

VIBRATING DRYER

FIELD OF THE INVENTION

[0001]

5 The present invention relates to a vibrating dryer configured to dry a material while conveying it by vibration.

BACKGROUND OF THE INVENTION

[0002]

10 JP 2017-075745 A describes a conventional vibrating dryer. This vibrating dryer includes a straightening plate for conveyance of a material in, for example, a granular form, and a gas feeder for feeding gas into a box-shaped gas feeding chamber formed below the straightening plate to allow gas to pass through a number of opening holes provided in the
15 straightening plate, and is thereby configured to feed gas to the material to dry the same during conveyance. The vibrating dryer further includes a partition plate for changing gas flow fed in a width direction of the gas feeding chamber.

[0003]

20 According to the disclosure on the vibrating dryer of JP 2017-075745 A, it is assumed that: a part of gas changes its flowing direction by the partition plate, which decreases the flow rate of gas hitting the wall of the gas feeding chamber and then blowing up therealong, and hence suppresses increase in velocity of gas passing through the opening holes of the
25 straightening plate near the wall; as a result, the material near the wall is not pushed pressed and moved by gas so that uneven distribution of the material in the width direction of the gas feeding chamber is reduced, and the material can thereby be uniformly fluidized and dried.

30 SUMMARY OF THE INVENTION

[0004]

Adjustments such as changing an installation angle of the partition plate in the gas feeding chamber are sometimes required to change gas flow passing through the opening holes of the straightening plate according to the granule size or specific gravity of the material. In addition, since the
5 vibrating dryer conveys a material in, for example, a granular form, the material is likely to be fragmented during the conveyance and the fragments or powder generated therefrom fall into the gas feeding chamber. This causes the necessity for cleaning the inside of the vibrating dryer in some cases.

10 [0005]

However, the vibrating dryer of JP 2017-075745 A, in which the partition plate is installed inside the gas feeding chamber, necessitates the removal of the straightening plate or the cover of the vibrating dryer itself to reach the partition plate when maintenance works such as adjustment or
15 cleaning works are to be performed. Some vibrating dryers are large with a longitudinal dimension of several to several tens of meters, which imposes a large maintenance workload. In addressing this problem, it is still necessary to provide the vibrating dryer a fundamental function, that is, a function of maintaining uniform gas feeding to the straightening plate.

20 [0006]

It is therefore an object of the present invention to provide a vibrating dryer that ensures excellent workability of maintenance with eliminating the necessity to remove the straightening plate at the time of maintenance while keeping uniform gas feeding to the straightening plate.

25 [0007]

According to the present invention, there is provided a vibrating dryer including: a straightening plate that allows gas to pass therethrough in its thickness direction and conveys a material placed thereon by vibration; a gas feeding chamber that is located below the straightening plate and is
30 defined by a wall; a gas feeder that feeds gas to the gas feeding chamber; the gas feeder including a gas inlet that penetrates through the wall of the gas

feeding chamber and has an inner surface, and a hollow cylindrical flow guide part being detachably attached to the gas inlet and configured to be inserted from the outside of the gas feeding chamber into the inside thereof to be attached to the gas inlet; the flow guide part having a side face part that extends along the inner surface of the gas inlet and an end face part that is positioned at an inner end in an axial direction of the flow guide part; and each of the side face part and the end face part having a plurality of vent holes penetrating therethrough.

[0008]

According to this configuration, gas is introduced through the plurality of vent holes of the side face part of the flow guide part into the gas feeding chamber and introduced through the plurality of vent holes of the end face part thereof into the gas feeding chamber, so that gas flows in different directions can be generated inside the gas feeding chamber. Thus, gas flow having optimal conditions for the material to be conveyed on the straightening plate can be generated in the gas feeding chamber. In addition, the flow guide part can be easily detached from the gas inlet.

[0009]

The present invention may be configured such that the wall of the gas feeding chamber include a side wall, at which the gas inlet is positioned, and that the side face part of the flow guide part has the plurality of vent holes formed along its peripheral direction, and has a non-ventilating part with no vent hole in an area on one side of the side face part of the gas inlet, the one side becoming an upper side when the flow guide part is attached to the gas inlet, the area being defined by the extension of the plurality of vent holes in the peripheral direction.

[0010]

According to this configuration, gas can be prevented from being introduced from the area on the upper side of the side face part into the gas feeding chamber. Thus, gas flowing from the flow guide part directly to the straightening plate can be reduced, which enables velocity distribution of gas

passing through the straightening plate to be adjusted.

[0011]

According to the present invention, gas flow having optimal conditions for the material to be conveyed on the straightening plate can be generated in the gas feeding chamber. In addition, the flow guide part can be easily detached from the gas inlet. Thus, the present invention can provide a vibrating dryer that ensures excellent workability of maintenance with eliminating the necessity to remove the straightening plate at the time of maintenance while keeping uniform gas feeding to the straightening plate.

BRIEF DESCRIPTION OF DRAWINGS

[0012]

Fig. 1A is a schematic plan view showing a vibrating dryer according to an embodiment of the present invention.

Fig. 1B is a schematic front view showing the vibrating dryer.

Fig. 2 is a schematic perspective view from obliquely upward, showing the structure of the vibrating dryer with part seen through from the outside.

Fig. 3 is a schematic perspective view from obliquely downward, showing the structure of the vibrating dryer with part seen through from the outside.

Fig. 4 is a perspective view showing an end face part side of a flow guide part in the vibrating dryer.

Fig. 5 is a longitudinal cross sectional view of the vibrating dryer in its width direction.

Fig. 6A is a front view showing the flow guide part in the vibrating dryer.

Fig. 6B is a longitudinal cross sectional view showing the flow guide part in the vibrating dryer, along with a gas inlet.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0013]

The present invention will be hereinafter described by taking an embodiment, with reference to the drawings. Directional expressions in the following description shall be in accordance with the relationship mentioned below, unless otherwise specified by a directional reference. A vertical direction corresponds to the vertical direction shown in Fig. 2 and Fig. 5. An inside-outside direction corresponds to the inside-outside direction with reference to a gas feeding chamber 4. A width direction corresponds to the width direction of a body 2.

[0014]

First, the overall configuration of a vibrating dryer 1 of this embodiment will be described. Note, however, that this description will be roughly provided since the vibrating dryer 1 has the same basic configuration as a conventional vibrating dryer. As shown in Fig. 1A and Fig. 1B, the vibrating dryer 1 of this embodiment includes a box-shaped body 2 that is swingably supported by spring supports 51 from below. Note that the left and right direction in Fig. 1A corresponds to the longitudinal direction of the vibrating dryer 1 while the vertical direction therein corresponds to the width direction of the vibrating dryer 1.

[0015]

The body 2 is constituted by side walls 211 defining its four sides, a bottom wall 212 defining its lower part, and a top wall 213 defining its upper part, to form space inside the body 2. A straightening plate 3 is arranged inside the body 2 to be oriented in the horizontal direction. The body 2 is configured to be vibrated by a vibrator 5. The top wall 213 of the body 2 has a material charging port 22 formed in its left end portion, and the bottom wall 212 of the body 2 has a material discharging port 23 formed in its right end portion. A material M charged into the body 2 (schematically shown in Fig. 1B and Fig. 5) is conveyed on the straightening plate 3 in the direction shown by arrow D in Fig. 1B. Note that the material M to be conveyed and dried by the vibrating dryer 1 of this embodiment is to be in an indefinite

form in an aggregate state, such as a granular form, and can be a material used for various applications, such as food, chemicals, fertilizers, and industrial materials.

[0016]

5 Fig. 2 and Fig. 3 show a constituting unit 2U provided for each of a plurality of gas inlets 61 in a gas feeder 6, which are views extracted from the body 2 for explanation, and thus it is not necessary that the body 2 is physically separated into a plurality of constituting units 2U. The body 2 is constituted by the plurality of constituting units 2U continually arranged in
10 the longitudinal direction (i.e., a direction from the top left to the bottom right in Fig. 2 and Fig. 3). A description will be hereinafter made for one constituting unit 2U.

[0017]

The constituting unit 2U includes (a part of each of) the
15 straightening plate 3, the gas feeding chamber 4, and the gas feeder 6.

[0018]

The straightening plate 3 allows gas to pass therethrough in its thickness direction and conveys the material M placed thereon by vibrations caused to the constituting unit 2U by the vibrator 5. The straightening
20 plate 3 can be made of, for example, punching metal, so as to have a number of small through holes 31 (only several of which are shown in Fig. 2 and Fig. 3) through which gas flow can pass. Each small through hole 31 is preferably formed to have such a dimension as to allow gas flow to pass therethrough but not to cause the material M being conveyed to fall
25 therethrough. The straightening plate 3 is reinforced from below by a plurality of reinforcing members 32 that extend in the width direction, as shown in, for example, Fig. 3.

[0019]

The gas feeding chamber 4 is positioned below the straightening
30 plate 3, and a wall 21 (specifically, the side walls 211 and the bottom wall 212) of the body defines the inside and the outside of the gas feeding chamber

4. The gas feeder 6 is configured to supply gas to the gas feeding chamber 4. Gas used in this embodiment is air.

[0020]

Fig. 2 and Fig. 3 each shows one of the plurality of gas inlets 61 of the gas feeder 6. A blower 62 shown in Fig. 1A is connected to the respective gas inlets 61 so that gas is fed through an inlet passage 63 into the gas inlets 61. Although not shown, the inlet passage 63 can be, for example, constituted by two systems, namely: one system in the form of a heating passage including a heater; and another system in the form of a cooling passage including a cooler. In this case, for example, the configuration can be such that the heating passage is connected to the gas inlet 61 located upstream of the conveying direction, and the cooling passage is connected to the gas inlet 61 located downstream of the conveying direction. Gas flow fed to the gas inlets 61 is made to pass upward from the gas feeding chamber 4 through the straightening plate 3, and is discharged from gas outlets 24 provided in the top wall 213 of the body 2. The gas outlets 24 are connected to a dust collector 25 shown in Fig. 1B and configured to collect powder or the like of the material M that is present in the discharged gas flow.

[0021]

The gas feeder 6 in this embodiment has a configuration that has not existed in the past, and includes the gas inlets 61 that penetrate through the wall 21 of the gas feeding chamber 4, and flow guide parts 64 detachably attached to the gas inlets 61 and configured to be inserted from the outside to the inside of the gas feeding chamber 4 to be attached to the gas inlets 61, respectively. The gas inlets 61 of this embodiment have a cylindrical shape, more specifically a circular cylindrical shape, that penetrates through the side wall 211 defining the gas feeding chamber 4, without limitation thereto. The gas inlets 61 can have various shapes as long as the flow guide parts 64 are detachably attached thereto.

[0022]

Fig. 4 shows a shape of one of the flow guide parts 64. The flow

guide part 64 has a side face part 641 extending along the circumferential inner surface of the corresponding circular cylindrical shaped gas inlet 61, and an end face part 642 positioned at an inner end in the axial direction of the flow guide part 64 (i.e., an end close to the inside of the gas feeding chamber 4). The side face part 641 has a circular cylindrical shape, and the end face part 642 has a disk shape to close the opening at the inner end of the side face part 641. The flow guide part 64 has a flange 643 at its outer end in the axial direction. The flange 643 abuts the outer end edge of the gas inlet 61 so that the positioning of the flow guide part 64 in the inside-outside direction with respect to the gas inlet 61 can be made. According to the configuration in which the flow guide part 64 has a circular cross section orthogonal to the axial direction, as in the cross section of the circular hollow cylindrical side face part 641 in this embodiment, the velocity distribution inside the flow guide part 64 is simpler than in the case where the flow guide part 64 has a different cross sectional shape. The flow guide part 64 therefore has an advantage of being easily designed to achieve a desired gas flow to be introduced into the gas feeding chamber 4.

[0023]

The side face part 641 and the end face part 642 have a plurality of vent holes 644 and 645 formed therethrough for spouting gas. Out of these vent holes, the vent holes 644 of the side face part 641 are formed in plural along the circumferential direction of the side face part 641. The vent holes 644 of the side face part 641 of this embodiment are through holes in a rectangular shape as viewed in the radial direction, with their long sides provided along the circumferential direction. The vent holes 644 are not provided in an area which is positioned on the upper side of the side face part 641 when the gas flow part 64 is attached to the gas inlet 61. That is, the flow guide part 64 has a vent hole-free part 646 with no vent hole 644 therein in an area on the upper side of the side face part 641 when the flow guide part 64 is attached to the gas inlet 61, the area being defined by the extension of the plurality of vent holes 644 of the side face part 641 in the

circumferential direction. The vent holes 645 of the end face part 642 are circular through holes and arranged in plural along the circumferential direction. The vent holes 645 of the end face part 642 of this embodiment are arranged along each of the lines of two imaginary concentric outer and inner circles (see Fig. 6A), and specifically six vent holes 645 of the end face part 642 having the same size are formed along each of the inner and outer circumferential lines.

[0024]

The flow guide part 64 configured as above is attached to the gas inlet 61, so that gas is introduced through the vent holes 644 in the side face part 641 of the flow guide part 64 into the gas feeding chamber 4 while being introduced through the vent holes 645 in the end face part 642 into the gas feeding chamber 4. Through the vent holes 644 of the side face part 641, air blows out radially outward in every direction except the direction where the vent hole-free part 646 faces. With such a configuration, gas flow schematically shown by the arrows in Fig. 5 is generated in the gas feeding chamber 4, so that the flow rate of gas in an area close to the gas inlet 61 can be secured. The vent hole-free part 646 thus provided in the flow guide part 64 can prevent gas from being introduced from the area on the upper side of the side face part 641 into the gas feeding chamber 4. As a result, gas flow from the flow guide part 64 directly toward the straightening plate 3 (i.e., gas that flows the shortest distance to the straightening plate 3 with no detours) can be reduced. Thus, it is possible to prevent occurrence of an area in which gas intensively passes due to the shortest distance to the straightening plate 3, so that the variation in the velocity distribution of gas passing through the straightening plate 3 can be adjusted to be small.

Through the vent holes 645 of the end face part 642, air blows out so as to radially expand while flowing in the axial direction. As a result, the flow rate of gas in an area located away in the width direction from the gas inlet 61 can be secured in the gas feeding chamber 4.

[0025]

Introducing gas through the plurality of vent holes 644 and 645 that face in different directions from each other as described above can generate gas flows in different directions in the gas feeding chamber 4. As a result, gas flow having optimal conditions for the material M to be conveyed on the straightening plate 3 can be generated in the gas feeding chamber 4. In addition, the flow guide part 64 of this embodiment is detachably attached to the gas inlet 61 so that the flow guide part 64 can be easily detached from the gas inlet 61.

[0026]

As compared with the configuration in which a structural element, such as a conventional partitioning plate (see JP 2017-075745 A), difficult to be taken out to the outside is installed inside the gas feeding chamber 4, the configuration in this embodiment only needs the flow guide parts 64 to be pulled out from the gas inlets 61 to the outside of the gas feeding chamber 4 at the time of maintenance works such as adjustment or cleaning works. This eliminates the necessity to remove the cover or the like to open the gas feeding chamber 4 or the body 2. Thus, an operator's maintenance workload is relatively reduced at the time of maintenance works. In addition, a basic function of the vibrating dryer, that is, a function of maintaining uniform gas feeding to the straightening plate 3, is also sufficiently secured.

[0027]

In this embodiment, the opening area of each of the vent holes 645 in the end face part 642 of the flow guide part 64 that is positioned close to the center of the end face part 642 (i.e., on the center side) can be the same as or smaller (as shown in Fig. 6A) than the opening area of each of the vent holes 645 of the end face part 642 that is positioned away from the center of the end face part 642 (i.e., on the outer circumferential side). The "center" refers to the center of gas flow passing through the circular flow guide part 64, and when referred to a cross sectional shape, the center is a position including the position at equal distances from the edge of the cross section,

and coincides with, for example, the axial center of the cylindrical shape.

When the opening area of each of the vent holes 645 of the end face part 644 on the center side is smaller than that on the outer circumferential side, the velocity of gas flow inside the flow guide part 64 on the center side is larger than that on the outer circumferential side; thus, the magnitude of the velocity can be adjusted by varying the opening area.

[0028]

In this embodiment, the plurality of vent holes 645 of the disk-shaped end face part 642 are concentrically arranged in the circumferential direction (i.e., the plurality of vent holes 645 of the end face part 642 are arranged along each of the imaginary lines of the concentric circles). As shown in Fig. 6A, the plurality of vent holes 645 aligned along the inner circumferential line of the end face part 642 are displaced in position in the circumferential direction from the plurality of vent holes 645 aligned along the outer circumferential line of the end face part 642. With such a configuration, gas flow through the plurality of vent holes 645 aligned along the inner circumferential line is less likely to overlap with gas flow through the plurality of vent holes 645 aligned along the outer circumferential line. As a result, the velocity of gas flow is less likely to increase so that variation in velocity distribution in the gas feeding chamber 4 can be made small.

[0029]

In this embodiment, the plurality of vent holes 644 formed in the side face part 641 of the flow guide part 64 are located so close to the inner surface of the side wall 211 gas flow through the vent holes 644 of the side face part 641 hits the inner surface of the side wall 211. According to this configuration, gas flowing sideward from the flow guide part 64 can be generated in an area close to the gas inlet 61 that is opened to the gas feeding chamber 4. As a result, gas flow can be generated in a broad area from an end part of the gas feeding chamber 4 close to the gas inlet 61 to the inside of the gas feeding chamber 4.

[0030]

The present invention has been described by taking one embodiment. However, the present invention is not limited to the aforementioned embodiment, but various modifications can be made without departing from the gist of the present invention.

5 [0031]

For example, in the aforementioned embodiment, the gas inlets 61 are provided in the side wall 211, without limitation thereto. The gas inlets 61 can be formed in the bottom wall 212. In this case, the flow guide parts 64 are to be inserted upward from below.

10 [0032]

The side face part 641 of the flow guide part 64 of the aforementioned embodiment has a circular cylindrical shape, that is, has a circular (perfectly circular) cross section, without limitation thereto. The side face part 641 in a cylindrical shape can have a polygonal shape, an oval shape, or an elliptical shape in cross section.

15 [0033]

In the aforementioned embodiment, the end face part 642 of the flow guide part 64 has a disk shape, without limitation thereto. The end face part 642 can have, for example, a spherical shape or a conical shape. The end face part 642 of the aforementioned embodiment is arranged orthogonal to the axial direction, without limitation thereto. The end face part 642 can be arranged at an angle not being 90 degrees relative to the axial direction.

[0034]

The flow guide part 64 in the aforementioned embodiment has one space inside, without limitation thereto. The inside of the flow guide part 64 can have a device, such as a fixed blade (a fin), for guiding gas flow, or can have a mechanism, such as a rotating blade (a propeller), for increasing or decreasing the energy of gas flow. The inside of the flow guide part 64 can also have a partition wall to partition the space into a plurality of spaces through which gas flow passes. The vent hole 645 of the end face part 642 can have a hollow cylindrical body or a nozzle added thereto.

[0035]

The plurality of vent holes 644 and 645 in the flow guide part 64 of the aforementioned embodiment are left open, without limitation thereto. Each of the vent holes 644 and 645 can be configured to be openable and
5 closeable to adjust the opening ratio thereof. For example, each of the vent holes 644 and 645 can have a movable lid attached thereto. Further, for example, the flow guide part 64 can be constituted by a combination of two hollow cylindrical bodies, one of which is fitted into the other. In this case, the configuration can be such that each of the two hollow cylindrical bodies
10 has a through hole and the two hollow cylindrical bodies are rotated with respect to each other or slidably moved along the axial direction, so that the opening ratio of the through hole can be adjusted. This configuration that enables the opening ratio of each of the vent holes 644 and 645 to be adjustable can easily achieve a desired gas flow state inside the gas feeding
15 chamber 4.

WHAT IS CLAIMED IS:

1. A vibrating dryer, comprising:
 - a straightening plate that allows gas to pass therethrough in its
 - 5 thickness direction and conveys a material placed thereon by vibration;
 - a gas feeding chamber that is located below the straightening plate
 - and is defined by a wall;
 - a gas feeder that feeds gas to the gas feeding chamber;
 - the gas feeder comprising a gas inlet that penetrates through the
 - 10 wall of the gas feeding chamber and has an inner surface, and a hollow
 - cylindrical flow guide part being detachably attached to the gas inlet and
 - configured to be inserted from the outside of the gas feeding chamber into
 - the inside thereof to be attached to the gas inlet;
 - the flow guide part having a side face part that extends along the
 - 15 inner surface of the gas inlet and an end face part that is positioned at an
 - inner end in an axial direction of the flow guide part; and
 - each of the side face part and the end face part having a plurality of
 - vent holes penetrating therethrough.
- 20 2. The vibrating dryer according to claim 1, wherein
 - the walls of the gas feeding chamber comprise a side wall, at which
 - the gas inlet is positioned, and
 - the side face part of the flow guide part has the plurality of vent holes
 - formed along its peripheral direction, and has a non-ventilating part with no
 - 25 vent hole in an area on one side of the side face part of the gas inlet, the one
 - side becoming an upper side when the flow guide part is attached to the gas
 - inlet, the area being defined by the extension of the plurality of vent holes in
 - the peripheral direction.