

DESCRIPTION

Title of Invention

PURGE DEVICE AND PURGE METHOD

5 Technical Field

[0001] The present invention relates to a purge apparatus and a purge method of purging the inside of a storage container in which a product is stored, with a purge gas, such as an inert gas or purified dry air.

Background Art

10 [0002] For example, a purge apparatus is known which keeps cleanliness by introducing a purge gas (purging) to the inside of a storage container in which a product, such as a semiconductor wafer or a glass substrate, is stored. In such a purge apparatus, the flow rate of the purge gas supplied to the storage container may be controlled.

15 However, a failure of a control circuit in the purge apparatus or a problem occurred in a supply channel of purge gas may prevent purge gas from being actually supplied into the storage container at a desired flow rate and may result in unsatisfactory purging. There is therefore a demand for determining whether purge gas is supplied into a storage

20 container at a desired flow rate (whether satisfactory purging is being performed).

Citation List

Patent Literature

[0003] [Patent Literature 1] Japanese Patent No. 4670808

25 Summary of Invention

Technical Problem

[0004] Patent Literature 1 (Japanese Patent No. 4670808) discloses a technique for measuring the flow rate of purge gas supplied to the inside of a storage container. With the measurement container described in Patent Literature 1, a dedicated flow rate-measuring unit is placed on the purge apparatus to measure the flow rate of the purge gas supplied from the purge apparatus, so that whether satisfactory purging is performed can be determined. However, it is sometimes desired that whether satisfactory purging is being performed should be determined during a process of actually supplying purge gas to a storage container to be purged.

[0005] It is therefore an object of the present invention to provide a purge apparatus and a purge method capable of determining whether satisfactory purge is being performed during a process of actually supplying purge gas to a storage container to be purged.

Solution to Problem

[0006] A purge apparatus according to an aspect of the present invention purges an inside of a storage container in which a product is stored, with a purge gas. The purge apparatus includes a discharge pipe configured to connect to a discharge port of the storage container to discharge the purge gas inside the storage container, a meter configured to measure an exhaust flow rate that is a flow rate of the purge gas flowing through the discharge pipe when the purging is carried out, and a determination unit configured to determine whether the purging is satisfactory, based on the exhaust flow rate measured by the meter.

[0007] In such a purge apparatus, the meter for measuring the flow rate of purge gas flowing through the discharge pipe is provided not in the

measuring unit placed on the purge apparatus but in the purge apparatus side. Thus, the exhaust flow rate can be measured when purge gas is supplied to the storage container in a state in which the storage container to be purged is actually placed on the purge apparatus, and whether purging is satisfactory can be determined based on the measured exhaust flow rate. Accordingly, whether satisfactory purging is being performed can be determined during a process of actually supplying purge gas to the storage container.

[0008] The inventors of the subject application have conducted elaborate studies to find that the exhaust efficiency is greatly affected by the hermeticity of the storage container. That is, when the flow rate of purge gas supplied to the storage container is greater than a predetermined flow rate (when the internal pressure of the storage container is greater than a predetermined pressure), the purge gas leaks from a portion other than the discharge port of the storage container (for example, between the cover and the body of the storage container) and the flow rate of exhaust discharged from the discharge pipe tends to be saturated. In other words, it has been found that the exhaust flow rate substantially proportional to the supply flow rate is obtained up to the predetermined flow rate at which purge gas leaks from a portion other than the discharge port of the storage container.

[0009] In an embodiment, the purge apparatus may further include a flow rate control unit configured to switch between a first mode in which the purging is carried out by supplying the purge gas to the storage container at a first flow rate and a second mode in which the purging is carried out by supplying the purge gas to the storage

container at a second flow rate. In this case, the meter may measure the exhaust flow rate in the first mode, and the determination unit may determine whether the purging is satisfactory, based on the exhaust flow rate measured in the first mode. Here, the first flow rate is a flow rate up to a predetermined flow rate, in the storage container in which the purge gas leaks from a portion other than the discharge port of the storage container when the flow rate of the purge gas supplied to the storage container is greater than the predetermined flow rate. The second flow rate is a flow rate greater than the first flow rate.

[0010] With such a purge apparatus, whether purging is being performed satisfactorily can be determined based on the supply flow rate that is the first flow rate at which the exhaust flow rate is proportional to the supply flow rate, and the exhaust flow rate obtained when the purging is being performed at the first flow rate. Thus, whether purging is being performed satisfactorily can be determined based on the supply flow rate and the exhaust flow rate proportional to each other, thereby enabling an accurate determination.

[0011] In an embodiment, the flow rate control unit may start the purging in the second mode and thereafter switch to the first mode. The meter may measure the exhaust flow rate in the first mode. The determination unit may determine whether the purging is satisfactory, based on the exhaust flow rate measured in the first mode.

[0012] Such a purge apparatus can initially supply purge gas to the storage container at a relatively large flow rate thereby to clean the inside of the storage container early. This can reduce the possibility that the product is contaminated.

[0013] A purge method according to an aspect of the present invention is a method of purging an inside of a storage container in which a product is stored, with a purge gas. The purge method includes: connecting a discharge pipe to a discharge port of the storage container, the discharge pipe being capable of discharging the purge gas inside the storage container; measuring an exhaust flow rate that is a flow rate of the purge gas flowing through the discharge pipe when the purging is carried out; and determining whether the purging is satisfactory, based on the measured exhaust flow rate.

[0014] With this purge method, whether satisfactory purging is being performed can be determined during a process of actually supplying purge gas to the storage container.

[0015] In an embodiment, an exhaust flow rate that is a flow rate of the purge gas flowing through the discharge pipe when the purging is carried out by supplying the purge gas to the storage container at a first flow rate may be measured. Whether the purging is satisfactory may be determined based on the measured exhaust flow rate. Here, the first flow rate is a flow rate up to a predetermined flow rate, in the storage container in which the purge gas leaks from a portion other than the discharge port of the storage container when the flow rate of the purge gas supplied to the storage container is greater than the predetermined flow rate. A second flow rate is a flow rate greater than the first flow rate.

[0016] With this purge method, whether the purging is being performed satisfactorily can be determined based on the supply flow rate that is the first flow rate at which the exhaust flow rate is proportional to the

supply flow rate, and the exhaust flow rate obtained when the purging is being performed at the first flow rate. Thus, whether the purging is being performed satisfactorily can be determined based on the supply flow rate and the exhaust flow rate proportional to each other, thereby enabling an accurate determination.

Advantageous Effects of Invention

[0017] According to the present invention, whether satisfactory purging is being performed can be determined during a process of actually supplying purge gas to a storage container.

Brief Description of Drawings

[0018] [FIG. 1] FIG. 1 is a front view showing a purge stocker including a purge apparatus according to an embodiment.

[FIG. 2] FIG. 2 is a cross-sectional view of the purge stocker in FIG. 1 as viewed from the line II-II.

[FIG. 3] FIG. 3(A) is a cross sectional view showing a configuration of a storage container to be purged by the purge apparatus in FIG. 1. FIG. 3(B) is a perspective view showing a configuration of a storage container to be purged by the purge apparatus in FIG. 1.

[FIG. 4] FIG. 4 is a schematic configuration diagram showing a configuration of the purge apparatus in FIG. 1.

[FIG. 5] FIG. 5 is a timing chart showing mode switching in a flow rate control unit in FIG. 4.

[FIG. 6] FIG. 6 is a graph showing the relation between a supply flow rate and an exhaust flow rate in a state in which a discharge pipe is connected to a discharge port of the storage container.

[FIG. 7] FIG. 7(A) and FIG. 7(B) are timing charts showing

mode switching in the flow rate control unit according to modifications.

Description of Embodiments

[0019] An embodiment will be described below with reference to the drawings. In a description of the drawings, the same elements are denoted with the same reference signs, and an overlapping description will be omitted. The scale in the drawings is not always the same.

[0020] A purge apparatus 30 according to an embodiment will be described. The purge apparatus 30 is an apparatus for purging the inside of a storage container 50, such as a front opening unified pod (FOUP), in which a product, such as a semiconductor wafer or a glass substrate, is stored, with a purge gas. Examples of the purge gas as used herein include inert gases and purified dry air. The purge apparatus 30 is disposed, for example, in a purge stocker 1 for keeping a storage container 50 in which a product is stored. As shown in FIG. 1 and FIG. 2, the purge stocker 1 is provided in, for example, a clean room 100.

[0021] The purge stocker 1 provided in such a clean room 100 includes a partition 3, fan filter units (FFUs) 5, racks 7, a crane 9, an exhaust port 15A, an overhead hoist transfer (OHT) port 21, and a manual port 23.

[0022] The partition 3 is a part that partitions (defines) a region above a floor 100A, and a storage area 1A is formed inside the partition 3. A plurality of FFUs 5 are provided along a predetermined direction on the ceiling of a space separated by the partition 3, that is, above the storage area 1A. The FFUs 5 suck the purified air from the outside of the storage area 1A to the inside of the storage area 1A to blow the purified air downward of the storage area 1A. The exhaust port 15A is a part

provided near the bottom of the storage area 1A to discharge gas including purge gas from the inside of the storage area 1A to the outside of the storage area 1A. The gas including purge gas is discharged from the storage area 1A by the exhaust fan 15.

5 [0023] The racks 7 are parts for keeping storage containers 50 and are provided in multiple rows (here, two rows) in the inside of the storage area 1A. Each rack 7 extends in a predetermined direction X, and the two rows of racks 7, 7 are disposed to be opposed to each other in the depth direction Y. Each rack 7 has a plurality of storage shelves 7A on
10 which storage containers 50 are placed and kept, along the predetermined direction X and the vertical direction Z.

[0024] The crane 9 is a part for loading and unloading storage containers 50 into/from the storage shelves 7A and is disposed in a region sandwiched between the racks 7 and 7 opposed to each other.
15 The crane 9 can run on a transport rail (not shown) disposed on the floor along the direction X in which the racks 7 extend, to move along the direction X in which the racks 7 extend. The crane 9 has a stage 9A that can be lifted and lowered along a guide rail 9B so that storage containers 50 can be loaded into and unloaded from a plurality of
20 storage shelves 7A provided in the vertical direction.

[0025] A storage container 50 is loaded into and unloaded from the purge stocker 1 through the OHT port 21 and the manual port 23. The OHT port 21 is a part for delivering a storage container 50 between the purge stocker 1 and a ceiling vehicle (OHT) 27 running on a transport
25 rail 25 laid on the ceiling 100B and has a conveyor 21A for transferring a storage container 50. The manual port 23 is a part for delivering a

storage container 50 between the operator and the purge stocker 1 and has a conveyor 23A for transferring a storage container 50.

[0026] The storage shelf 7A of the rack 7 is provided with a purge apparatus 30 for purging the inside of the storage container 50 placed thereon with a purge gas (for example, nitrogen gas). The purge apparatus 30 is an apparatus for supplying and discharging a purge gas into the storage container 50 placed on the storage shelf 7A.

[0027] The storage container 50 will now be described. As shown in FIG. 3(A) and FIG. 3(B), the storage container 50 includes a body 51 and a cover 53 to form a casing. The storage container 50 has a sealed space 54 formed with the body 51 and the cover 53. The sealed space 54 accommodates a plurality of semiconductor wafers (not shown).

[0028] The lower surface of the bottom 52 that is the bottom surface of the body 51 has discharge ports 56 near the right and left ends of the front end, and supply ports 55 at the right and left ends of the rear end, where the side on which the cover 53 is disposed is the front. The supply ports 55 each include a connection portion 52A and a communication portion 52C. The discharge ports 56 each include a connection portion 52B and a communication portion 52D. In this example, the connection portion 52A is configured to be connectable to the supply pipe 31 of the purge apparatus 30 described in details later. The connection portion 52B is configured to be connectable to the discharge pipe 33 of the purge apparatus 30. The connection portions 52A, 52B have the communication portions 52C, 52D, respectively, having diameters equivalent to the inner diameters of the supply pipe 31 and discharge pipe 33. The communication portions 52C, 52D are

holes that communicate the sealed space 54 with the outside of the storage container 50.

[0029] The cover 53 is disposed at one face that is a side surface of the body 51. The cover 53 is provided with, for example, a latch mechanism 58. The latch mechanism 58 has a latch 58A and a cam 58B. The latch 58A is configured such that an end of the latch 58A on the side opposite to the cam 58B is put in and out by inserting a key (not shown) into an insertion hole 58C provided at the cam 58B and turning the key. This end of the latch 58A is then fitted into a fitting groove 51A provided in the body 51 on the surface facing the latch 58A, whereby the cover 53 is fixed to the body 51.

[0030] The purge apparatus 30 will now be described, which purges the inside of the storage container 50 as described above with a purge gas (for example, nitrogen gas). FIG. 4 is a schematic configuration diagram showing a configuration of the purge apparatus 30. As shown in FIG. 4, the purge apparatus 30 includes a supply pipe 31, a mass flow controller (MFC) 35, a purge gas source 37, a discharge pipe 33, a flowmeter (meter) 39, and a controller 40.

[0031] The front end of the supply pipe 31 has a nozzle configured to connect to the supply port 55 of the storage container to supply a purge gas to the storage container 50. In the present embodiment, the supply pipe 31 is brought into intimate contact with the connection portion 52A to be connected to the communication portion 52C. The MFC 35 is equipment that measures the mass flow rate of the purge gas flowing through the supply pipe 31 and performs flow rate control. The purge gas source 37 is a tank for storing a purge gas.

[0032] The front end of the discharge pipe 33 has a nozzle configured to connect to the discharge port 56 of the storage container 50 to suck the purge gas in the inside 54 of the storage container 50 and discharge the purge gas in the inside 54 of the storage container 50. In the present embodiment, the discharge pipe 33 is brought into intimate contact with the connection portion 52B to be connected to the communication portion 52D. The flowmeter 39 is equipment that measures the flow rate of the purge gas flowing through the discharge pipe 33.

[0033] The controller 40 is a part that controls a variety of purging in the purge apparatus 30 and is, for example, an electronic control unit including a central processing unit (CPU), a read only memory (ROM), and a random access memory (RAM). As shown in FIG. 4, the controller 40 has a flow rate control unit 41 and a determination unit 43 serving as conceptual units that execute a variety of control processes in the purge apparatus 30. The functions executed by such conceptual units are executed under the control of the CPU or the like.

[0034] The flow rate control unit 41 is a unit that switches between a first mode in which purging is carried out by supplying purge gas to the storage container 50 at a first flow rate and a second mode in which purging is carried out by supplying purge gas to the storage container 50 at a second flow rate. Here, the "first flow rate" refers to a flow rate up to a predetermined flow rate, in the storage container 50 in which purge gas leaks from a portion other than the discharge port of the storage container 50 (for example, as shown in FIG. 3(A) and FIG. 3(B), the portion between the body 51 and the cover 53) when the flow rate of the

purge gas supplied to the storage container 50 is greater than the predetermined flow rate. The "second flow rate" refers to the flow rate greater than the first flow rate.

[0035] The determination unit 43 is a unit that determines whether purging is satisfactory, based on the exhaust flow rate measured by the flowmeter 39. Specifically, the determination unit 43 determines whether purging is satisfactory, based on a supply flow rate F_s by the MFC 35 when controlled with the first flow rate (the first mode) by the flow rate control unit 41, and an exhaust flow rate F_e measured by the flowmeter 39 disposed at the discharge pipe 33. For example, when the exhaust flow rate F_e is smaller than the supply flow rate F_s by a predetermined amount or more, it can be determined that purging is not being performed satisfactorily.

[0036] The determination unit 43 may determine whether purging is satisfactory, considering the flow rate transfer ratios in the not-shown nozzle for injecting purge gas from the front end of the supply pipe 31 to the storage container 50 and the not-shown nozzle for injecting purge gas from the storage container 50 to the discharge pipe 33. For example, when the flow rate transfer ratio of the nozzle for injecting purge gas to the storage container 50 in the supply pipe 31 is defined as A, and the flow rate transfer ratio of the nozzle for injecting purge gas to the discharge pipe 33 in the storage container 50 is defined as B, if the exhaust flow rate F_e is smaller than a value obtained by multiplying the supply flow rate F_s by A and B ($F_s \times A \times B$), by a predetermined amount or more, it may be determined that purging is not being performed satisfactorily.

[0037] The flow rate transfer ratios A and B can be set as appropriate according to the characteristics of the nozzles. If the nozzles are made of metal, a value of 0.70 to 0.95 may be set as the flow rate transfer ratios A and B. If the nozzles are elastic, a value of 0.90 to 1.00 may be set as the flow rate transfer ratios A and B.

[0038] The operation of purging in the foregoing purge apparatus 30 will now be described. When placement of the storage container 50 on the purge apparatus 30 is detected (or the user inputs a purging instruction), the flow rate control unit 41 starts supply of a purge gas to the storage container 50 (purging). As shown in FIG. 5, the flow rate control unit 41 starts a mode of supplying purge gas at a flow rate f2 that is the second flow rate (the second mode) and continues the second mode until time t1.

[0039] The flow rate control unit 41 thereafter switches to a mode of supplying purge gas at a flow rate f1 that is the first flow rate (the first mode) in order to determine whether the purging is satisfactory, and continues the first mode until time t2. The determination unit 43 determines whether the purging is satisfactory by the method as illustrated above at this time (the first mode). The flow rate control unit 41 thereafter switches again to the mode of supplying purge gas at the flow rate f2 that is the second flow rate (the second mode), and continues the mode for a predetermined time or until the storage container 50 is moved from the storage shelf 7A.

[0040] The result of the determination by the determination unit 43 as to whether the purging is satisfactory may be indicated to the operator, for example, by display appearing on a not-shown display (not shown)

of the purge apparatus 30, by producing warning sound, or by transmitting information of the result to another terminal.

[0041] In the purge apparatus 30 configured as described above, the flowmeter 39 for measuring the flow rate of the purge gas flowing through the discharge pipe 33 is provided not in the measuring unit placed on the purge apparatus 30 but in the purge apparatus 30. Thus, the exhaust flow rate can be measured when purge gas is supplied to the storage container 50 in a state in which the storage container 50 to be purged is actually placed on the purge apparatus 30, and whether purging is satisfactory can be determined based on the measured exhaust flow rate. Accordingly, whether satisfactory purging is being performed can be determined during a process of actually supplying purge gas to the storage container 50.

[0042] The inventors of the subject application have conducted elaborate studies to find that the exhaust efficiency is greatly affected by the hermeticity of the storage container 50. That is, as shown in FIG. 6, when the flow rate of purge gas supplied to the storage container 50 is greater than a predetermined flow rate $F1$ (when the internal pressure of the storage container 50 is greater than a predetermined pressure $P1$), the purge gas leaks from between the cover 53 and the body 51 of the storage container 50 and the flow rate of exhaust discharged from the discharge pipe 33 tends to be saturated. In other words, it has been found that the exhaust flow rate substantially proportional to the supply flow rate is obtained up to the predetermined flow rate $F1$ (0 to $F1$) at which purge gas leaks from between the cover 53 and the body 51 of the storage container 50.

[0043] The purge apparatus 30 configured as described above is switchable between the first mode in which purging is carried out by supplying purge gas to the storage container 50 at a first flow rate f_1 and the second mode in which purging is carried out by supplying purge gas to the storage container 50 at a second flow rate f_2 , where the first flow rate f_1 is a supply flow rate up to a predetermined flow rate F_1 , in the storage container 50 in which purge gas leaks from between the cover 53 and the body 51 of the storage container 50 when the flow rate of the purge gas supplied to the storage container 50 is greater than the predetermined flow rate F_1 , as shown in FIG. 6, and the second flow rate f_2 is a flow rate greater than the first flow rate. The purge apparatus 30 then measures the exhaust flow rate in the first mode and determines whether purging is satisfactory based on the exhaust flow rate measured in the first mode.

[0044] This purge apparatus 30 determines whether purging is satisfactory, based on the supply flow rate that is the first flow rate f_1 at which the exhaust flow rate is substantially proportional to the supply flow rate, and the exhaust flow rate obtained when purging is performed at the first flow rate f_1 . Thus, whether purging is satisfactory can be determined based on the supply flow rate and the exhaust flow rate substantially proportional to each other, thereby enabling an accurate determination.

[0045] The purge apparatus 30 configured as described above starts purging in the second mode, thereafter switches to the first mode, measures the exhaust flow rate in the first mode, and determines whether purging is satisfactory, based on the exhaust flow rate measured

in the first mode. Thus, purge gas is initially supplied to the storage container 50 at a relatively large flow rate, so that the inside of the storage container 50 can be cleaned early. This can reduce the possibility that the product is contaminated.

5 [0046] Although an embodiment of the present invention has been described above, the present invention is not limited to the foregoing embodiment and susceptible to various modifications without departing from the scope of the invention.

[0047] First Modification

10 In the purge stocker 1 in the foregoing embodiment, the first mode and the second mode are switched at the timings illustrated in FIG. 5. However, the present invention is not limited to this embodiment. For example, as shown in FIG. 7(A), the purge apparatus 30 may start purging in the first mode, determine whether purging is
15 satisfactory based on the exhaust flow rate measured in the first mode, and then switch to the second mode to continue the purging. In this case, whether purging is satisfactory can be determined at an early stage in the purging, so that if a problem arises, measures can be taken early.

[0048] Second Modification

20 As shown in FIG. 7(B), the purge apparatus 30 may start purging in the second mode, switch to the first mode at the last stage in which the purging is terminated, determine whether the purging is satisfactory based on the exhaust flow rate measured in the first mode, and terminate
25 the purging as it is. In this case, purge gas is initially supplied to the storage container 50 at a relatively large flow rate, so that the inside of the storage container 50 can be cleaned early. This control is effective

when whether purging has been performed satisfactorily is confirmed at any timing.

[0049] Other Modifications

In the foregoing embodiment, the purge apparatus 30 disposed in the purge stocker 1 has been illustrated. However, the present invention is not limited to this embodiment. The present invention is not limited to a purge apparatus disposed in a space defined by the partition 3 or the like, and the purge apparatus in the foregoing embodiment and modifications is applicable to, for example, a relay point between ceiling vehicles, a delivery point (load port) from a conveyor to a ceiling vehicle, and a ceiling buffer.

Reference Signs List

[0050] 1 ... purge stocker, 1A ... storage area, 3 ... partition, 7 ... rack, 7A ... storage shelf, 21 ... OHT port, 23 ... manual port, 30 ... purge apparatus, 31 ... supply pipe, 33 ... discharge pipe, 37 ... purge gas source, 39 ... flowmeter (meter), 40 ... controller, 41 ... flow rate control unit, 43 ... determination unit, 50 ... storage container, 51 ... body, 52 ... bottom, 53 ... cover, 54 ... sealed space, 55 ... supply port, 56 ... discharge port, 100 ... clean room.

CLAIMS

1. A purge apparatus for purging an inside of a storage container in which a product is stored, with a purge gas, the purge apparatus comprising:

a discharge pipe configured to connect to a discharge port of the storage container to discharge the purge gas inside the storage container;

a meter configured to measure an exhaust flow rate that is a flow rate of the purge gas flowing through the discharge pipe when the purging is carried out; and

a determination unit configured to determine whether the purging is satisfactory, based on the exhaust flow rate measured by the meter; and

a flow rate control unit configured to switch between a first mode in which the purging is carried out by supplying the purge gas to the storage container at a first flow rate and a second mode in which the purging is carried out by supplying the purge gas to the storage container at a second flow rate, the first flow rate being a flow rate up to a predetermined flow rate, in the storage container in which the purge gas leaks from a portion other than the discharge port of the storage container when the flow rate of the purge gas supplied to the storage container is greater than the predetermined flow rate, the second flow rate being a flow rate greater than the first flow rate,

wherein the meter measures the exhaust flow rate in the first mode, and

the determination unit determines whether the purging is satisfactory,

based on the exhaust flow rate measured in the first mode.

2. The purge apparatus according to claim 1, wherein the flow rate control unit starts the purging in the second mode, switches to the first mode to perform the purging to determine whether the purging is satisfactory, and performs again the purging in the second mode.

3. A purge method of purging an inside of a storage container in which a product is stored, with a purge gas, the purge method comprising:

connecting a discharge pipe to a discharge port of the storage container, the discharge pipe being capable of discharging the purge gas inside the storage container, the first flow rate being a flow rate up to a predetermined flow rate, in the storage container in which the purge gas leaks from a portion other than the discharge port of the storage container when the flow rate of the purge gas supplied to the storage container is greater than the predetermined flow rate, the second flow rate being a flow rate greater than the first flow rate;

measuring an exhaust flow rate that is a flow rate of the purge gas flowing through the discharge pipe when the purging is carried out by supplying the purge gas to the storage container at a first flow rate; and

determining whether the purging is satisfactory, based on the measured exhaust flow rate.