

System comprising a treatment device

The invention relates to a system comprising a treatment device.

Systems which can provide for homogeneous distribution of particles are advantageous for multiple applications. One of such applications relates to improving the separation efficiency when fractioning waste during waste treatment. Partly for environmental reasons there is a need to handle raw materials efficiently, this creating the desire to reuse as much residue as possible from production processes. Usable materials are recovered from waste flows.

Flammable residual waste and industrial waste similar thereto is converted to sustainable energy in waste energy plants. This creates combustion residues, the largest proportion of which is bottom ash. The Dutch term is 'AEC-bodemas', wherein AEC stands for 'AfvalEnergieCentrale' (waste energy plant). The international term is IBA. This bottom ash is often employed as a secondary building material in groundworks, road-building and hydraulic engineering.

In addition to stone, glass and ceramic, bottom ash does however also comprise valuable raw materials which do not burn. These are non-ferrous metals in particular, such as copper, aluminium, zinc and brass. There is a continuing need to separate these materials ever more precisely and to achieve an improved recovery of usable materials from bottom ash.

A precise separation benefits from a point of departure in which the base material is homogeneously distributed, which is difficult to bring about.

The closest prior art is formed by DE 20 2012 006328, relative to which at least the measures of the characterizing part of claim 1 are new. DE 20 2012 006328 describes a separator in which domestic or green waste is separated in each case into three fractions with disc screens. The waste is supplied via a feed to a main disc screen which is disposed at an incline. This separates the waste into a heavy fraction which does not pass through an intermediate space between the disc screens and because of the gravitational force moves to the descending side of the main disc screen, a light fraction which is driven to the ascending side of the main disc screen by the rotating rollers, and a screened fraction. This screening principle can be repeated several times if desired. The screened fraction finally drops onto a discharge conveyor. It is noted that the amount of material which comes to lie on the discharge conveyor is directly related to the amount of material which is supplied by the feed. If a great deal of material is supplied, this results in heaps of material on the discharge conveyor, whereby there is no homogenizing effect on the screened material.

The German publications DE 25 10 407 and DE 41 25 236 and the American patent US 5 242 047 are acknowledged as further prior art.

The invention now has for its object to provide a system of the above described type, wherein drawbacks of the prior art do not occur, or at least do so to lesser extent.

The stated object is achieved according to the invention with a system comprising:

- a treatment device, comprising:

- a feed;

- an elongate distributor;

5 - wherein the feed is arranged above the distributor; and

- a discharge conveyor located below the distributor, wherein a longitudinal direction of the distributor and a discharge direction of the discharge conveyor are at an angle relative to each other; and

10 - wherein the angle between the distributor and the discharge conveyor defines a varying drop height between the distributor and the discharge conveyor;

- wherein the treatment device is a homogenizing device, the discharge conveyor of which is drivable in a direction in which the drop height decreases; and

- wherein a separating device is arranged downstream of the discharge conveyor of the homogenizing device.

15 The elongate distributor distributes the particles supplied through the feed and thereby performs a first homogenizing step of the particles. The particles subsequently drop from the distributor onto the discharge conveyor located below the distributor. This dropping of the already distributed particles onto the discharge conveyor results in a second homogenizing step.

Homogenizing is further enhanced because the longitudinal direction of the distributor and the discharge direction of the discharge conveyor are at an angle relative to each other. The second homogenizing step is enhanced because the angle between the distributor and the discharge conveyor defines a varying drop height between the distributor and the discharge conveyor and the discharge conveyor is drivable in a direction in which the drop height decreases. Because the discharge conveyor is configured to be driven in the direction in which the drop height of the particles decreases, the particles which drop from the greatest height will still have the longest retention time on the discharge conveyor before they are discharged on a discharge side. This enables these particles to lose their potential energy, which is released during the fall, and to come to a standstill relative to the discharge conveyor. Particles which on the other hand drop from the distributor onto the discharge conveyor closer to the discharge side of the discharge conveyor drop from a smaller height. They have less potential energy, whereby a shorter retention time suffices to come to a standstill relative to the discharge conveyor. An additional effect is that the particles which have fallen from a relatively great height will be struck from above while bouncing on the discharge conveyor by particles dropping from a smaller height. The process of particles coming to a standstill relative to the discharge conveyor is enhanced as a result.

35 The present invention thus relates to a system comprising a homogenizing device and a separating device arranged downstream thereof. The separating device known from the closest

prior art formed by DE 20 2012 006328 does not have a homogenizing effect. The amount of material which is supplied to the separating device is after all directly related to the amount of material which comes to lie on the discharge conveyor. Because the device itself is a separating device, DE 20 2012 006328 lacks a separating device arranged downstream of the discharge conveyor of the homogenizing device. The material moreover drops from the lower disc screen mainly onto a part of the discharge conveyor which is directed toward the discharge side of the discharge conveyor. The retention time of the material on the discharge conveyor is thereby relatively short, whereby no homogenizing effect occurs in the separating device of DE 20 2012 006328. The present invention provides a homogeneous distribution of the material on the basis of the particle dimensions. The choice of the screen can influence the bandwidth of particle dimensions which is allowed through the screen and then comes to lie in a homogeneous layer of material to be formed on the discharge conveyor. This homogeneous layer on the discharge conveyor of the homogenizing device is created in that the discharge conveyor is configured to be driven in the direction in which the drop height of the particles decreases. Such a homogeneous layer enhances the efficiency of a separating device connected downstream. Such a separating device can subsequently separate by particle mass the material flow preselected according to dimensions. An air knife can for instance thus be used to blow the material flow flowing from the discharge conveyor, wherein light parts are more susceptible to being deflected by the airflow than heavier parts.

Because the discharge conveyor according to a preferred embodiment is substantially flat in a width direction thereof, accumulation of particles is prevented.

The discharge conveyor has a width substantially corresponding to a width of the distributor in order to provide the particles with an unimpeded free fall from the distributor to the discharge conveyor. It is particularly advantageous when standing side walls are arranged between the distributor and the discharge conveyor which bound a longitudinal direction of a drop space and thereby protect the drop space from possibly disruptive airflows. When according to yet another preferred embodiment these standing side walls are oriented substantially vertically, the particles are moreover prevented from colliding with the wall and sliding downward along it, whereby an accumulation could occur close to the walls.

Once a homogeneous distribution of particles has been obtained on the discharge conveyor, it is desirable to disrupt this homogeneous distribution as little as possible during the further treatment of the particles.

According to yet another preferred embodiment, the distributor and the discharge conveyor are for this reason arranged in individual frames. Transfer of vibrations from the distributor to the discharge conveyor is hereby prevented and the discharge conveyor can be kept as vibration-free as possible. The homogeneous particle distribution on the discharge conveyor hereby continues

undisturbed.

Keeping the discharge conveyor free of vibration is also achieved when the system comprises one or more than one trough idler for supporting the discharge conveyor, wherein the trough idler comprises at least two support rollers which are arranged in a width direction of the discharge conveyor and have a shared or a parallel rotation axis. The discharge conveyor is held flat in a width direction of the discharge conveyor by these trough idlers, whereby the particles are not exposed to transverse forces such as would be the case with a conventional concave discharge conveyor. Although it is usual in the case of a flat arrangement of the discharge conveyor to apply long support rollers along the whole width of the discharge conveyor, there is a conscious deviation herefrom according to the invention. It is very difficult in practice to guarantee and to maintain a pure roundness of the support rollers during operation. Adverse effects of a possible non-roundness are minimized by providing a plurality of support rollers in the width of the discharge conveyor. Nor does a possible slight misalignment of a support roller have an effect over the whole width of the discharge conveyor. Finally, shorter support rollers are less susceptible to sagging.

Further particularly advantageous preferred embodiments form the subject-matter of the dependent claims.

Preferred embodiments of the present invention are further elucidated in the following description with reference to the drawing, in which:

Figure 1 is a perspective view of a system comprising a homogenizing device and a separating device according to the invention;

Figure 2 is a schematic side view of the system shown in figure 1;

Figure 3 is a perspective detail view of the separating device;

Figure 4 is a schematic cross-sectional view of the discharge conveyor;

Figure 5 is a schematic top view of a trough idler; and

Figure 6 is a schematic cross-sectional view of the discharge conveyor in a further preferred embodiment.

System 1 in Figure 1 comprises a treatment device which is a homogenizing device 2 and a separating device 3 arranged downstream of homogenizing device 2. Homogenizing device 2 provides for a homogeneous distribution of particles 4 supplied by a feed 5. In the shown embodiment feed 5 is an elevator conveyor arranged above a higher point of an elongate distributor 6. Particles 4 which are supplied by feed 5 are distributed on distributor 6. This distribution defines a first homogenizing step of homogenizing device 2. Located below distributor 6 is a discharge conveyor 7, wherein a longitudinal direction of distributor 6 and a discharge direction D of discharge conveyor 7 are at an angle α relative to each other. When particles 4 drop from distributor 6 onto discharge conveyor 7, a further distribution of particles 4 takes place which

defines a second homogenizing step. Homogenizing device 2 is able in two steps to form on discharge conveyor 7 a very precisely homogeneously distributed layer of particles 4 which is preferably about one particle size in height. Such a homogeneously distributed layer of particles 4 is an advantageous point of departure for separation of particles 4 into different fractions based on particle mass, which takes place in the separating device 3 still to be discussed. Homogenizing device 2 thus contributes toward a precise separation of particles 4 into different fractions, wherein particles come to lie on discharge conveyor 7 in a predetermined bandwidth of dimensions. An improved recovery of usable materials from bottom ash can thus be achieved when system 1 is a waste treatment system. System 1 is for instance a waste treatment system which is configured to separate from a particle flow at least two fractions with particles 4 which can have different material properties.

The angle α between distributor 6 and discharge conveyor 7 defines a varying drop height H between distributor 6 and discharge conveyor 7. Discharge conveyor 7 is preferably drivable in a direction D in which drop height H decreases. Particles 4 which drop from the greatest height H will still have the longest retention time on discharge conveyor 7 before they are discharged on a discharge side 8. This enables particles 4 to lose their potential energy, which is released during the fall, while bouncing (indicated with B in Figure 2) and to come to a standstill relative to discharge conveyor 7 before they are discharged on discharge side 8. Particles 4 which on the other hand drop from distributor 6 onto discharge conveyor 7 closer to discharge side 8 of the discharge conveyor drop from a smaller height. They consequently have less potential energy, whereby a shorter retention time suffices to come to a standstill relative to discharge conveyor 7. An additional effect is that particles 4 which have fallen from a relatively great height H will be struck from above while bouncing B on discharge conveyor 7 by particles 4 dropping from a smaller height. The process of particles 4 coming to a standstill relative to the discharge conveyor 7 is enhanced as a result and a homogeneously distributed layer of particles 4 is created on discharge conveyor 7.

Drop height H lies in the range 0.2 - 6 metres, preferably 0.5 - 5 metres and more preferably 1 - 4 metres. In the shown preferred embodiment discharge conveyor 7 is arranged substantially horizontally and distributor 6 is disposed at an incline in its longitudinal direction. Distributor 6 has an angle of inclination relative to the horizontal in the range of $15^\circ - 30^\circ$, more preferably in the range of $20^\circ - 25^\circ$, and in the shown embodiment of about 23° .

Distributor 6 preferably comprises a screen 9. Screen 9 is preferably a so-called flip-flow screen. A flip-flow screen is also known as a flip-flop screen. Such a screen 9 is known in German as a "Spanwellensieb". Such a screen 9 is particularly suitable for screening relatively moist bulk material, for instance in the 0 - 12 mm fraction, particularly in IBA. An elastic band with openings is subjected to a flat wave movement which cyclically stretches and relaxes the openings. Material

difficult to screen can hereby be dry screened. In a waste treatment system the starting material can for instance comprise granulate with a grain size between 0 and 12 mm. A fraction of particles 4 with a particle size in the range of 0 - 5 mm can for instance be screened with screen 9 and distributed. Particles 4 in the 0 - 6 mm fraction drop through the distributor 6 embodied as screen 9 onto discharge conveyor 7 located therebelow (Figure 2). Particles larger than 6 mm (i.e. the fraction with a particle size of 6 - 11 mm) leave distributor 6 on a lower-lying discharge side 10 of distributor 6 and are there discharged by a discharge transporter 11 (Figure 2).

Discharge conveyor 7 preferably has a width which substantially corresponds to a width of distributor 6, so that particles 4 are received on discharge conveyor 7 after a free fall from distributor 6. So that the free fall of particles 4 is not influenced by for instance airflows, standing side walls 12 which bound a longitudinal direction of a drop space F are preferably arranged between distributor 6 and discharge conveyor 7. Only a part of such a side wall 12 is shown for the sake of clarity in Figure 1. When standing side walls 12 are oriented substantially vertically, particles 4 are moreover prevented from colliding with side wall 12 and sliding downward along it, whereby an undesirable accumulation could occur close to side walls 12, which would adversely affect an intended homogeneous distribution.

As shown in Figures 3 and 4, discharge conveyor 7 is provided with an upright edge 13 arranged outside drop space F. Figure 4 further shows that a seal 14 is provided which extends between standing side wall 12 of drop space F and upright edge 13 of discharge conveyor 7. Upright edge 13 prevents local wear of discharge conveyor 7 due to seal 14 pressing thereon, particularly in combination with a relatively high speed of discharge conveyor 7.

As alternative to an upright edge 13 a discharge conveyor 7 can also be applied which is bent upward in a width direction extending transversely of the direction of forward movement, i.e. in the direction of the side edges thereof (Figure 6). This upward bending of discharge conveyor 7 can be obtained with inclining support rollers 118' of trough idlers 17. Figure 6 shows that the discharge conveyor has a centre part 7a and close to the side edges is supported by support rollers 118' and has an inclining part 7b.

Figure 4 further shows that upright edge 13 is arranged outside standing side wall 12 of drop space F. In Figure 6 the transition between the substantially lying centre part 7a and inclining part 7b is also arranged outside standing side wall 12 of drop space F. This has the following advantages: in the embodiment of Figure 6, in contrast to the embodiment shown in Figure 4, discharge conveyor 7 is wholly clear of side wall 12 and a possible seal 14 (not shown). As a consequence of this free space, discharge conveyor 7 is not damaged by wear. Discharge conveyor 7 moreover runs in more stable manner due to the conveyor guiding with extra trough idlers, i.e. the inclining support rollers 118' as shown in Figure 6. The minimum distance between the underside of standing side wall 12 and discharge conveyor 7, in combination with the relatively

high speed, ensures that the number of particles which leave drop space F in sideward direction, i.e. in the direction of a side edge of discharge conveyor 7, is reduced. The height between the underside of vertical side wall 12 and discharge conveyor 7 lies in the range of 0 - 16 mm, preferably in the range of 4 - 12 mm, and is still more preferably about 8 mm. The possibility of particles 6 mm in size getting stuck is hereby prevented.

Discharge conveyor 7 is a fast-running conveyor and is preferably driven at a discharge speed in the range of 2 - 6 m/s, preferably in the range of 3 - 5 m/s, and still more preferably about 4 m/s. This relatively high discharge speed has two effects. A first effect is a ballistic effect wherein the homogeneous layer of particles 4 is propelled from the discharge side 8 at a relatively high speed, whereby separating device 3, which is still to be discussed, can function optimally. Depending on the specific density in combination with the size thereof, a particle 4 will be propelled further or less far away. A second effect is that particles 4 dropping onto discharge conveyor 7 will tumble backwards, which results in the bouncing movement represented by B in Figure 2, which it is suspected contributes toward providing a homogeneous distribution of particles 4 on discharge conveyor 7.

Once a homogeneous distribution of particles 4 has been obtained on discharge conveyor 7, it is desirable to disrupt this homogeneous distribution as little as possible during the further treatment of particles 4. Distributor 6 and discharge conveyor 7 are for this reason arranged in individual frames 15, 16 in the shown preferred embodiment. Transfer of vibrations from distributor 6 to discharge conveyor 7 is hereby prevented and discharge conveyor 7 can be kept as vibration-free as possible.

Keeping discharge conveyor 7 free of vibration is also achieved when system 1 comprises one or more than one trough idler 17 for supporting discharge conveyor 7, wherein trough idler 17 comprises at least two support rollers 18 which are arranged in a width direction of discharge conveyor 7 and have a shared or a parallel rotation axis 19 (Figures 3 and 5). Discharge conveyor 7 is held flat, whereby particles 4 are not exposed to transverse forces, such as would be the case with a conventional concave discharge conveyor. By providing a plurality of support rollers 18 in the width of discharge conveyor 7 adverse vibration effects of discharge conveyor 7 as a consequence of a possible non-roundness are minimized. Nor does a possible slight misalignment of a support roller 18 have an effect over the whole width of the discharge conveyor. Finally, shorter support rollers 18 are less susceptible to sagging.

As shown in Figure 5, trough idler 17 applied in the shown embodiment comprises three support rollers 18, wherein two support rollers 18¹, 18² have a shared rotation axis 19¹ and a third support roller 18³ has a rotation axis 19² which extends parallel to the shared rotation axis 19¹.

A compact construction of system 1 is obtained when elevator conveyor 5 has a lifting direction O which is opposite to the direction of movement D of discharge conveyor 7.

Once homogenizing device 2 has provided a homogeneously distributed layer of particles 4, this layer is supplied to a separating device 3 of system 1. Separating device 3 comprises a blower 20 disposed on discharge side 8 of discharge conveyor 7. Blower 20 is preferably an air knife 21 directed substantially transversely of discharge direction D of discharge conveyor 7. As shown in Figure 3, the exact position and orientation of air knife 21 is adjustable, so that precise setting is possible such that a desired fraction of particles 4 is separated from the layer of particles 4 supplied homogeneously by discharge conveyor 7. A fraction of particles with a particle size in the range of 0 - 2 mm is for instance separated using air knife 21. A separation efficiency of 75% can be achieved in practice. This 0 - 2 mm fraction is represented schematically as a heap of particles 22 in Figure 2, though it will be apparent that the separated fraction will in practice generally be discharged with a further transporter (not shown).

Due to the relatively high speed of discharge conveyor 7 the particles 4 forming part of the 2 - 12 mm fraction have enough momentum not to be blown away by air knife 21. Because the separation efficiency with air knife 21 is about 75%, the 2 - 12 mm fraction will also still comprise about 25% of the original quantity of the 0 - 2 mm fraction. Depending on the specific density in combination with the size of a particle 4, particle 4 will be propelled further or less far away as a consequence of the above-mentioned ballistic effect. Particles 4 which have a high specific density, for instance metals, but a relatively small size of 0 - 2 mm can thus come to lie in the fraction with a particle size > 2 mm. A higher efficiency can be achieved with an additional separation step.

The shown system 1 preferably further comprises an additional discharge conveyor 23 and an additional blower 24 which is disposed on a discharge side 25 of the additional discharge conveyor 23. The 2 - 12 mm fraction will come to lie on this additional discharge conveyor 23. In a preferred embodiment the additional blower 24 is also an air knife 26. A fraction of particles with a particle size in the range of 0 - 2 mm is separated again using additional blower 24. This 0 - 2 mm fraction is shown schematically as a heap of particles 27 in Figure 2. An efficiency of 10 % relative to the total 0 - 2 mm fraction can be obtained in practice with this second step. The two air knives 21 and 26 can together separate the 0 - 2 mm fraction with an efficiency of 85 %, represented by heaps 22 and 27.

When an additional discharge conveyor 23 is provided, it will preferably have the same technical characteristics as discharge conveyor 7. It is further the case for additional discharge conveyor 23 that - just as discharge conveyor 7 - it is preferably kept as vibration-free as possible. An individual frame can be provided for discharge conveyor 23, or it can be combined with frame 16 of discharge conveyor 7, wherein the distributor is arranged in another frame 15.

Additional discharge conveyor 23 has trough idlers 28 similar to trough idlers 17 of discharge conveyor 7.

Although a screen 9 in the form of a flip-flow screen/flip-flop screen is applied in the

shown embodiment because of the suitability of such a screen for screening a fine fraction, the skilled person will appreciate that alternative screens can also be applied. A possible alternative (not shown) is a linear motion screen, which can be disposed almost horizontally.

Although it shows a preferred embodiment of the invention, the above described
5 embodiment is intended only to illustrate the present invention and not in any way to limit the specification of the invention. When measures in the claims are followed by reference numerals, such reference numerals serve only to contribute toward understanding of the claims, but are in no way limitative of the scope of protection. The rights described are defined by the following claims, within the scope of which many modifications may be envisaged.

Claims

1. System, comprising:

- a treatment device, comprising:

- a feed configured to supply particles;
- an elongate distributor;
- wherein the feed is arranged above the distributor; and
- a discharge conveyor located below the distributor, wherein a longitudinal direction of the distributor and a discharge direction of the discharge conveyor are at an angle relative to each other; and
- wherein the angle between the distributor and the discharge conveyor defines a varying drop height between the distributor and the discharge conveyor,

characterized in that

- the elongate distributor of the treatment device is configured to lay the particles supplied by the feed in a homogeneously distributed layer on the discharge conveyor;
- the discharge conveyor is drivable in a direction in which the drop height decreases; and
- a separating device is arranged downstream of the discharge conveyor of the treatment device, wherein said separating device is configured to separate the homogeneously distributed layer into different fractions based on particle mass.

2. System as claimed in claim 1, wherein the separating device comprises a blower disposed on a discharge side of the discharge conveyor.

3. System as claimed in claim 2, wherein the blower is an air knife directed substantially transversely of the discharge direction of the discharge conveyor.

4. System as claimed in claim 2 or 3, comprising an additional discharge conveyor and an additional blower which is disposed on a discharge side of the additional discharge conveyor.

5. System as claimed in any of the foregoing claims, wherein the drop height lies in the range of 0.2 - 6 metres, preferably 0.5 - 5 metres and more preferably 1 - 4 metres.

6. System as claimed in any of the foregoing claims, wherein the distributor is disposed at an incline in its longitudinal direction.

7. System as claimed in claim 6, wherein the distributor has an angle of inclination relative

to the horizontal in the range of 15° – 30°, more preferably in the range of 20° – 25°.

8. System as claimed in any of the claims 5-7, wherein the discharge conveyor takes a flatter form in a width direction thereof than the inclining distributor.

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9. System as claimed in any of the claims 5-8, wherein the discharge conveyor takes a flatter form than the inclining distributor and is preferably disposed horizontally.

10. System as claimed in any of the foregoing claims, wherein the feed is arranged above a higher point of the distributor.

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11. System as claimed in any of the foregoing claims, wherein the distributor comprises a screen, and is preferably a flip-flow screen.

12. System as claimed in any of the foregoing claims, wherein the discharge conveyor has a width which substantially corresponds to a width of the distributor.

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13. System as claimed in claim 12, wherein standing side walls are arranged between the distributor and the discharge conveyor which bound a longitudinal direction of a drop space.

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14. System as claimed in claim 13, wherein the standing side walls are oriented substantially vertically.

15. System as claimed in any of the claims 12-14, wherein the discharge conveyor comprises an upright edge arranged outside the drop space.

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16. System as claimed in claim 15, wherein a seal is provided which extends between the standing side wall of the drop space and the upright edge of the discharge conveyor.

17. System as claimed in any of the foregoing claims, wherein the discharge conveyor is configured to be driven at a discharge speed in the range of 2 - 6 m/s, preferably in the range of 3 - 5 m/s.

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18. System as claimed in any of the foregoing claims, wherein the distributor and the discharge conveyor are arranged in individual frames.

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19. System as claimed in any of the foregoing claims, comprising one or more than one trough idler for supporting the discharge conveyor, wherein the trough idler comprises at least two support rollers which are arranged in a width direction of the discharge conveyor and have a shared or parallel rotation axis.

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20. System as claimed in claim 19, wherein the trough idler comprises three support rollers, wherein two support rollers have a shared rotation axis and a third support roller has a rotation axis extending parallel to the shared rotation axis.

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21. System as claimed in any of the foregoing claims, wherein the feed is an elevator conveyor.

22. System as claimed in claim 21, wherein the elevator conveyor has a lifting direction which is opposite to the direction of movement of the discharge conveyor.

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23. System as claimed in any of the foregoing claims, wherein the system is a waste treatment system which is configured to separate from a particle flow at least two fractions with particles which have different material properties.