

TITLE: WASTE COMPACTION**TECHNICAL FIELD**

This disclosure generally concerns the management of waste in a waste collection system and
5 specifically concerns a method and equipment for the processing of waste introduced into
such a system.

BACKGROUND

In connection with the transporting and conveying of waste material in chutes and/or pipes,
10 e.g. for waste handling in various applications of pneumatic waste collection systems, the
volume of waste is a significant issue. In order to manage large quantities of waste con-
tinuously in a given system or area or to manage concentrated large quantities during certain
time periods in the system or area, one obvious solution would be to increase dimensions of
the chutes and/or pipes. Increasing the chute/pipe dimension does, however, cause problems
15 of increased energy consumption for blowers or fans and increased space requirements for
the larger dimensions.

An alternative to the increased chute/pipe dimension has involved the provision of extended
temporary storage facilities close to waste inlets in order to cope with the mentioned concen-
20 trated large quantities during certain time periods. Such a temporary local waste storage
capacity necessarily has involved an increased space requirement that may not always be
met. A further alternative for managing increased waste volumes is by increasing the
frequency of the waste emptying cycles for introduced and/or locally stored waste. This latter
solution has the further consequence of increasing the energy costs due to the more frequent
25 emptying.

The mentioned solutions thus exemplify prior art attempts that have been made to solve the
discussed types of problems but that do not provide any optimum solution to the basic
problems encountered in association with collecting and handling large amounts of waste
30 introduced into a waste collection system.

SUMMARY

It is a general object to provide a solution to the above discussed problems.

In particular it is an object to suggest an improved method of processing waste material introduced into a waste collection system.

It is another object to suggest an improved waste material processing unit for a waste
5 collection system.

It is a further object to suggest an improved waste compactor for compacting waste material having been conducted into a compaction space of a waste material processing unit.

10 These and other objects are met by embodiments defined by the accompanying claims.

In a first aspect the technology relates to a method of processing waste material that has been introduced into a waste collection system for transfer from a generally tubular waste material inlet chute to a likewise generally tubular waste material transport pipe, wherein the transfer
15 is controlled by a discharge valve. In a basic configuration the method includes forming a waste material compaction space at a position upstream of the discharge valve, closing the discharge valve and conducting introduced waste material into said compaction space. A waste compactor is then extended in a waste compaction stroke towards the introduced waste material in the compaction space to thereby compact the waste material having been con-
20 ducted into said compaction space in a longitudinal direction of the compaction space.

In another aspect the technology relates to a waste material processing unit having an inlet connection area for connection to a generally tubular waste material inlet chute of a waste collection system and an outlet connection area for connection to a generally tubular waste
25 material transport pipe through a discharge valve. In a basic configuration the unit comprises a compaction space communicating with the inlet connection area as well as the outlet connection area and a waste compactor movable in a compaction stroke and a return stroke, towards and away from, respectively, waste material received in the compaction space.

30 In yet another aspect the technology relates generally to a waste compactor for compacting waste material having been conducted into a compaction space of a waste material processing unit according to this technology. In a basic configuration the waste compactor comprises a cylinder having a continuous or uninterrupted outer peripheral wall and at least a closed

bottom wall and being moveable in a compaction and a return stroke, respectively, towards and away from, respectively, waste material in the compaction space.

Preferred further developments of the basic inventive idea as well as embodiments thereof
5 are specified in the dependent subclaims.

Advantages offered in addition to those described, will be readily appreciated upon reading the below detailed description of embodiments.

10 BRIEF DESCRIPTION OF THE DRAWINGS

The invention and its further objects and advantages will be best understood by reference to the following description taken together with the accompanying drawings, in which:

- Fig. 1 is a partial perspective view of a first embodiment of an exemplary waste
15 processing unit included in a schematically illustrated waste collection system;
- Fig. 2 is a partial side view of the waste material processing unit of Fig. 1;
- Fig. 3A is a side view of the waste processing unit of Figs. 1 and 2 in a schematical,
20 partial longitudinal section along line A-A of Fig. 3B;
- Fig. 3B is a schematical top view of the waste processing unit of Figs. 1 and 2 in a
cross-section along line B-B of Fig. 3A;
- 25 Fig. 4 is a flow diagram of a method of processing waste material that is introduced
into a waste collection system;
- Fig. 5 is a schematical side view of an alternative second embodiment of a waste
processing unit for inclusion in a waste collection system;
- 30 Fig. 6 is a very schematical illustration from one side of a third embodiment of a waste
material processing unit; and
- Figs. 7A-B are partial and very schematical illustrations of alternative waste processing unit
35 configurations.

DETAILED DESCRIPTION

The present technology will be explained below with reference to exemplifying embodiments of a waste material processing unit, a waste compactor and a method of processing waste material introduced into a waste collection system. The disclosed embodiments relate to an application of the present technology specifically to the handling of waste in a pneumatic waste collection system of the general kind where introduced waste is transported by means of generated vacuum from waste inlet facilities to waste collection facilities. The present technology may be applied generally in the field of material handling and it is emphasized that the waste processing units as well as associated waste collection systems are schematically illustrated in the attached drawing figures and are only given as examples of environments where the present technology may be applied. The described technology is equally well suited for application to other types of environments and for other types of material handling. Thus, the illustrations are for the sole purpose of describing preferred embodiments of the present technology and are not intended to limit the technology to details or to any specific field of application. It shall be realized that the disclosure covers the incorporation of features related to other applications and any combination of features disclosed herein.

As discussed above, previous solutions for handling large and/or varying waste material quantities were commonly based on the use of large pipe/chute dimensions or regulated waste emptying cycles. Such earlier solutions have not been able to eliminate waste handling problems without causing other consequential problems. The present technology attempts to find a more effective and versatile solution to such problems by taking a new approach for combining compact and uncomplicated configuration and energy efficient handling of waste. It is apparent that energy consumption and space issues are vital in many areas of application for waste collection and handling facilities, such as at waste inlet points e.g. of pneumatic waste collection systems. An object is therefore to provide a fairly simple and space saving solution that will also contribute to low energy consumption for the emptying process. The solution will allow for the use of different types of peripheral equipment, such as discharge valves of the flap type or sliding type etc. and may be applied to all types of waste by making the appropriate adjustments that will be described below. Basically this is accomplished by means of waste material processing methods and associated units that will allow efficient and compact waste material compaction but will exclude unduly energy consuming waste emptying cycles.

The present technology will be explained below with reference to exemplifying schematical embodiments thereof that are illustrated in the accompanying drawing figures 1-7B. In Figs. 1-3 is outlined a first embodiment of a unit 2 for processing waste material W that is introduced into a waste collection system. Specifically, in Fig. 1 is shown a very schematic view of an exemplary waste collection system 1 of a general vacuum operated type. The waste collection system 1 incorporates at least one inlet chute 3 that normally extends substantially vertically through a number of floors of a schematically indicated building 20. On each floor of the building 20 is normally provided one waste inlet opening (not illustrated) through which waste is charged into the system 1. Waste is then periodically discharged from the waste charging chute 3 through a discharge valve 6. When opened the discharge valve 6 allows temporarily stored waste to be discharged into one or more transport pipes 5 that connect the waste charging chute 3 and discharge valve 6 to a central waste collecting site (not shown) that may be a stationary waste collection central or a waste collection truck.

The waste material processing unit 2 has an inlet connection area 4A for connection to the generally tubular waste material inlet chute 3 of the waste collection system 1 and an outlet connection area 4B for connection to the likewise generally tubular waste material transport pipe 5 through the discharge valve 6. In the embodiment illustrated in Figs. 1-3 a compaction space 7 is provided that communicates with the inlet connection area 4A as well as the outlet connection area 4B. In this embodiment the compaction space 7 of the waste material processing unit 2 has a cross-sectional contraction 8 provided in a downstream section 7B of the compaction space 7. This downstream section 7B of the compaction space 7 connects to a compacted waste temporary storage space 7C being located upstream of the outlet connection area 4B of the waste material processing unit 2. The compacted waste temporary storage space 7C has a cross section that is essentially smaller than that of the actual compaction space 7 as well as than that of the waste material inlet chute 3. Specifically, the waste material processing unit 2 serves to process waste material W to transfer it from a waste material inlet chute 3 having a first inner diameter to a waste material transport pipe 5 having a second diameter that is smaller than said first diameter.

A waste compactor 9 (Figs. 2 and 3) is provided in the compaction space 7. In this embodiment the waste material compaction space 7 as well as the compactor 9 and a major portion of the inlet chute 3 is intended to be arranged with a longitudinal central axis thereof directed in a generally vertical direction. As is illustrated in Fig. 3A the waste compactor 9 is movable

into and out from, respectively, the compaction space 7 in a compaction stroke CS, between an upstream section 7A and the downstream section 7B of the compaction space 7, and in a return stroke RS, respectively, back from the downstream section 7B and to the upstream section 7A. The waste compactor 9 of Figs. 1-3 has the shape of a cylinder having a continuous, i.e. uninterrupted, outer peripheral wall 9A and at least a closed bottom wall 9B.

Fluid cylinders 10, 11 are connected to the waste compactor 9 through a crossbar 12 extending transversely through the compaction space 7 and being fixed to an upper portion of the compactor cylinder 9. These fluid cylinders 10, 11 are used for performing the compaction CS and return RS strokes of the waste compactor 9 when actuated. They may for certain applications having ample free upper space above the waste processing unit 2, well be replaced by a single central upper cylinder (not illustrated here) directly actuating the compactor cylinder. During the compaction CS and return RS strokes of the waste compactor 9 the crossbar 12 is free to move in fitting grooves 13 (only one visible in Figs. 1 and 2) formed in appropriate sides of an outer wall of the compaction space 7. For applications receiving various kinds of waste it may also be desirable to provide means 30 for controlling/adjusting a compaction stroke force and/or a compaction stroke length of the waste compactor 9.

The cross-sectional contraction 8 in the compaction space 7 has a cone angle α (see Fig. 2) that may be varied in accordance with the type of waste material W to be compacted and/or, for bagged waste material W, based on a size of processed waste material bags before compaction. In an exemplary case this cone angle α may be approximately 70° . The force of the actuating fluid cylinders 10, 11 may likewise be varied in accordance with the type and size of processed waste W in order to optimize waste material W compaction and further discharge. Accordingly it shall be able to adjust the degree of compaction depending upon the actual waste material to be processed. Fig. 2 illustrates that with the described embodiment of Figs. 1-3 the waste material W is compacted very effectively by reducing not only the height but also the width of the compacted waste CW.

It will be understood that the described technology likewise concerns a method of processing waste material W that is introduced into a waste collection system 1 for transfer from a generally tubular waste material inlet chute 3 to a likewise generally tubular waste material transport pipe 5, whereby said transfer is controlled by a discharge valve 6. In an initial step S1, as shown in the flow chart of Fig. 4, the discharge valve 6 is closed. In step S2 waste

material is then introduced through the waste inlet chute 3 and conducted into the compaction space 7 that has been formed at a position upstream of the discharge valve 6. In a main feature S3 of this technology the waste compactor 9 is extended in a waste compaction stroke CS towards the introduced waste material W in the compaction space 7, to thereby compact waste material W having been conducted into said compaction space 7. In said embodiment of Figs. 1-3 the compaction stroke CS is also performed in a generally vertical, longitudinal direction of the compaction space 7.

As the compaction stroke CS of waste W in the compaction space 7 is performed compacted waste CW is pushed into the compacted waste temporary storage space 7C. In step S4 the compactor 9 is returned to its initial position by retracting the waste compactor 9 in a return stroke RS to allow further conducting of introduced waste material W into said compaction space 7. The compaction stroke CS and the return stroke RS of the waste compactor 9 is then repeated in step S5 to allow said further conducting of introduced waste material into said compaction space and further compaction of all waste W being introduced. In a further step S6 the discharge valve 6 is opened and finally in step S7 the compacted waste material CW is transferred from the compaction space 7, or actually the waste temporary storage space 7C, by performing a compaction stroke CS of the waste compactor 9 with open discharge valve 6.

In a further development of the method the fill level of compacted waste material CW in the waste temporary storage space 7C of the compaction space 7 is detected, continuously or at regular intervals. Then, the repeated performing of the compaction stroke CS and return stroke RS of the waste compactor 9 is discontinued when a set maximum fill level of the waste temporary storage space 7C of the compaction space 7 is detected. At that point the discharge valve 6 is opened to transfer the compacted waste material CW into the waste material transport pipe 5.

In a variation of the method, applied to the embodiment of the waste processing unit 2 illustrated in Figs. 1-3, where the cross-sectional contraction 8 is formed in the downstream section 7B of the compaction space, the introduced waste material is not only compressed in a longitudinal direction but also in a general cross sectional direction of the compaction space 7. In further developments of the method the degree of compaction of the waste material is adjusted based on the type of waste material being processed, a cone angle α of the cross-section contraction 8 and/or a compaction stroke CS force or a contraction stroke length of

the waste compactor 9 are chosen based on the type of waste material to be compacted and/or on a size of processed waste material bags before compaction.

These basic configurations of the unit and method may present several advantages, such as:

- 5 - The chute compactor is applicable to all types of waste;
- Waste bags may be compacted to smaller dimensions, height and/or width, which means that a narrower transport pipe may be used, which in turn means that the pipe is filled up better so that a more effective waste material transport may be performed;
- The compaction of waste material provides for an increased local storage capacity;
- 10 - Less frequent emptying procedures or a need for fewer discharge or sectioning valves;
- The compaction has the positive effect of holding waste material together by the transport and this also means that plug transport may be achieved;
- Plug transport means that air speed and thus energy consumption may be lowered;
- The internal wear of the transport pipes is reduced significantly; which in turn
- 15 - Allows for the use of cheaper alternative pipe materials e.g. plastic pipes;
- Effective waste compaction with minimum space requirement.
- The compaction may be performed without destroying waste bags and it will therefore be possible to sort the bags after transport, such as by optical sorting
- The presented solution is applicable to systems having chute diameters from 400 to 600
- 20 mm and transport pipe diameters from 300-600 mm to increase local storage capacity.
- Thus, otherwise required doubling of the number of waste inlets may be avoided.

In an alternative, second embodiment illustrated in Fig. 5 this technology has been applied to a commonly used type of freestanding waste inlet 125 that is very schematically illustrated in

25 the drawing figure. The waste inlet 125 has a waste inlet opening 126 through which waste is communicated to a waste processing unit 102 having an inner combined inlet chute 103 and compaction space 107. Like in the first embodiment the compaction space 107 connects to a waste temporary storage space 107C for compacted waste CW through a cross-sectional contraction 108. The waste inlet 125 is shown having an exemplary interface 125A that is

30 normally provided at ground level to facilitate repair and service work at the discharge valve 106. The discharge valve 106 is in this case illustrated as a commonly used flap valve that is controlled through a valve actuation unit 106A that normally includes an actuating fluid cylinder and a linkage connecting the fluid cylinder to the flap valve 106. Below the interface 125A, upstream of the discharge valve 106 may be provided a lower waste temporary storage

space 125B being an extension of the upper waste temporary storage space 107C or being a separate part. In all respects the waste processing unit 102 of the second embodiment may be operated in the same manner as that of the first embodiment.

5 An exemplifying third embodiment of a waste processing unit 202 is illustrated in Fig. 6, where the technology has again been applied to a type of freestanding waste inlet 225 being similar to the one of Fig. 5. This waste inlet 225 is very basic and again includes a waste inlet opening 226 through which introduced waste is communicated to a waste processing unit 202 having a similar inner combined inlet chute 203 and compaction space 207. However, in this
10 case the compaction space 207 connects directly to the waste temporary storage space 207C for compacted waste CW without any cross-sectional contraction. The waste inlet 125 is again shown having an exemplary interface 225A provided at ground level to facilitate repair and service work at the discharge valve 206. In this third embodiment the introduced waste is compacted only in one direction, namely in a longitudinal direction of the compaction space
15 207.

In alternative, but not specifically illustrated embodiments variations of different parts of the units and configurations may be employed without departing from the scope of the technology. An example of this is the use of a waste material compaction unit that has a substantially horizontal positioning so that it compresses or compacts the waste material in a
20 lying position. Other examples of feasible configuration variants are e.g. an application where the waste material compaction unit connects to a tubular inlet chute having a non-cylindrical cross section shape. A square or even oval shape of the chute would provide an increased chute volume. In such a situation the waste compaction space 307, 407, the waste
25 material compaction unit 302, 402, the compactor 309, 409 and the waste temporary storage space 307C, 407C may likewise have a square or oval shape, as is schematically indicated in Figs. 7A and 7B. The waste compaction unit may also for various applications be used with any appropriate type of discharge valve as well as with any appropriate type of actuator replacing the mentioned, at least one fluid cylinder, e.g. an electric motor.

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The present technology has been described in connection with an embodiment that is to be regarded as an illustrative example thereof. It will be understood by those skilled in the art that the present technology is not limited to the disclosed embodiments but is intended to cover various modifications and equivalent arrangements. The present technology likewise

covers any feasible combination of features described and illustrated herein. The scope of the present technology is defined by the appended claims.

PATENT CLAIMS

1. A method of processing waste material (W) introduced into a waste collection system (1) for transfer from a generally tubular waste material inlet chute (3; 103; 203) to a likewise
5 generally tubular waste material transport pipe (5), said transfer being controlled by a discharge valve (6; 106; 206), **characterized by**:

- forming a waste material compaction space (7; 107; 207; 307; 407) at a position upstream of the discharge valve;
- closing the discharge valve;
- 10 - conducting introduced waste material into said compaction space;
- extending a waste compactor (9; 309; 409) in a waste compaction stroke (CS) towards the introduced waste material in the compaction space; thereby
- compacting the waste material having been conducted into said compaction space in a general longitudinal direction of the compaction space.

15 2. A method according to claim 1, **characterized by** retracting the waste compactor (9; 309; 409) in a return stroke (RS) after completing the compaction (CS) stroke to allow further conducting of introduced waste material (W) into said compaction space (7; 107; 207; 307; 407).

20 3. A method according to claim 2, **characterized by** repeatedly performing the compaction stroke (CS) and the return stroke (RS) of the waste compactor (9; 309; 409) to allow said further conducting of introduced waste material (W) into said compaction space (7; 107; 207; 307; 407).

25 4. A method according to any of claims 1-3 for waste material (W) transfer from a waste material inlet chute (3; 103) having a first inner diameter to a waste material transport pipe (5) having a second diameter smaller than said first diameter, **characterized by** forming a cross-sectional contraction (8; 108) in a downstream section (7B; 107B) of the compaction
30 space (7; 107) to thereby compact the introduced waste material (W) also in a general cross sectional direction of the compaction space.

5. A method according to claims 3 or 4, **characterized by** detecting the fill level of compacted waste material (CW) in a compacted waste temporary storage space (7C; 107C; 207C;

307C; 407C) connecting to the compaction space (7; 107; 207; 307; 407), by discontinuing the repeated performing of the compaction stroke (CS) and return stroke (RS) of the waste compactor (9; 309; 409) when a set maximum fill level of the compaction space is detected and by then opening the discharge valve (6; 106; 206) to transfer the compacted waste material into the waste material transport pipe (5).

6. A method according to claim 5, **characterized by** transferring the compacted waste material (CW) from the compaction space (7; 107; 207; 307; 407) by performing a compaction stroke (CS) of the waste compactor (9; 309; 409) with open discharge valve (6; 106; 206).

7. A method according to any of claims 1-6, **characterized by** adjusting the degree of compaction of the waste material (W) based on the type of waste material being processed.

8. A method according to any of claims 4-6, **characterized by** choosing a cone angle (α) of the cross-section contraction (8; 108) and/or a compaction stroke (CS) force or a compaction stroke length of the waste compactor (9; 309; 409) based on the type of waste material (W) to be compacted and/or on a size of processed waste material bags before compaction.

9. A waste material processing unit (2; 102; 202; 302; 402) having an inlet connection area (4A) for connection to a generally tubular waste material inlet chute (3; 103; 203) of a waste collection system (1) and an outlet connection area (4B) for connection to a generally tubular waste material transport pipe (5) through a discharge valve (6; 106; 206), **characterized by** comprising:

- a compaction space (7; 107; 207; 307; 407) communicating with the inlet connection area as well as the outlet connection area; and
- a waste compactor (9; 309; 409) movable in a compaction (CS) and a return (RS) stroke, respectively, towards and away from, respectively, waste material received in the compaction space.

10. A waste material processing unit (2; 102; 202; 302; 402) according to claim 9, **characterized in** that the waste compactor (9; 309; 409) is a cylinder having a continuous or uninterrupted outer peripheral wall (9A) and at least a closed bottom wall (9B).

11. A waste material processing unit (2; 102; 202; 302; 402) according to claims 9 or 10, **characterized by** at least one fluid cylinder (10, 11) being connected to the waste compactor (9; 309; 409) for performing the compaction (CS) and a return (RS) strokes of the waste compactor.

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12. A waste material processing unit (2; 102; 302; 402) according to any of claims 9-11, **characterized by** a cross-sectional contraction (8; 108) provided in a downstream section (7A; 107A) of the compaction space (7; 107; 307; 407), upstream of the outlet connection area (4B) thereof.

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13. A waste material processing unit (2; 102; 202; 302; 402) according to any of claims 9-12, **characterized by** control means (30) for controlling/adjusting a compaction stroke (CS) force and/or a compaction stroke (CS) length of the waste compactor (9; 309; 409).

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14. A waste material processing unit (2; 102; 202; 302; 402) according to any of claims 9-13, **characterized in** that the waste material compaction space (7; 107; 207; 307; 407) is arranged with a longitudinal central axis thereof directed in a generally vertical or alternatively horizontal direction.

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15. A waste material processing unit (2; 102; 302; 402) according to any of claims 12-14, **characterized in** that the cross-sectional contraction (8; 108) in the downstream section (7A; 107A) of the compaction space (7; 107; 307; 407) has a cone angle (α) depending on e.g. the type of waste material (W) to be compacted and/or, for bagged waste material, on a size of processed waste material bags before compaction.

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16. A waste compactor (9; 309; 409) for compacting waste material having been conducted into a compaction space (7; 107; 207; 307; 407) of a waste material processing unit (2; 102; 202; 302; 402) according to any of claims 9-15, **characterized by** a cylinder having a continuous or uninterrupted outer peripheral wall (9A) and at least a closed bottom wall (9B) and being moveable in a compaction (CS) and a return (RS) stroke, respectively, into and out from, respectively, the compaction space.

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