

DESCRIPTION

FILLING NOZZLE, RESIN PELLET FILLING SYSTEM AND
RESIN PELLET FILLING METHOD

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Technical Field

[0001]

The present invention relates to a filling nozzle, a resin pellet filling system and a resin pellet filling method for filling resin pellets within a storage facility such as a silo into a transport receptacle such as a lorry or container. More particularly, the present invention relates to a filling nozzle, a resin pellet filling system and a resin pellet filling method suitable for the filling of polycarbonate-based resin pellets requiring a low content of foreign substances.

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Background Art

[0002]

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Resin pellets requiring a low content of foreign substances have been known. For example, polycarbonate-based resin pellets with a low content of foreign substances used as a material for a substrate of an optical disk require reductions in the content of metal powder derived from the side of equipment such as a silo or pipes, the content of fine resin powder produced in the process of forming a resin into pellets (process of cutting a strand put out of an extruder into a granular state), the content of small resin fragments produced due to contact with a pipe wall when the resin pellets are

carried on air, etc. The reason is that, in an optical disk having an optical disk substrate formed of the resin pellets, the foreign substances inhibit the transmission of laser and increase errors when the information recorded on the optical disk is read with the laser or when information is written onto the optical disk. Especially, requirements for the reduction of contained foreign substances have recently been increasingly severe along with the increase in a storage capacity (recording density) in the optical disks.

[0003]

Furthermore, along with the increase in the global demand for optical disk products, the amount of production of the polycarbonate-based resin pellets with a low content of foreign substances has been increasing, and its production facilities have been increasing in size. Under such circumstances, the utilization of lorries and containers has been proposed to improve the efficiency in the transport of the resin pellets (e.g., refer to Patent documents 1 to 4), but much consideration needs to be given to the foreign substances described above when the lorries and containers are applied to the resin pellets for the optical disk substrates.

Patent document 1: Japanese Patent Publication Laid-open No. 11-208893

Patent document 2: Japanese Patent Publication Laid-open No. 2000-355426

Patent document 3: Japanese Patent Publication Laid-open No. 2000-261090

Patent document 4: Japanese Patent Publication Laid-open

No. 2003-335305

[0004]

When the resin pellets requiring a low content of foreign substances are filled from a storage facility such as a silo into a transport receptacle such as the lorry or container, a nozzle or hose is connected to the transport receptacle under a clean environment such as a clean room (including a clean booth) to prevent the resin pellets from being contaminated with foreign substances.

At this point, a connection port of the transport receptacle does not always come to the same position every time due to the positional difference of a stop position caused by the technique of operating a transport vehicle or due to dimensional tolerance between vehicle bodies.

Therefore, it is necessary for the nozzle or hose to be able to allow positional differences of about ± 50 mm in a forward/backward direction and in a horizontal direction, ± 150 mm in a vertical direction and $\pm 5^\circ$ in an inclination direction. Moreover, it is also essential to increase the diameter of the nozzle or hose to fill the resin pellets into the transport receptacle more quickly.

[0005]

A stainless-steel flexible hose has been known to satisfy such requirements. However, the stainless-steel flexible hose has problems of impaired operability and an increased size of the clean room because it requires a length of 3 m or more to compensate positional differences of about ± 50 mm in the forward/backward direction and in the horizontal direction, ± 150 mm in the vertical direction and $\pm 5^\circ$ in the inclination direction when the

diameter of the flexible hose is, for example, 100 mm (four inches).

Moreover, when the diameter of the flexible hose is as large as 150 mm (six inches), the weight of the hose increases, and the operability becomes worse.

[0006]

Furthermore, it is necessary to polish or clean the inner wall of the hose to prevent foreign substances, derived from the hose, from being produced when the resin rubs against the inner wall of the flexible hose.

However, the hose is generally accordion-shaped to allow for flexibility, and it is not easy to polish or clean the inner wall of the accordion-shaped hose.

[0007]

The present invention has been made in view of such circumstances, and is directed to provide a filling nozzle, a resin pellet filling system and a resin pellet filling method, the filling nozzle being small in size and capable of not only exerting satisfactory positional difference compensation effects and but also removing foreign substances from resin pellets being filled.

DISCLOSURE OF THE INVENTION

[0008]

A filling nozzle of the present invention for achieving the above-mentioned purpose is a filling nozzle to fill resin pellets within a silo into a transport receptacle, and the filling nozzle comprises: an upper part connected with a discharge outlet of the silo; and a lower part connected with a filling inlet of the transport

receptacle, the upper part including: an inner cylinder which guides, into the lower part, the resin pellets discharged from the discharge outlet of the silo; and an outer cylinder covering the outer periphery of the inner cylinder, the lower part including a movable cylinder which is inserted in a space between the inner cylinder and the outer cylinder so as to be allowed to move in a forward/backward direction, in a horizontal direction, in a vertical direction and in an inclination direction and which guides, to the filling inlet of the transport receptacle, the resin pellets discharged from the inner cylinder.

[0009]

Thus, while the filling nozzle is more easily downsized than a flexible hose, the movable cylinder is capable of independent movements in the forward/backward direction, in the horizontal direction and in the vertical direction, that is, in directions of X, Y and Z axes, and a movement in the inclination direction, it is possible to compensate such positional difference. For example, even when a linear dimension is about 2 m, it is possible to compensate positional differences of about ± 50 mm in the backward/forward and horizontal directions, ± 150 mm in the vertical direction and $\pm 5^\circ$ in the inclination direction.

[0010]

In addition, in the filling nozzle having such a configuration, it is possible to remove foreign substance, such as fine resin powders and small resin fragments caused due to resin pellet pelletizing or its pneumatic conveyance, through using a space formed between the upper

part and the lower part. For example, air discharged from the filling inlet of the transport receptacle in accordance with the filling amount of the resin pellets is discharged via the above-mentioned space, such that the quantity of foreign substances, such as the fine resin powder and small resin fragments, contained in the discharged air can be reduced as much as possible.

[0011]

Moreover, in the configuration of the filling nozzle of the present invention, the upper part can be equipped with an exhaust duct which discharges air from the outer cylinder to the outside.

Thus, a suction unit is connected to the exhaust duct, the foreign substances such as the fine resin powder and small resin fragments can be actively discharged with air from the inside of the filling nozzle.

[0012]

Furthermore, a resin pellet filling system of the present invention comprises: a filling nozzle to fill resin pellets within a silo into a transport receptacle, the filling nozzle having an upper part connected with a discharge outlet of the silo, and a lower part connected with a filling inlet of the transport receptacle, the upper part including an inner cylinder which guides, into the lower part, the resin pellets discharged from the discharge outlet of the silo, and an outer cylinder covering the outer periphery of the inner cylinder, the lower part including a movable cylinder which is inserted in a space between the inner cylinder and the outer cylinder so as to be allowed to move in a forward/backward direction, in a

horizontal direction, in a vertical direction and in an inclination direction and which guides, to the filling inlet of the transport receptacle, the resin pellets discharged from the inner cylinder; a clean room which stores the filling nozzle; a clean air blower which blows clean air into the clean room; and an exhaust device which discharges air inside the outer cylinder to the outside of the clean room via the exhaust duct of the upper part.

[0013]

Thus, it is possible to maintain a clean condition inside the filling nozzle, and prevent the foreign substances from entering into the filling nozzle and the transport receptacle. Moreover, the air inside the outer cylinder is discharged to the outside of the clean room via the exhaust duct of the upper part, so that it is possible not only to actively avoid filling of the foreign substances contained in the resin pellets, but also to avoid contamination of the clean room with the air containing such foreign substances.

[0014]

In addition, the resin pellet filling system of the present invention can comprise clean air intake mean for taking clean air into the transport receptacle via a clean air intake inlet provided separately from the filling inlet of the transport receptacle.

Thus, during the operation of opening/closing the filling inlet and the operation of connecting the filling nozzle to the filling inlet, the air is blown into the transport receptacle to maintain a positive pressure in the transport receptacle, and have air blown from the resin

pellets filling inlet, so that accidental entering of an extraneous substance into the transport receptacle due to its unexpected dropping can be suppressed.

Moreover, if the clean air is blown into the transport receptacle during resin pellets filing, it is possible to actively separate light foreign substances such as the fine resin powder and small resin fragments from the heavier resin pellets, together with air. As the result, the content of such foreign substances contained in the resin pellets filled into the transport receptacle can be reduced through discharging the air.

[0015]

Furthermore, a resin pellet filling method of the present invention is a method of filling resin pellets within a silo into a transport receptacle, and the resin pellet filling method comprises: using the resin pellet filling system described above, and bringing the discharge outlet of the silo into communication with the filling inlet of the transport receptacle via the filling nozzle and then filling the resin pellets from the silo into the transport receptacle.

Thus, the positional difference of the transport receptacle is compensated by using the filling nozzle, so that the filling nozzle is easily connected to the transport receptacle, and it is possible to use space formed between the upper part and the lower part to remove the foreign substances such as the fine resin powder and small resin fragments from the resin pellets being filled.

[0016]

In addition, in the resin pellet filling method of

the present invention, a relation among an amount (a) m^3/min of the clean air blown into the clean room, an amount (b) m^3/min of the air discharged from the inside of the outer cylinder to the outside of the clean room via the exhaust duct of upper part, and an amount (c) m^3/min of air discharged from resin pellets filling inlet of the transport receptacle in accordance with the filling amount of the resin pellets preferably satisfies

$$(c) \leq (b) < (a).$$

Thus, it is possible to ensure that the air (the amount of air corresponding to the filling amount of the resin pellets) discharged from the filling inlet of the transport receptacle during filling is discharged to the outside of the clean room, and it is also possible to maintain a positive pressure in the clean room and prevent the outside air from entering into the clean room through the connection opening.

[0017]

Moreover, in a resin pellet filling method of the present invention, a relation among an amount (a) m^3/min of the clean air blown into the clean room, an amount (b) m^3/min of the air discharged from the inside of the outer cylinder to the outside of the clean room via the exhaust duct of the upper part, an amount (c) m^3/min of the air discharged from the filling inlet of the transport receptacle in accordance with the filling amount of the resin pellets, and an amount (d) m^3/min of the clean air taken into the transport receptacle via the clean air intake inlet satisfies

$$(c) + (d) \leq (b) < (a).$$

Thus, it is possible to ensure that the air (the amount of air corresponding to the filling amount of the resin pellets and the clean air blown into the transport receptacle) discharged from the resin pellets filling inlet of the transport receptacle during filling is discharged to the outside of the clean room, and it is also possible to maintain a positive pressure in the clean room and prevent the outside air from entering into the clean room through the connection opening into the clean room.

[0018]

As described above, according to the present invention, while the filling nozzle is more easily downsized than a flexible hose, the movable cylinder is capable of independent movements in the forward/backward direction, in the horizontal direction and in the vertical direction, that is, in directions of X, Y and Z axes, and a movement in the inclination direction, such that it is possible to compensate such positional difference by the movement in the inclination direction. As a result, an increase in the size of the clean room is avoided, and it is possible to reduce costs of the resin pellet filling system and improve operability thereof.

Moreover, it is possible to use the space formed between the upper part and the lower part to remove the foreign substances from the resin pellets being filled, so that the content of the foreign substances in the resin pellets filled into the transport receptacle can be reduced.

[0019]

FIG. 1(a) is a front view of a filling nozzle according to an embodiment of the present invention, FIG. 1(b) is a partly sectional front view showing an upper
5 part of the filling nozzle according to the embodiment of the present invention, and FIG. 1(c) is a partly sectional front view showing a lower part of the filling nozzle according to the embodiment of the present invention;

FIG. 2(a) is a front view showing positional
10 difference compensation effects (horizontal and vertical directions) of the filling nozzle according to the embodiment of the present invention, and FIG. 2(b) is a front view showing positional difference compensation effects (inclination direction) of the filling nozzle
15 according to the embodiment of the present invention; and

FIG. 3 is an explanatory diagram showing the entire configuration of a resin pellet filling system according to the embodiment of the present invention.

20 Best Mode for Carrying out the Invention

[0020]

An embodiment of the present invention will hereinafter be described with reference to the drawings.

[0021]

25 [Filling Nozzle]

First, a filling nozzle according to the embodiment of the present invention will be described with reference to FIG. 1 and FIG. 2.

(a) of FIG. 1 is a front view of the filling nozzle
30 according to the embodiment of the present invention, (b)

of FIG. 1 is a partly sectional front view showing an upper part of the filling nozzle according to the embodiment of the present invention, and (c) of FIG. 1 is a partly sectional front view showing a lower part of the filling nozzle according to the embodiment of the present invention. (a) of FIG. 2 is a front view showing positional difference compensation effects (horizontal and vertical directions) of the filling nozzle according to the embodiment of the present invention, and (b) of FIG. 2 is a front view showing positional difference compensation effects (inclination direction) of the filling nozzle according to the embodiment of the present invention.

[0022]

A filling nozzle 10 shown in FIG. 1 is used to fill resin pellets within a silo into a transport receptacle, and comprises an upper part 11 connected to a discharge outlet of the silo, and a lower part 12 connected to a filling inlet of the transport receptacle.

The upper part 11 has a double cylinder structure including an inner cylinder 13 and an outer cylinder 14, and when the upper end of the inner cylinder 13 is connected to the discharge outlet of the silo, the resin pellets discharged from the discharge outlet of the silo are guided into the lower part 12 along the inner periphery of the inner cylinder 13.

The outer cylinder 14 covers the outer periphery of the inner cylinder 13 via a predetermined space S. The top of the space S is covered/lidded by an inward flange formed at the upper end of the outer cylinder 14 or an outward flange formed in the inner cylinder 13, but the

bottom of the space S is open.

[0023]

The lower part 12 comprises a funnel-shaped movable cylinder 15 having a tilting step formed on its lower end side, and the lower end of this movable cylinder 15 is connected to the filling inlet of the transport receptacle during filling, such that the resin pellets discharged from the inner cylinder 13 are guided to the filling inlet of the transport receptacle through the funnel-shaped lower end of the movable cylinder 15. The movable cylinder 15 has a diameter larger than that of the inner cylinder 13 and smaller than that of the outer cylinder 14. The movable cylinder 15 is inserted from beneath into the space S between the inner cylinder 13 and the outer cylinder 14 so as to be capable of independent movements in a forward/backward direction, in a horizontal direction and in a vertical direction, that is, in directions of X, Y and Z axes, and a movement in an inclination direction. The movable cylinder 15 is supported by the upper part 11 via an elastic support mechanism such as a suspension holding mechanism achieved by a flexible chain 17.

[0024]

Thus, while the filling nozzle 10 is more easily downsized than a flexible hose, satisfactory positional difference compensation effects are achieved owing to the movements of the movable cylinder 15 in the forward/backward direction, horizontal direction, vertical direction and inclination direction as shown in FIG. 2, so that the filling nozzle 10 can be easily connected to the transport receptacle. For example, the inner cylinder 13

has an outside diameter dimension of 101.6 mm and an inside diameter dimension of 95 mm, the outer cylinder 14 has an outside diameter dimension of 400 mm and an inside diameter dimension of 394 mm, and the movable cylinder 15 has an outside diameter dimension of 250 mm and an inside diameter dimension of 244 mm, in which case it is possible to compensate positional differences of about ± 50 mm in the backward/forward and horizontal directions, ± 150 mm in the vertical direction and $\pm 5^\circ$ in the inclination direction even when the filling nozzle 10 has a linear dimension (height dimension) of about 2 m.

[0025]

Furthermore, according to the filling nozzle 10 having such a configuration, it is possible to use the space S formed between the upper part 11 and the lower part 12 to remove foreign substances from the resin pellets being filled. For example, if air discharged from the filling inlet of the transport receptacle in accordance with the filling amount of the resin pellets is discharged via the space S, the content of the foreign substances can be reduced as much as the foreign substances (such as fine resin powder and small resin fragments) contained in the discharged air.

When such air discharge is carried out, the upper part 11 is provided with an exhaust duct 16 which discharges the air inside the outer cylinder 14, and a suction unit is connected to the exhaust duct 16, and then the air containing the foreign substances is actively discharged from inside of the filling nozzle 10, thereby enabling more preferable effects of removing foreign

substances.

[0026]

[Resin Pellet Filling System]

5 Next, a resin pellet filling system according to the embodiment of the present invention will be described with reference to FIG. 3.

FIG. 3 is an explanatory diagram showing the entire configuration of the resin pellet filling system according to the embodiment of the present invention.

10 The resin pellet filling system shown in FIG. 3 is a system for filling resin pellets within a silo 20 into a transport receptacle 30, and comprises the filling nozzle 10 described above, a clean booth (clean room) 40 which stores the filling nozzle 10, a clean air blower (clean
15 air blowing means) 50 which blows clean air into the clean booth 40, and an exhaust unit (filling nozzle exhaust means) 60 which discharges air inside the outer cylinder 14 to the outside of the clean booth 40 via the exhaust duct 16 of the upper part 11.

20 [0027]

The silo 20 retains the resin pellets such as polycarbonate-based resin pellets with a low content of foreign substances, and discharges the resin pellets from a discharge outlet 21 formed at its lower end.

25 The transport receptacle 30 is a lorry or container which can be carried by a vehicle, and a lorry capable of tipping is used as the transport receptacle 30 in the present embodiment.

30 The transport receptacle 30 configured by the lorry is tipped during filling. The transport receptacle 30 has

a filling inlet 31 at the top of the front end side which is a tipping side, and this filling inlet 31 is covered with a dustproof cap 32. This dustproof cap 32 is removed before or after the tipping of the transport receptacle 30.

It is to be noted that there is a lorry which does not tip the transport receptacle during filling and achieves filling while keeping the transport receptacle in a horizontal state, in which case, in order to enhance filling efficiency, it is necessary to provide a plurality of filling inlets in the transport receptacle so that the filling is carried out more than one time, or to provide a plurality of filling nozzles so that the filling is carried out all at once. Therefore, this is not a desirable form because operations are complicated and there are more chances for the interfusion of extraneous objects every time the filling inlets are opened and closed and every time the filling nozzles are connected and detached.

[0028]

The clean booth 40 is provided on the upper floor of a space which stores the transport receptacle 30, for example, on the second floor of a building in which the resin pellet filling system is constructed. The filling nozzle 10 connected to the discharge outlet 21 of the silo 20 is suspended from and held by the ceiling of the clean booth 40, and a connection opening 41 for connecting the filling nozzle 10 to the filling inlet 31 of the transport receptacle 30 is formed in the floor of the clean booth 40.

The clean air blower 50 is configured by, for example, a fan unit provided on the ceiling of the clean booth 40, and outside air (clean air) filtered by a prefilter and an HEAP filter (capable of collecting 99.97% of suspended particulates of 0.3 μm or more) provided in the fan unit, more desirably, ULPA filter is blown from the ceiling into the clean booth 40.

The exhaust unit 60 is configured by use of, for example, a suction unit which sucks the air inside the outer cylinder 14 to the outside of the clean booth 40 via a clean pipe 61 connected to the exhaust duct 16.

[0029]

According to the resin pellet filling system having the configuration as described above, in filling the resin pellets within the silo 20 into the transport receptacle 30 via the filling nozzle 10, it is possible to keep the periphery of the filling nozzle 10 clean and prevent the interfusion of foreign substances into the filling nozzle 10 and into the transport receptacle 30. In addition, the air inside the outer cylinder 14 is discharged to the outside of the clean booth 40 via the exhaust duct 16 of the upper part 11, so that it is possible to actively remove the foreign substances contained in the resin pellets being filled, and to avoid a disadvantage that the air containing the foreign substances is discharged into the clean booth 40 and contaminates the inside of the clean booth 40.

[0030]

Furthermore, in the resin pellet filling system described above, it is preferable to provide a clean air

intake unit 70 which takes the clean air into the transport receptacle 30 via a clean air intake inlet 33 provided separately from the filling inlet 31. The clean air intake unit 70 comprises, for example, clean air supply means (not shown) such as a compressor unit or a blower equipped with a HEPA filter, a coupler 71 connectable to the clean air intake inlet 33, and a clean air intake line (pressure resistant PVC hose) 72 coupling the clean air supply means to the coupler 71.

When such a clean air intake unit 70 is provided, the clean air is taken into the transport receptacle 30 during the operation of opening and closing the filling inlet 31 and the operation of connecting the filling nozzle 10 to the filling inlet 31, such that the air is blown from the filling inlet 31, and the drop and interfusion of the foreign substances and the interfusion of outside air can be prevented.

Still further, when the clean air is taken into the transport receptacle 30 being filled, finely powdered foreign substances such as the fine resin powder and small resin fragments contained in the resin pellets can be actively discharged together with the air from the filling inlet 31, so that the content of the foreign substances in the resin pellets filled into the transport receptacle 30 can be further reduced.

[0031]

Further yet, the resin pellet filling system may also be provided with a sampling nozzle 80 and a clean air gun 90.

The sampling nozzle 80 samples the resin pellets

retained in the silo 20 before filled into the transport receptacle 30 in order to check its quality, and is coupled to the silo 20 via a pipe 81.

5 The clean air gun 90 blows off dust adhering to the peripheries of the filling inlet 31 and the dustproof cap 32 before the filling inlet 31 of the transport receptacle 30 is opened in order to clean the filling inlet 31 and the dustproof cap 32 and remove the dust, and is coupled to the clean air supply means (not shown) via a clean air
10 intake line (e.g., a pressure resistant PVC hose) 91.

[0032]

[Resin Pellet Filling Method]

Next, a resin pellet filling method according to the embodiment of the present invention will be described with
15 reference to FIG. 1 to FIG. 3.

The resin pellet filling method according to the embodiment of the present invention is a method of filling the resin pellets within the silo 20 into the transport receptacle 30, and the method comprises: using the resin
20 pellet filling system described above; bringing the discharge outlet 21 of the silo 20 into communication with the filling inlet 31 of the transport receptacle 30 via the filling nozzle 10; and filling the resin pellets within the silo 20 into the transport receptacle 30.

25 According to such a resin pellet filling method, positional differences of the transport receptacle 30 are compensated by the filling nozzle 10, such that the transport receptacle 30 is easily connected to the filling nozzle 10. Moreover, it is possible to use the space S
30 formed between the upper part 11 and the lower part 12 to

remove the finely powdered foreign substances such as the fine resin powder and small resin fragments from the resin pellets being filled.

[0033]

5 Furthermore, during the filling of the resin pellets,
 $(c) \leq (b) < (a)$

is preferably satisfied by a relation among an amount (a) m^3/min of the clean air blown into the clean booth 40, an amount (b) m^3/min of the air discharged from the inside of
 10 the outer cylinder 14 to the outside of the clean booth 40 via the exhaust duct 16 of upper part 11, and an amount (c) m^3/min of air discharged from resin pellets filling inlet 31 of the transport receptacle 30 in accordance with the filling amount of the resin pellets

15 Thus, it is possible to ensure that the air (the amount of air corresponding to the filling amount of the resin pellets) discharged from the filling inlet 31 of the transport receptacle 30 during filling is discharged. It is also possible to maintain a positive pressure in the
 20 clean booth 40 and prevent contamination due to the flow of the outside air from the connection opening 41 into the clean booth 40.

[0034]

Moreover, when the clean air is taken from the clean
 25 air intake inlet 33 into the transport receptacle 30 during the filling of the resin pellets,

$$(c) + (d) \leq (b) < (a)$$

is preferably satisfied by a relation among an amount (a) m^3/min of the clean air blown into the clean booth 40, an
 30 amount (b) m^3/min of the air discharged from the inside of

the outer cylinder 14 to the outside of the clean booth 40 via the exhaust duct 16 of the upper part 11, an amount (c) m^3/min of the air discharged from the filling inlet 31 of the transport receptacle 30 in accordance with the
5 filling amount of the resin pellets, and an amount (d) m^3/min of the clean air taken into the transport receptacle 30 via the clean air intake inlet 33.

Thus, it is possible to actively discharge the foreign substances contained in the resin pellets being
10 filled, from the filling inlet 31 by use of the clean air taken from the clean air intake inlet 33 into the transport receptacle 30. Moreover, it is possible to ensure that the air (the amount of air corresponding to the filling amount of the resin pellets and the clean air
15 taken into the transport receptacle 30) discharged from the filling inlet 31 of the transport receptacle 30 during filling is discharged. It is also possible to maintain a positive pressure in the clean booth 40 and prevent contamination due to the flow of the outside air from the
20 connection opening 41 into the clean booth 40.

[0035]

Next, a specific procedure of the resin pellet filling method will be described. It is to be noted that the resin pellets are filled while the clean air is being
25 taken into the transport receptacle 30 from the clean air intake inlet 33.

When the resin pellets within the silo 20 are filled into the transport receptacle 30, the vehicle loaded with the transport receptacle 30 is stopped at a predetermined
30 position of the first floor, and then the dustproof cap 32

of the transport receptacle 30 is removed and the transport receptacle 30 is tipped.

5 An operator on the second floor (the clean booth 40) removes dust adhering to the dustproof cap 32 and its periphery by use of the clean air gun 90, an alcohol, a clean wiper (dustproof type cloth), etc. On the other hand, an operator on the first floor connects the clean air intake unit 70 to the clean air intake inlet 33 of the transport receptacle 30, and starts the intake of the
10 clean air into the transport receptacle 30. After confirming the intake of the clean air into the transport receptacle 30, the operator on the second floor opens the dustproof cap 32 of the filling inlet 31. At this point, because the air is blown from the filling inlet 31, it is
15 possible to prevent the drop of the dust, the clean wiper, etc. into the receptacle even if the filling inlet 31 is directed upward and open.

[0036]

20 Next, the operator on the second floor moves the movable cylinder 15 of the filling nozzle 10, and aligns its lower end with the filling inlet 31 of the transport receptacle 30. At this point, the movable cylinder 15 moves in a predetermined amount in the forward/backward direction, horizontal direction, vertical direction and
25 inclination direction and achieves satisfactory positional difference compensation effects, so that it is possible to easily perform the operation of connecting to the filling inlet 31 of the transport receptacle 30.

30 After the filling nozzle 10 is connected to the filling inlet 31 of the transport receptacle 30, the resin

pellets are discharged from the silo 20, and the filling of the resin pellets into the transport receptacle 30 is started. Then, during filling, a state is maintained in which

$$(c)+(d)\leq(b)<(a)$$

is satisfied by a relation among an amount (a) m^3/min of the clean air blown into the clean booth 40, an amount (b) m^3/min of the air discharged from the inside of the outer cylinder 14 to the outside of the clean booth 40 via the exhaust duct 16 of the upper part 11, an amount (c) m^3/min of the air discharged from the filling inlet 31 of the transport receptacle 30 in accordance with the filling amount of the resin pellets, and an amount (d) m^3/min of the clean air taken into the transport receptacle 30 via the clean air intake inlet 33.

[0037]

That is, when the filling of the resin pellets is started, the air (c) corresponding to the filling amount of the resin pellets and the air (d) taken from the clean air intake inlet 33 are blown from the filling inlet 31 of the transport receptacle 30. However, when there is no air (b) discharged from the exhaust duct 16, the foreign substances such as the cut powder contained in the resin pellets leak out from the filling nozzle 10, and contaminate the inside of the clean booth 40. Therefore, the amount (b) of the discharged air is secured which is larger than the amounts (c)+(d) of the airs blown from the filling inlet 31 of the transport receptacle 30, thereby keeping the inside of the clean booth 40 clean.

Furthermore, if the amount (b) of the discharged air

is too large, the air (a) maintaining the cleanliness level (positively pressured state with respect to the outside atmospheric pressure) within the clean booth 40 is also sucked as the discharged air (b). Thus, the inside
5 of the clean booth 40 is brought to a negative pressure, and the outside air flows in from the connection opening 41 and contaminates the inside of the clean booth 40. Therefore, the clean air (a) more than the amount (b) of the discharged air is blown into the clean booth 40.

10 It is to be noted that if the clean air is taken into the transport receptacle 30 during filling, the amount of air blown from the filling inlet 31 increases, and the drop velocity of the resin pellets decreases due to the air resistance, so that the time required for the filling
15 becomes longer accordingly. However, if the amount of air blown from the filling inlet 31 increases, there are more chances that the foreign substances such as the cut powder contained in the resin pellets are discharged together with the air, so that it is possible to expect the effects
20 of further reducing the amount of the foreign substances contained in the resin pellets.

[0038]

In addition, it should be understood that the present invention is not limited to the embodiment described
25 above, and can be suitably modified within the scope defined in claims. For example, the lorry is used as the transport receptacle in the embodiment described above, but a container (with any shape such as a columnar or rectangular parallelepiped shape) may also be used.
30 Moreover, the filling may be carried out while the

transport receptacle is kept in a horizontal state without tipping the transport receptacle. However, when the resin pellets are filled from one place into the transport receptacle in the horizontal state, filling efficiency decreases due to the repose angle of the resin pellets, and it is therefore preferable to simultaneously or sequentially fill the resin pellets from a plurality of filling inlets (e.g., three to four filling inlets).

[0039]

Furthermore, the resin pellets to which the present invention is directed are not limited in material as long as it requires a low content of foreign substances. For example, the present invention can be applied to the filling of the polycarbonate-based resin pellets with a low content of foreign substances currently mass-produced for use in optical disks, cyclohexane-based resin pellets with a low content of foreign substances which have the potential of being used in next-generation optical disks, polyethylene-based resin pellets with a low content of foreign substances for use as a cover material of a high-voltage electric cable, etc.

Industrial Applicability

[0040]

The present invention can be applied to a filling nozzle, a resin pellet filling system and a resin pellet filling method for filling resin pellets within a silo into a transport receptacle such as a lorry or container. More particularly, the present invention can be suitably used to the filling of polycarbonate-based resin pellets

requiring a low content of foreign substances.

CLAIMS

1. A filling nozzle to fill resin pellets within a silo into a transport receptacle, the filling nozzle
5 characterized by comprising:

an upper part connected with a discharge outlet of the silo; and

a lower part connected with a filling inlet of the transport receptacle,

10 the upper part including:

an inner cylinder which guides, into the lower part, the resin pellets discharged from the discharge outlet of the silo; and

15 an outer cylinder covering the outer periphery of the inner cylinder,

the lower part including:

20 a movable cylinder which is inserted in a space between the inner cylinder and the outer cylinder so as to be allowed to move in a forward/backward direction, in a horizontal direction, in a vertical direction and in an inclination direction and which guides, to the filling inlet of the transport receptacle, the resin pellets discharged from the inner cylinder.

25 2. The filling nozzle according to claim 1, characterized in that

the upper part is equipped with:

an exhaust duct which discharges air from the outer cylinder to the outside.

3. A resin pellet filling system characterized by comprising:

a filling nozzle to fill resin pellets within a silo into a transport receptacle, the filling nozzle having an upper part connected with a discharge outlet of the silo, and a lower part connected with a filling inlet of the transport receptacle, the upper part including an inner cylinder which guides, into the lower part, the resin pellets discharged from the discharge outlet of the silo, and an outer cylinder covering the outer periphery of the inner cylinder, the lower part including a movable cylinder which is inserted in a space between the inner cylinder and the outer cylinder so as to be allowed to move in a forward/backward direction, in a horizontal direction, in a vertical direction and in an inclination direction and which guides, to the filling inlet of the transport receptacle, the resin pellets discharged from the inner cylinder;

a clean room which stores the filling nozzle;

a clean air blower which blows clean air into the clean room; and

an exhaust device which discharges air inside the outer cylinder to the outside of the clean room via the exhaust duct of the upper part.

4. The resin pellet filling system according to claim 3, characterized by comprising:

clean air intake mean for taking clean air into the transport receptacle via a clean air intake inlet provided separately from the filling inlet of the transport

receptacle.

5. A resin pellet filling method characterized by comprising:

5 using a resin pellet filling system, the resin pellet filling system being provided with:

10 a filling nozzle to fill resin pellets within a silo into a transport receptacle, the filling nozzle having an upper part connected with a discharge outlet of the silo, and a lower part connected with a filling inlet of the transport receptacle, the upper part including an inner cylinder which guides, into the lower part, the resin pellets discharged from the discharge outlet of the silo, and an outer cylinder covering the outer periphery of the inner cylinder, the lower part including a movable cylinder which is inserted in a space between the inner cylinder and the outer cylinder so as to be allowed to move in a forward/backward direction, in a horizontal direction, in a vertical direction and in an inclination direction and which guides, to the filling inlet of the transport receptacle, the resin pellets discharged from the inner cylinder;

a clean room which stores the filling nozzle;

25 a clean air blower which blows clean air into the clean room; and

an exhaust device which discharges air inside the outer cylinder to the outside of the clean room via the exhaust duct of the upper part, and

30 bringing the discharge outlet of the silo into communication with the filling inlet of the transport

receptacle via the filling nozzle and then filling the resin pellets from the silo into the transport receptacle.

6. The resin pellet filling method according to claim 5, characterized in that a relation among an amount (a) m^3/min of the clean air blown into the clean room,

an amount (a) m^3/min of the clean air blown into the clean room,

an amount (b) m^3/min of the air discharged from the inside of the outer cylinder to the outside of the clean room via the exhaust duct of upper part, and

an amount (c) m^3/min of air discharged from resin pellets filling inlet of the transport receptacle in accordance with the filling amount of the resin pellets satisfies

$$(c) \leq (b) < (a).$$

7. A resin pellet filling method comprising:

using a resin pellet filling system according to claim 4, characterized in that a relation among an amount (a) m^3/min of the clean air blown into the clean room,

an amount (b) m^3/min of the air discharged from the inside of the outer cylinder to the outside of the clean room via the exhaust duct of the upper part,

an amount (c) m^3/min of the air discharged from the filling inlet of the transport receptacle in accordance with the filling amount of the resin pellets, and

an amount (d) m^3/min of the clean air taken into the transport receptacle via the clean air intake inlet satisfies

$$(c) + (d) \leq (b) < (a) .$$