Title: PURGE SYSTEM FOR GAS SUPPLY EQUIPMENT CAPABLE OF HIGH-TEMPERATURE HIGH-PRESSURE PURGING

Abstract: The purge system for gas supply equipment capable of high-temperature and/or high-pressure purging according to this invention: at least one purge valve controls the supply of the purge gas; a cylinder filled with said reaction gas; at least one vent valve that is connected to said cylinder and to said at least one purge valve so as to vent said reaction gas and said purge gas; and at least one vent control valve optionally purging at atmospheric or vacuum pressure the system may comprise a heater for said purge gas.
TITLE OF THE INVENTION:

Purge System for Gas Supply Equipment Capable of High-Temperature
High-Pressure Purging

CROSS-REFERENCE TO RELATED APPLICATIONS


BACKGROUND OF THE INVENTION

[0002] This invention relates to a purge system for gas supply equipment capable of purging a gas supply line that supplies gas to semiconductor manufacturing equipment, and more particularly, to a purge system for gas supply equipment capable of high-temperature and/or high-pressure purging that enables the reduction of corrosion and removal of line impurities in corrosive gas supply equipment by optionally using a high-temperature and/or high-pressure and/or low-pressure purge gas.

[0003] Semiconductor wafer production processes mainly comprise CVD (Chemical Vapor Deposition), photographic and etching processes. In order to perform such a process, a strongly corrosive liquefied reaction gas such as Cl₂ or HCl must be injected into the process chamber. This reaction gas is stored in a container that typically is a cylinder, and the reaction gas charged into the cylinder by the operation of the valve is always either supplied to the process chamber at a fixed pressure or blocked from the process chamber.

[0004] When the amount of the reaction gas filled in the cylinder falls below a certain quantity, due to continuous use of the reaction gas filled in the cylinder, then reaction gas at the pressure required for the semiconductor wafer manufacturing process may no longer be supplied, so that it is necessary to swap in a new cylinder to supply reaction gas at the required pressure.

[0005] A pair of cylinders is typically installed in the gas supply equipment to which the reaction gas is supplied; when the gas filled into one cylinder has been depleted (or the pressure of the reaction gas is lowered), the valve is controlled so as to use the reaction gas filled in the other cylinder, and then the cylinder in which the reaction gas has been depleted is replaced with a reaction gas filled cylinder.
[0006] In the cylinder replacement operation, the reaction gas remaining in the gas supply line has a fatal adverse effect on the human body and the environment; because there is a possibility that an explosion accident may occur during cylinder replacement, due to the residual reaction gas; a purging process must be performed for discharging the reaction gas present in the process gas lines in the gas cabinet to the atmosphere.

[0007] The gas supply equipment purge method of the prior art will be described with reference to FIG. 1.

[0008] The lines connected from the pair of cylinders 100, 200 have the same configuration. Further, when one of a pair of cylinders 100, 200 is in use, the other cylinder is not used. Accordingly, in the description below, one cylinder (for example, 100) will be described for the sake of convenience, and it will be understood that the other cylinder 200 is also configured and operated in the same manner as the first cylinder 100.

[0009] A cylinder 100 filled with a reaction gas such as Cl₂ or HCl is installed, and a scale WTA is installed below the cylinder 100 for measuring the load of the cylinder 100. The open or closed state of the cylinder 100 is controlled by a valve shutter VSA.

[0010] A pair of process valves AV2A, AV3A, a pressure regulator REGA installed between these valves AV2A, AV3A adjust the pressure of the reaction gas discharged from the cylinder 100 so that the reaction gas is supplied to a process chamber (not shown) at a specified pressure that is required for the process.

[0011] A plurality of purge valves AV1A, AV7, AV9 are installed in the purge gas supply line so as to supply purge gas N₂ when the gas supply line is purged in order to replace the cylinder 100. Between the respective purge valves AV1A, AV7, AV9, backflow prevention valves CV1, CV2A are installed for preventing backflow of purge gas and reaction gas.

[0012] The vent valves AV4A, AV5A which are interlocked with the process valves AV2A, AV3A are installed so as to vent the reaction gas and purge gas, or to allow the process gas to flow to the process chamber (not shown). When the vent valves AV4A, AV5A are in the open state, the process valves AV2A, AV3A are closed, and when the vent valves AV4A, AV5A are in a closed state, the process valves AV2A, AV3A are opened.
[0013] At the rear end of the vent valves AV4A, AV5A, a vacuum generator VG is installed that evacuates the gas supply line; the vacuum generator VG, shown as a venturi vacuum generator, is installed between the vacuum gas (N₂) supply line and the vent apparatus. In addition, a vacuum valve AV8 is installed between the vacuum gas supply line and the vacuum generator VG, so as to control whether there is a vacuum in the gas supply line.

[0014] A certain number of pressure meters PT1A - PT4 are installed in the gas supply line; the pressure meters PT1 - PT4 measure the pressure of the gas supply line and display the result of that measurement. A certain number of line filters LF1A, LF2 are installed in the reaction gas supply line. A manual valve MV1A is installed between the process valve AV3 and the process chamber, ultimately controlling the supply of the reaction gas to the process chamber.

[0015] One of the purge valves AV1A, AV7, AV9 (for example, AV9) is configured as a trickle valve, so as to prevent inflow of air via the gas supply line on the side of the cylinder 100 during replacement of the cylinder 100.

[0016] The valve AV8 (shown in FIG. 1) installed between the vacuum gas supply line and the vacuum generator VG is configured as a bleed valve, so as to prevent corrosion of the vacuum generator VG by small quantities of reaction gas or purge gas vented from the vent valves AV4A, AV5A.

[0017] Gas supply equipment of the prior art keeps the purge valves AV1A, AV7, AV9 closed during process operations, and the vacuum valve AV8 is also closed. In addition, the vent valves AV4A, AV5A are kept closed and the process valves AV2A, AV3A are kept open, so that the reaction gas supplied from the cylinder 100 is supplied to the process chamber via the process valve AV2A, the pressure regulator REGA, the process valve AV3A, and the manual valve MV1A.

[0018] When the gas supply line is purged in order to replace the cylinder 100, the process valves AV2A, AV3A are closed, the vent valves AV4A, AV5A are opened, and the vacuum valve AV8 is opened.

[0019] When the vacuum valve AV8 is opened, the vacuum creating gas is supplied to the vacuum generator VG via the vacuum valve AV8, and the vacuum generator VG is operated to put the gas supply line in a vacuum state so that the vent valves AV4A, AV5A discharge the residual reaction gas from the gas supply line to the vent apparatus.
[0020] When the residual reaction gas is discharged so that the vacuum state is maintained, purge gas is supplied by opening all the purge valves AV1A, AV7, AV9, and as the purge gas fills the gas supply line, the remaining reaction gas (the reaction gas converted to a liquid phase while reacting with the valve and pressure regulator, etc.) is vented by the pressure of the purge gas. The gas supply line is purged by alternating the opening and closing the purge valves AV1A, AV7, AV9, to fill the gas supply lines with purge gas and then opening and closing the vacuum gas valves to put the gas supply lines under vacuum and repeating this process several times (for example, at least 300 times) to remove the residual gas from the gas supply lines.

[0021] However, according to the purge method of prior art gas supply equipment, fusion of reaction gas to the valves occurs due to the repeated opening and closing of the valves that are in direct contact with the reaction gas during the vent process, i.e., the purge valve AV1A, the vent valves AV4A, AV5A. In this case, the valves are corroded due to strongly corrosive reaction gases of the chlorine series (Cl₂, HCl, etc.), shortening the service life of the valve; the pressure regulator REGA, which is also in direct contact with the reaction gas, also has a shortened life.

[0022] To prevent reaction gas that remains during the vent process from contacting the vacuum generator VG and thereby corroding the vacuum generator VG, a trickle valve was installed between the vacuum gas supply line and the vacuum generator VG; as a result, even when the valve is closed, a certain quantity of vacuum gas must always be discharged through the vent system; consequently, vacuum gas loss occurs.

[0023] To solve this problem, in “Purge system and method for gas supply equipment” (Korean Registered Patent No. 10-0863941, Patent Reference 1) shown in FIG. 2, a purge system and method for gas supply equipment are disclosed in which vacuum valves AV11, AV10 are installed between the vacuum gas supply line and vacuum generator VG and on the vacuum gas supply line, so that the valves that directly contact the reaction gas during the gas supply line purge operation are opened 1 time, and the opening/closure of the valves not directly contacting the reaction gas is controlled so that the purge operation is performed in such a way as to extend the service life of the valves.

[0024] However, even if a vacuum valve is installed in the vacuum gas supply line as in Patent Reference 1, there have been problems of frequent parts failure due to corrosion
of the gas cabinet to which gas is supplied and increasing maintenance and repair costs and risk of gas supply shutoff.

[0025] In particular, purge gas is typically supplied with low-pressure nitrogen gas; in this case, there has also been the fundamental problem that impurities are generated and corrosion occurs in the gas supply line.


BRIEF SUMMARY OF THE INVENTION

[0027] The purge system for gas supply equipment capable of high-temperature and/or high-pressure purging according to this invention has been devised to address these problems that occur in the prior art; the occurrence of corrosion may be reduced and impurities may be readily removed through a high-pressure gas by enabling purging optionally using either low-pressure gas or high-pressure gas, by adding a line that supplies high-pressure purge gas to a line that supplies low-pressure purge gas.

[0028] Further, because a heater that heats the purge gas is installed on the purge line, not only is it possible to facilitate the removal of impurities attached to the gas piping and valves by purging with simple high-pressure gas, but in addition it is possible to provide high-temperature high or low pressure purge gas also.

[0029] In addition, because an atmospheric pressure vent and/or a vacuum generator is installed near the vent, (exit end) of the purge line that is the vent-end line, it is sought to enable selective atmospheric-pressure and vacuum purging, so as to maximize the purge effect.

[0030] In order to solve the above problems, the purge system for gas supply equipment capable of high-temperature and/or high-pressure and/or low pressure purging according to this invention comprises; at least one or a plurality of purge valves that control the supply of the purge gas; a cylinder filled with said reaction gas; at least one vent valve that is connected to said cylinder and to said plurality of purge valves so as to vent said reaction gas and said purge gas; and at least one vent control valve that is installed between said vent valve and a vacuum generator or other vacuum source or atmospheric pressure vent and controls the venting of said reaction gas and said purge gas; characterized in that the purge line that supplies said purge gas may be configured as a low-pressure purge line with one end connected to a purge gas supply line and the
other end supplying low-pressure purge gas; and a high-pressure purge line wherein one end is connected to a purge gas supply line and the other end is supplied with high-pressure purge gas; and wherein a backflow prevention valve and purge valve are respectively installed on said low-pressure purge line and high-pressure purge line.

Additionally, the system may further comprise a vacuum valve that is fluidly connected to said vacuum generator, wherein said vacuum generator is installed between the vacuum valve and a vent opening, wherein said vacuum generator creates a vacuum state in said gas supply line by means of a vacuum gas that is supplied via said vacuum valve. Alternatively, the system may further comprise an alternative vacuum source, such as a house vacuum supply and a vacuum transmitter fluidly connected to said at least one vent control valve. Additionally, the system may further comprise an atmospheric vent connected to said system via said at least one vent control valves. Alternatively, the purge system may comprise only a high-pressure purge gas supply source.

[0031] In any embodiment of this invention, a heater that heats the supplied purge gas may be installed on said purge line.

[0032] More specifically or alternatively, a heater 105 may be installed on a purge gas supply line downstream of where the low-pressure purge supply line 300 and high-pressure purge supply line 400 are combined into a purge gas supply line 500.

[0033] Alternatively, a heater may be installed on the low-pressure purge line 300.

[0034] Alternatively or additionally, a heater (not shown) may be installed on the high-pressure purge line 400.

[0035] In addition, a vacuum generator or connection to any vacuum source may be installed at the vent end of said purge line (downstream of the portions of the reaction gas supply line 600A to be purged that is downstream of the vent valves AV4A and AV5A), and purging may be performed that optionally uses a high-pressure purge gas that may be vented to a vacuum and/or to an atmospheric vent.

[0036] Alternatively, this invention provides a purge system for gas supply equipment, comprising a cylinder filled with a reaction gas, fluidly connected to a reaction gas supply line, of which at least a portion of said reaction gas supply line is to be purged by said purge system; a vent-end line and a purge gas supply line each fluidly connected to said portion of said reaction gas supply line so that a purge gas supplied by said purge gas supply line flows through said portion of said reaction gas supply line through said vent-
end line and to a vent so as to vent said reaction gas and said purge gas from said gas supply equipment; at least one purge valve that controls the supply of purge gas to said purge gas line; at least one vent valve in said portion of said reaction gas supply line that fluidly connects said cylinder to said vent-end line; said vent-end line fluidly connected to at least one vent; wherein a high-pressure purge gas supply line 400 fluidly connects to said purge gas supply line 500 for supplying high pressure purge gas, a backflow prevention valve and purge valve are respectively installed on said high-pressure purge gas supply line 400, and said vent-end line is connected to an atmospheric pressure process vent for venting said high-pressure purge gas. In another aspect of this invention, alone or with other aspects the invention further comprises a low-pressure purge gas supply 300 fluidly connected to said purge gas supply line 500 for supplying low pressure purge gas to said purge gas supply line. In another aspect of the invention, alone or with other aspects, the invention further comprises a heater for said high pressure purge gas for supplying heated high pressure purge gas to said purge gas supply line and/or a heater for said low pressure purge gas for supplying heated low pressure purge gas to said purge gas supply line and/or a heater located in or on said gas supply line 500. The heater may be located in or on said gas supply line 500 the high pressure gas supply line 400 or in or on said low pressure gas supply line 300. In another aspect alone or with other aspects of the invention, the invention further comprises a vacuum vent. In another aspect alone or with other aspects of the invention, the invention further comprises at least one vent control valve for opening a vacuum vent line 800 or a process vent line 900. In another aspect alone or with other aspects of the invention, the invention, said at least one vent control valve opens said vacuum vent line in response to a controller to create a vacuum in said purge lines during a purge cycle.

[0037] In another aspect alone or with other aspects of the invention, the invention further comprises a purge system for gas supply equipment, comprising a cylinder filled with a reaction gas, fluidly connected to a reaction gas supply line, of which at least a portion of said reaction gas supply line is to be purged by said purge system; a vent-end line and a purge gas supply line each fluidly connected to said portion of said reaction gas supply line so that a purge gas supplied by said purge gas supply line flows through said portion of said reaction gas supply line, through said vent-end line and to a vent so as to vent said reaction gas and said purge gas from said gas supply equipment; at least one purge valve that controls the supply of purge gas to said purge gas line; a vent valve
in said reaction gas supply line that fluidly connects said cylinder to said vent-end line; said vent-end line fluidly connected to at least one vent; low-pressure purge gas supply line 300 or high-pressure purge gas supply line 400 fluidly connected to said purge gas supply line 500 for supplying low or high pressure purge gas; a backflow prevention valve and purge valve respectively installed on said low-pressure purge gas supply line 300, and high-pressure purge gas supply line 400, and a heater provided on at least one of: said low-pressure purge gas supply line 300, said high-pressure purge gas supply line 400, or said purge gas supply line 500. In another aspect alone or with other aspects of the invention, the invention further comprises a vacuum vent and/or an atmospheric pressure vent. In another aspect alone or with other aspects of the invention, the invention further comprises at least one vent control valve to direct said reaction and/or purge gas from said vent-end line through either said vacuum vent or said atmospheric pressure vent. In another aspect alone or with other aspects of the invention, the invention further comprises a vacuum provided to said vent-end line by a house vacuum supply or a vacuum generator.

[0038] By means of this invention, the occurrence of corrosion may be reduced and impurities may be readily removed through a high-pressure gas by enabling purging optionally using either low-pressure gas or high-pressure gas source, by adding a line that supplies high-pressure purge gas to a line that supplies low-pressure purge gas.

[0039] Further, because a heater that heats the purge gas is installed in the purge line or purge gas supply line, not only is it possible to purge with simple high-pressure gas, or low-pressure gas, but it is also possible to facilitate the removal of impurities attached to the gas piping and valves by providing high-temperature purge gas either high or low pressure, which facilitates the removal of moisture within the gas piping. By the use of heated purge gas, the reaction of corrosive gases with moisture may be prevented.

[0040] In addition, because a vacuum generator or vacuum source is installed at the rear end (near the vent/exit end) of the purge line, atmospheric-pressure and vacuum purging may be selectively performed, thereby maximizing the purge effect.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWINGS

[0041] FIG. 1 shows a purge system for gas supply equipment of the prior art.

[0042] FIG. 2 shows a purge system according to Patent Reference 1.
FIGS. 3 to 8 show embodiments of the purge system for gas supply equipment of this invention.

DETAILED DESCRIPTION OF THE INVENTION

In broad terms, the purge system for gas supply equipment capable of high-temperature high-pressure purging according to this invention relates to a purge system for gas supply equipment comprising: a gas supply line in which reaction gas is supplied; a plurality of purge valves that control the supply of the purge gas; a cylinder filled with said reaction gas; at least one vent valve that is connected to said cylinder and to said plurality of purge valves so as to vent said reaction gas and said purge gas; and at least one vent control valve that is installed between said vent valve and a vacuum source and controls the venting of said reaction gas and said purge gas. The system may further comprise a vacuum generator or vacuum pump or connection to a house vacuum source in fluid communication with said vent control valve. The vacuum generator may be in fluid communication with a vacuum valve that controls the supply of vacuum gas to said vacuum generator. The vacuum generator may be installed between the vacuum valve and vent opening and creates a vacuum state in said gas supply line. The system further comprises a process vent to atmospheric pressure in fluid communication with said vent control valve. The vent control valve may optionally vent to the purge gas and reactive gas to an atmospheric pressure vent.

Hereinafter, a specific embodiment will be described.

First, it is necessary to understand that in assigning reference numerals to the components in each drawing, to the extent possible the same reference numerals have been used to designate only the identical components, even when they are shown in a different drawing. In the following description, numerous specific details are set forth, such as specific circuit components, etc.; these are provided to aid a more thorough understanding of this invention, and it will be apparent to persons of ordinary skill in the art of this field that this invention may be practiced even without these specific details. Additionally, in describing this invention, the detailed explanation is omitted of functions and components which are common knowledge and would unnecessarily obscure the substance of the invention.
[0047] FIGS. 3 to 8 are overall configuration diagrams of a purge system for gas supply equipment according to an embodiment of this invention.

[0048] First, compared to the configuration of prior art gas supply equipment shown in FIGS. 1 and 2, the purge line to which the purge gas is supplied has been divided into a low-pressure purge line 300 and a high-pressure purge line 400, and the low-pressure purge line 300 and the high-pressure purge line 400 while also being connected together are connected to the purge gas supply line 500 and to a portion of the reactive gas supply line 600A to the at least one vent control valve. (The fluid flow between the purge line 500 and the reactive gas line 600A is as described earlier for FIG. 1 and FIG. 2.)

[0049] As shown, the low-pressure purge line 300 is connected to the gas supply line on one side, and the low-pressure purge gas is supplied on the other side; however alternative configurations are possible.

[0050] The high-pressure purge line 400 is connected to the gas supply line on one end of the line, and connected to a high pressure gas supply (not shown) on the other end of the line, so that high-pressure purge gas is supplied to the purge gas supply line 500.

[0051] In the gas cabinet 410, a gas cylinder (not shown) may be furnished for supplying high-pressure N₂ gas, in order to provide high-pressure purge gas.

[0052] A backflow prevention valve CV1 and purge valves AV7, AV9 are installed in the low-pressure purge line 300 and a backflow prevention valve CV6 and purge valve AV15 are installed in the high-pressure purge line 400. In some embodiments, the purge gas supply line 500 has a purge valve AV16 located downstream of the heater 105.

[0053] In addition, the at least one or two or more vent control valves AV14, AV12, and/or AV13 may optionally be installed between the vent valves AV4A, AV4B, AV5A, AV5B and the vacuum generator VG or vacuum pump or vacuum source, such as a house vacuum source and an associated vacuum vent 800 labeled VACUUM in FIG 5, and/or a vent to atmospheric pressure, labeled Process Vent in Figure 5. If the purge gas is at a high pressure, then the atmospheric vent 900 labeled Process Vent is typically used to vent the purge gas. If the purge gas is at a low pressure and the system is under or in the process of going under vacuum, then the VACUUM vent 800 may be used to vent the purge gas. Which vent is used is controlled by the system controller.
[0054] More specifically, in this invention as shown in FIG. 3, the lines connected from the pair of cylinders 100, 200 have the same configuration.

[0055] Further, when one of the cylinders 100, 200 is in use, the other cylinder is not used.

[0056] Accordingly, in the description below, one cylinder (for example, 100) will be described for the sake of convenience, and it will be understood that the other cylinder 200 is also configured and operated in the same manner as the first cylinder 100.

[0057] A cylinder 100 filled with a reaction gas such as Cl₂ or HCl is installed, and a scale WTA is installed below the cylinder 100 for measuring the load of the cylinder 100. The open or closed state of the cylinder 100 is controlled by a valve shutter VSA.

[0058] A pair of process valves AV2A, AV3A, a pressure regulator REGA installed between these valves AV2A, AV3A adjust the pressure of the reaction gas discharged from the cylinder 100 so that the reaction gas is supplied to a process chamber (not shown) at a specified pressure that is required for the process.

[0059] In FIG. 5 for example, a plurality of purge valves AV1A, AV11, AV7, AV15, AV16, AV9 are installed in the purge gas supply line so as to supply purge gas N₂ when the gas supply line (indicated by the solid line) is purged between the respective purge valves AV1A, AV11, AV7, AV15, AV16, AV9 in order to replace the cylinder 100. Backflow prevention valves CV1, CV6, CV3A, CV4A are installed for preventing backflow of purge gas and reaction gas.

[0060] The vent valves AV4A, AV5A which are interlocked with the process valves AV2A, AV3A are installed so as to vent the reaction gas and/or purge gas; when the vent valves AV4A, AV5A are in the open state, the process valves AV2A, AV3A are closed, and when the vent valves AV4A, AV5A are in a closed state, the process valves AV2A, AV3A are opened. When the vent valves AV4A, AV5A are in the open state, the vent-end line 700 is in fluid communication with at least a portion of the reaction gas supply line 600A. It is understood that when AV4A and AV5A are open during the purge process, the purge line 500 is in fluid communication with the vent-end line 700 and a portion of the reaction gas supply line 600A, and that lines 500, 600 and 700 are all a purge gas line; that is, the purge gas flows from either the high or low pressure purge gas supply 300 or 400 through purge line 500 through portions of the reaction gas supply line 600 to the vent-end line 700 and out of the gas cabinet 410 through one of the vent
lines exiting the gas cabinet either to the vacuum vent or to the atmospheric pressure vent. The line that is purged will be generally referred to as the “gas supply line”.

[0061] At the the exit end of the vent valves AV4A, AV5A, a vacuum generator VG or vacuum pump or connection to a house vacuum source is installed or provided that evacuates the gas supply line. The vacuum generator VG, if provided may be installed between the vacuum gas (N₂) supply line and the vent apparatus as shown in some of the figures.

[0062] In some embodiments, a vacuum valve AV8 is optionally and additionally installed between the vacuum gas supply line and the vacuum generator VG, so as to control the vacuum state of the gas supply line. In alternative embodiments, a vent control valve AV12 is optionally installed between the vacuum supply line or a vacuum transmitter VT, so as to control the vacuum state of the vacuum line 800. The vent control valve or a second vent control valve may optionally or additionally connect to an atmospheric pressure vent, as shown AV14.

[0063] A certain number of pressure meters PT1A - PT4 are installed in the gas supply lines 500, 600, 700; the pressure meters PT1 - PT4 measure the pressure of the gas supply line and display the result of that measurement. The output of the pressure meters may be used to control the vent control valves to direct the purge gas to the atmospheric vent 900 or the vacuum vent 800. A certain number of line filters LF1A, LF2 are installed in the reactive gas supply line 600. A manual valve MV3A (as shown in FIG. 5) is installed between the process valve AV3 and the process chamber, ultimately controlling the supply of the reaction gas to the process chamber.

[0064] One of the purge valves AV1A, AV11, AV7, AV15, AV16, AV9 (for example, AV9) is configured as a trickle valve, so as to prevent inflow of air into the gas supply line that is connected to the cylinder 100 when in use but is disconnected from the cylinder 100 during replacement of the cylinder 100.

[0065] The valve AV12 installed between the vacuum line and the vacuum generator VG or vacuum pump VT may be configured as an ordinary air valve (indicated as "AV~" in FIG. 3). This differs from the conventional method wherein a bleed valve is installed between a vacuum gas supply line and a vacuum generator VG in a conventional gas supply system; as a result, even if a bleed valve is not installed, direct contact between the residual reaction gas and the vacuum generator VG may be prevented by means of
the vent control valve AV10, (shown in FIG 2) which may be used in embodiments of this invention, thereby extending the service life of the vacuum generator VG.

[0066] On the other hand, in an additional configuration as shown in FIGS. 3 and 4, a heater 105 may be installed on the purge gas supply line 500. The heater may be any kind of heater known to heat gases. Commonly, trace heating is used, that is, an electrical heating element may be run in contact along the length of a pipe. Alternatively a separate heating unit, in which the purge gas flows through, such as an APU-type heater may be installed in the line to heat the purge gas.

[0067] In the embodiment of FIGS. 5 and 6, an embodiment is shown wherein the heater 105 is installed on a line in which the low-pressure purge line 300 and the high-pressure purge line 400 are combined into the purge gas supply line 500.

[0068] In FIGS. 7 and 8, an embodiment is shown in which a heater 105 is installed on a low-pressure purge line 300.

[0069] This heater 105 may cause the purge gas to be supplied while in a heated state to the reaction gas supply line 600A.

[0070] Preferably, as in FIGS. 3 and 4, the purge gas may be supplied from either the low-pressure purge line 300 or the high-pressure purge line 400 by opening the valve in one of the low-pressure purge line 300 or high pressure purge line 400 and preferably closing the valve in the other purge line (either the low-pressure purge line 300 or high pressure purge line 400.)

[0071] Also, a vacuum generator VG as shown in FIGS. 4, 6 and or a vacuum transmitter VT as shown in FIGs 3, 5 and 7, may be installed at the rear end (near the exit end) of said vacuum line (in fluid communication with the reactive gas supply line), so that purging using a low-pressure or high-pressure purge gas may optionally be performed in a vacuum or atmospheric-pressure state.

[0072] FIG. 3 is an embodiment in which a heater 105 is installed on a purge gas supply line, and a vacuum transmitter VT is installed at the rear end (near the exit end) of a low-pressure purge line (500 through 700 including a portion of 600A).

[0073] FIG. 4 is an embodiment in which a heater 105 is installed on a purge gas supply line, and a vacuum generator VG is installed at the rear end (near the exit end) of a high-pressure purge line.
[0074] FIG. 5 is an embodiment in which a heater 105 is installed on a line where the low-pressure purge line 300 and the high-pressure purge line 400 are combined, and a vacuum transmitter VT is installed at the rear end (near the exit end) that is, in the vent-end line, of the high-pressure purge line or low-pressure purge line.

[0075] FIG. 6 is an embodiment in which a heater 105 is installed on a line where the low-pressure purge line 300 and the high-pressure purge line 400 are combined, and a vacuum generator VG is installed at the rear end (near the exit end) of the high-pressure purge line.

[0076] FIG. 7 is an embodiment in which a heater 105 is installed on a low-pressure purge line 300, and a vacuum transmitter VT is installed at the rear end (near the exit end) of the high-pressure purge line and an atmospheric pressure vent is also provided at the exit end of the high pressure purge line, that is, in the vent-end line.

[0077] FIG. 8 is an embodiment in which a heater 105 is installed on a low-pressure purge line 300, and a vacuum generator VG is installed at the rear end (near the exit end) of the high-pressure purge line or low-pressure purge line.

[0078] The operation of an embodiment of this invention having this configuration may be described as follows.

[0079] In the gas supply equipment according to an embodiment of this invention, the purge valves AV1A, AV7, AV9 and AV11 are kept closed during process operations.

[0080] If a vent control valve AV10 and vacuum valve AV11 are installed as in FIG. 2 in an embodiment of this invention, these valves are also closed during the supply of reactive gas to the process chamber.

[0081] In addition, the vent valves AV4A, AV5A are kept closed and the process valves AV2A and AV3A are kept open, so that the reaction gas supplied from the cylinder 100 is supplied to the process chamber via the process valve AV2A, the pressure regulator REGA, the process valve AV3A, and the manual valve MV1A in reactive gas supply line 600.

[0082] When the gas supply line is purged in order to replace the cylinder 100, then when purge gas is supplied via the low-pressure purge line 300, the process valves AV2A, AV3A are closed, and the vent valves AV4A, AV5A are opened.

[0083] If a vacuum valve AV11 is installed as in FIG. 2, this valve is opened.
[0084] In one embodiment when the vacuum valve AV8 is opened, the vacuum gas is supplied to the vacuum generator VG, and as the vacuum generator VG operates, the line connected to the vacuum valve AV8, backflow prevention valve CV5 and vacuum generator VG enters a vacuum state.

5 [0085] When the vent control valve AV10 and the vacuum valve AV8 (as shown in FIG 2) and the vent valves AV4A, AV5A are opened, the residual reaction gas in the gas supply line 600 is discharged to the vent apparatus via the vent valves AV4A, AV5A, backflow prevention valve CV3A, CV4A and vent control valve AV10 due to the vacuum state.

10 [0086] When the residual vent gas in the gas supply line has been discharged so as to return to a vacuum state, the vent control valve AV10 (and vacuum valve AV8) is closed and AV1A is opened and the purge valves AV7, AV9 of the low-pressure purge line 300 are all opened.

[0087] At this time, the purge valve AV15 of the high-pressure purge line 400 is closed.

15 [0088] Accordingly, the purge gas is charged into the gas supply lines 500, portions of 600 and 700 via the low-pressure purge line 300.

[0089] When the purge gas has been sufficiently charged into the gas supply line, the purge valve AV15 is closed and the vent control valve AV10 and the vacuum valve AV8 is opened, so that the purge gas charged into the gas supply line is vented to the vacuum vent apparatus via the vent control valve AV10 and the vacuum valve AV8.

[0090] Further, the purge valve AV7 is closed to shut off the supply of the purge gas after the purge gas has been sufficiently charged into the gas supply line 500, 600, 700.

[0091] This purge gas supply process and purge gas discharge process are repeated several times to purge the gas supply line.

20 [0092] However, if the supply and discharge of the purge gas is repeated too many times, the service life of the valves is shortened as a result.

[0093] At this time, as needed, the high-pressure purge line 400 is opened while the purge valves AV9, AV7 of the low-pressure purge line 300 are optionally closed, and high-pressure purge gas is discharged into the high-pressure purge line 400.

30 [0094] In this case, the purge valve AV15 is opened, and high-pressure purge gas is supplied instead of low-pressure purge gas.
[0095] In this case, the supply and discharge of purge gas may be minimized, impurity removal within pipes is effective, and corrosion of the pipes may be prevented to the greatest possible extent.

[0096] Further, when the heater 105 in the pipe is operated as described above, impurity removal efficiency is further increased by supplying heated purge gas (either at high pressure or low pressure).

[0097] In addition, by selectively activating the vacuum generator VG in the pipe, the purge gas may be selectively supplied and discharged in an atmospheric pressure or vacuum state.

[0098] In FIG. 3, the vacuum generator or vacuum pump or other vacuum source, such as a house source for vacuum is connected to the vent-end line 700 to which the vacuum is supplied; although not shown in the drawing. As shown in FIG. 3 vent control valves AV12, AV13 and AV14 control to which vent the purge gas and/or residual gas is vented. If vent control valves AV12 and AV13 are open, and vent control valve AV14 is closed, then the purge gas and/or residual gas vents through the vacuum vent line 800, and if vent control valve AV14 is open and vent control valves AV12 and AV13 are closed, then the purge gas and/or residual gas vents through the atmospheric pressure vent line 900. The opening and closing of the at least one vent control valve is directed by the controller for the system (not shown) and typically follows a preprogrammed sequence, that may be modified if pressures and temperatures or other sensors are not within preset limits. In some embodiments, at least some of the high-pressure purge gas and/or residual gas will vent to the atmospheric pressure vent. In some embodiments, the high-pressure purge gas and/or residual gas will vent to the atmospheric pressure vent at least until the pressure nears atmospheric pressure inside the gas supply line. Optionally at that time, the system may switch from venting to the atmospheric pressure vent to venting to the vacuum vent by closing and opening the at least one vent control valves. In the embodiment shown in FIG 3, the vacuum transmitter detects if a vacuum is present after opening vent control valve AV13 is opened, but before vent control valve AV12 is opened. If insufficient vacuum is detected valve AV12 will not open and a malfunction signal will sound or the like.

[0099] The above-described structure enables the removal of impurities and particles attached to the seats of the valves and regulator by high-temperature and high-pressure nitrogen gas, so as to prolong the service life of the parts, and enables selectively
supplying nitrogen gas at high temperature and high pressure or low temperature and high pressure or at high temperature and low pressure or low temperature and low pressure and the exhaust of the purge line can be at ambient pressure or in a vacuum state, so as to maximize the purge effect.

[0100] The use of high-temperature nitrogen gas improves the impurity removal effect.

[0101] In this way, although the detailed explanation of this invention was given with respect to specific embodiment(s), there may obviously be many alterations which remain within the scope of this invention. Accordingly, the scope of the present invention must be considered not as restricted to the embodiment(s) described, but as encompassing both the patent claims enumerated below as well as other matters equivalent to these claims.
CLAIMS

1. A purge system for gas supply equipment, comprising a cylinder filled with a reaction gas, fluidly connected to a reaction gas supply line, of which at least a portion of said reaction gas supply line is to be purged by said purge system; a vent-end line and a purge gas supply line each fluidly connected to said portion of said reaction gas supply line so that a purge gas supplied by said purge gas supply line flows through said portion of said reaction gas supply line through said vent-end line and to a vent so as to vent said reaction gas and said purge gas from said gas supply equipment; at least one purge valve that controls the supply of purge gas to said purge gas line; at least one vent valve in said portion of said reaction gas supply line that fluidly connects said cylinder to said vent-end line; said vent-end line fluidly connected to at least one vent; wherein a high-pressure purge gas supply line 400 fluidly connects to said purge gas supply line 500 for supplying high pressure purge gas, a backflow prevention valve and purge valve are respectively installed on said high-pressure purge gas supply line 400, and said vent-end line is connected to an atmospheric pressure process vent for venting said high-pressure purge gas.

2. The purge system of claim 1, further comprising:

   a low-pressure purge gas supply 300 fluidly connected to said purge gas supply line 500 for supplying low pressure purge gas to said purge gas supply line.

3. The purge system of claim 1, further comprising a heater for said high pressure purge gas for supplying heated high-pressure purge gas to said purge gas supply line.

4. The purge system of claim 2, further comprising a heater for said low pressure purge gas for supplying heated low-pressure purge gas to said purge gas supply line.

5. The purge system of claim 1, further comprising a heater located in or on said gas supply line 500.

6. The purge system of claim 2, further comprising a heater located in or on said gas supply line 500.
7. The purge system of claim 1, further comprising a heater located in or on said high pressure gas supply line 400.

8. The purge system of claim 2, further comprising a heater located in or on said low pressure gas supply line 300.

9. The purge system of claim 2 further comprising a vacuum vent.

10. The purge system of claim 9 further comprising at least one vent control valve for opening a vacuum vent line 800 or a process vent line 900.

11. The purge system of claim 10 wherein said at least one vent control valve opens said vacuum vent line in response to a controller to create a vacuum in said purge lines during a purge cycle.

12. A purge system for gas supply equipment, comprising a cylinder filled with a reaction gas, fluidly connected to a reaction gas supply line, of which at least a portion of said reaction gas supply line is to be purged by said purge system; a vent-end line and a purge gas supply line each fluidly connected to said portion of said reaction gas supply line so that a purge gas supplied by said purge gas supply line flows through said portion of said reaction gas supply line, through said vent-end line and to a vent so as to vent said reaction gas and said purge gas from said gas supply equipment; at least one purge valve that controls the supply of purge gas to said purge gas line; a vent valve in said reaction gas supply line that fluidly connects said cylinder to said vent-end line; said vent-end line fluidly connected to at least one vent; low-pressure purge gas supply line 300 or high-pressure purge gas supply line 400 fluidly connected to said purge gas supply line 500 for supplying low or high-pressure purge gas, a backflow prevention valve and purge valve respectively installed on said low-pressure purge gas supply line 300, and high-pressure purge gas supply line 400 and a heater provided on at least one of: said low-pressure purge gas supply line 300, said high-pressure purge gas supply line 400, or said purge gas supply line 500.

13. The purge system of claim 12 comprising a vacuum vent.
14. The purge system of claim 12 further comprising an atmospheric pressure vent.

15. The purge system of claim 13 further comprising an atmospheric pressure vent.

16. The purge system of claim 15 further comprising at least one vent control valve to direct said reaction and/or purge gas from said vent-end line through either said vacuum vent or said atmospheric pressure vent.

17. The purge system of claim 16 wherein a vacuum is provided to said vent-end line by a house vacuum supply or a vacuum generator.
FIG. 1
PRIOR ART
FIG. 5
FIG. 7
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H01L 21/02 (2018.01)
CPC - H01L 21/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History Document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
See Search History Document

Electronic database consulted during the international search (name of database and, where practicable, search terms used)
See Search History Document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
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<td>US 5,516,367 A (LEI et al) 14 May 1996 (14.05.1996) Fig. 7; col 3 In 30-42, 48-54, col 4 In 49-58, col 6 In 34-38.</td>
<td>3-8, 12-17</td>
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</table>

* Further documents are listed in the continuation of Box C. □ See patent family annex.

* Special categories of cited documents:
  "A" document defining the general state of the art which is not considered to be of particular relevance
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  "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
  "&" document member of the same patent family

Date of the actual completion of the international search
29 October 2018

Date of mailing of the international search report
07 NOV 2018

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