied to it in metered amounts from containers 29, 31 via conveyors 27, 28, and delivers to the press or to the presses 17, 18. It is possible in this way to effect a capacity compensation, in particular independently of the secondary comminuting device 11 and of the mixer 24. For the purpose of the additional substances, reference is made to the effects mentioned at the beginning.

The feeding worm forming the charging device 16 is a commercially available pallet worm with a length of about 3 m or more. This causes the materials, including any additives that might have been introduced, to be thoroughly and intensively mixed.

The material introduced into the press 17 is formed in the die used under high pressure, acting together with frictional heat generated thereby, to form the desired compacts (pellets) in any desired size between 6 and 20 mm in diameter and between 10 and 30 mm in length.

Briquettes with greater measurements or dimensions, for example, with diameter between 40 and 100 mm and lengths between 200 and 300 mm, can be produced in the press 18. The way of working up the compressible biomasses remains the same. The presses 17, 18 can be supplied simultaneously or individually.

From the press or presses 17, 18 the hot compacts pass to a cooling zone or a cooling device 32 in which the compacts are cooled down to the ambient temperature. The final hardening of the compacts, which are still soft when warm, then also occurs.

The cooling device 32 is likewise a machine that is available on the market. After the compacts have been cooled, they can be stored and/or packed and/or be delivered to the consumer (combustion plants).

The compacts leave the device or plant in a ready-for-use state with a moisture content of about 5 to 10 % and can be stored indefinitely.

5 The individual positions in the exemplary embodiment according to Fig. 2 will now be described:

Position

- | | | |
|----|-----------|---|
| 10 | 41: | The base material is produced from mixed industrial refuse, or preferably from household refuse. |
| 15 | 42: | The wastes are pre-comminuted and freed from ferrous metals. |
| | 43: | They are subsequently comminuted to a maximum 10 mm diameter piece size. |
| 20 | 44: | They are dried in a further step to a water content of 5%. |
| 25 | 45: | The dry material is separated by means of sieving and air classification (cyclone separation) into an inorganic ballast fraction and into an organic base material fraction. |
| 30 | 46: | As a result of the pretreatment process, the organic dry fraction is flaky, flocky, lamina-like, fibrous and/or granular, this being of importance for the follow-up treatment. |
| 35 | 47: | The dry fraction is metered by weight or volume in a commercially available device and is passed on to be mixed at Position 61. |
| 40 | 51 to 55: | Here there are devices and process steps of existing sewage plants which give fresh sludge with about 2%, sanitized sludge with about 5% and drained sludge with about 30% dry substance. |
| 45 | 56: | Metering: The desired sludges (Positions 53, 54 and 55) are conducted individually or in the desired composition to a commercially available metering device which supplies the required quantity to Position 61. |
| 50 | 61: | Mixing of the sewage sludge and the dry fraction takes place by means of suitable mixers such as conventional double shaft or turbo mixers which are used in the chip-board industry for gluing wood shavings. The mixing device must be designed so that thorough and complete mixing is ensured in order that moisture balancing takes place immediately between the sludge and the dry fraction. |
| 55 | | |

Position

- 5 62: The shaping of compacts in a stamping or extruding press takes place here, in the same way as is required in the stone industry or for the production of briquettes. The pressing should preferably be adjustable so that the density of the compacts can be determined. Usually the moulded bodies or compacts are pressed using a pressure of between 40 - 70 bar. The pressing pressure depends on the type of sludge (Positions 53, 54 and 55) and also on the mixture ratio selected (see Table according to Figure 3). The size and shape of the compacts is chosen so that
- 10 a) optimum biogenic fermentation drying is ensured and
- 15 b) piling-up or stacking, preferably onto a base, e.g. a Europallet, is possible. In this way, space-saving storage and mechanical transportation are ensured (see Figs. 4 to 8, in which the compacts are denoted by 71). A size of about 250 x 800 mm, for the bottom surface, and a height of 200 mm has proved to be advantageous for a compact 71 shaped as a parallelepiped.
- 20 63: Stacking: The compacts 71 shaped in Position 62 are picked up by a stacking device and arranged in layers on the desired base, e.g. grating 72 or transportation pallet 73. These devices can also be obtained on the market. When stacking and arranging the compacts 71 care must be taken that:
- 25 a) air can circulate between the compacts (distance A) in order to allow the vapours evolved to escape, and that
- 30 b) only so many layers are piled one on top of the other that the lowest layer is not deformed by the weight about it (as a rule 4-5 layers are possible).
- 35 The stacks of compacts 74 can be moved by means of a conveyor, for example, a stacker truck, into the biological drying store (Fig.7).
- 40 64: Biogenic drying: The drying store should preferably be designed to ensure ventilation between the stacks 74. Advantageously, this roofed chamber is aspirated through a weak reduced-pressure system. As a result of the conditions described previously such as
- 45 - mixture ratio
- 50 - moisture content of the material to be mixed,
- 55 - density and pressing pressure when producing the compacts 71, and
- the organic dry fraction added, with the sewage sludge containing micro-organisms, an aerobic fermentation process immediately

begins.

As a result of the biological fermentation process self-heating is induced (within a few hours). The heating increases as a rule within 5 days to 70 - 80°C. These temperatures show that large quantities of water are being evaporated. The process lasts until the intermixed oxygen is consumed. As soon as the oxygen is used up by the organisms, the fermentation process subsides and the compacts cool completely. The cooling phase, as a rule (according to tests), lasts for 4-5 days. During cooling, the mycelium phase occurs, in which the compacts become completely fungoid. The compacts are reinforced by the fungal growth and this results in consolidation. As the compacts dry further, the fermentation process is suddenly interrupted. Even the mycelia are deprived of the living conditions as a result of the drying and they become rigid. As a result of the fungal growth which has also dried therein the compacts become self-supporting, this making it possible for them to be piled or stacked one on top of the other. For process details from tests, see the Table of Fig. 3.

Position

65: Store: The biogenically dried compacts 71, described under 64, are dried in a subsequent store shed either completely or to the moisture level to give the desired final water content. The final moisture level and thus the calorific value of the compacts can largely be determined by the final storage. The final store only needs to be roofed, so that no rain water reaches the compacts.

66: From the store (Position 65) the compacts 71 can be supplied to the desired consumer stations and be transformed into energy as required. All furnace units, such as grate firing, fluidized bed, pyrolysis, gasification etc., preferably equipped with appropriate gas purifying devices, are suitable for the recovery of heat from the fuel (compacts) described above.

As already mentioned in the case of the first exemplary embodiment, positions 41 to 46 are described in German Patent 31 05 597 and in German Patent Applications P 36 14 324.3 and P 36 14 325.1, to which reference is made.

It is possible and advantageous within the scope of the invention to separate further the granular, flaky or flocky, lamina-like and/or fibrous dry fraction and to use

only the lamina-like and/or fibrous fraction (light fraction), particularly made up of organic substances, for the aerobic fermentation process.

5

Claims

1. A method for preparing compacts from moist waste material, characterised by the following features:
- 10 - the moist waste material is mixed with a drying agent that is obtained by working-up household and industrial waste and is in the form of fibres, flakes or flocks and/or laminae,
 - 15 - the residual moisture content of this drying agent is 5% or less,
 - the moist waste material may have a water content of 25-75%, preferably 40-60%,
 - the moist waste material and the drying agent are mixed to give a pressing moisture content of about 15%,
 - 20 - and pressed to the finished compacts without after-treatment,
 - said compacts having a final moisture content after pressing of 7-9%.
- 25
2. A method according to claim 1, characterised in that the waste material is sewage sludge and/or residues from brewing, wine-making or the like, and that brewery residues, sewage sludge, lime and/or caustic soda is or are
- 30 mixed with the waste material.



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