[0006]

However, according to the conventional technology, an adsorption - desorption tower, from which ozone is supplied, will be used at the next cycle, as a tower of adsorption recovery use. Thereby, a high concentration of ozone, which remains at the time of preforming a process for supplying former ozone, is pushed out to the exit of the adsorption - desorption tower, by oxygen and a low concentration of ozone which are introduced into the adsorption - desorption tower, in the beginning stage of an adsorption process, and is forced to leak out from the adsorption - desorption tower. For these reasons, a high concentration of ozone is discarded, the ratio of ozone manufactured to ozone used effectively (utilization rate of ozone) is lowered, and there arises a problem that the running cost of the apparatus increases.

[0007]

The present disclosure is the one to disclose a technology for solving the subjects mentioned above, and aims at offering an ozone supply apparatus and an ozone supply method, which are capable of realizing the improvement in the utilization rate of ozone.

SOLUTION TO PROBLEM

[0008]

The present application discloses an ozone supply apparatus (100,200,300,400), which includes:

a first adsorption - desorption tower (3a) in which an adsorbent is stored,

a second adsorption - desorption tower (3b) in which an adsorbent is stored,

a first gas circuit of exhaust use (R0a), which discharges a gas discharged from the first adsorption - desorption tower (3a), to an outside of the ozone supply apparatus (100,200,300,400),

a first gas circuit of adsorption recovery use (R1a), which passes a gas discharged from the first adsorption - desorption tower (3a), to the second adsorption - desorption tower (3b), and then, discharges the gas to an outside portion of the ozone supply apparatus (100,200,300,400),

a circuit switching device (5), which switches a flow path of the first gas circuit of exhaust use (R0a) and the first gas circuit of adsorption recovery use (R1a), and

a control part (6), which controls, in an ozone adsorption process, an opening and closing of the circuit switching device (5) according to a state of the first adsorption - desorption tower (3a) and a state of the second adsorption - desorption tower (3b).

ADVANTAGEOUS EFFECTS OF INVENTION

[0009]

In this application, the ozone supply apparatus is configured to control and decide whether ozone gas of the first adsorption - desorption tower is exhausted or passed to the second adsorption - desorption tower, according to the result of comparison, which is made between the state of the first adsorption - desorption tower and the state of the second adsorption - desorption tower. Thereby, it becomes possible to restrain the leakage out of a high concentration of ozone gas, which is produced in the adsorption process of the first adsorption - desorption tower, and remains at the time of a supply process, and improvement in the utilization rate of ozone can be realized.

BRIEF EXPLANATION OF DRAWINGS

[0010]

FIG. 1 is a configuration diagram showing an ozone supply apparatus in accordance with Embodiment 1.

CLAIMS

[Claim 1]

An ozone supply apparatus (100,200,300,400), comprising:

a first adsorption - desorption tower (3a) in which an adsorbent is stored,

a second adsorption - desorption tower (3b) in which an adsorbent is stored,

a first gas circuit of exhaust use (R0a) which discharges a gas discharged from the first adsorption - desorption tower (3a), to an outside of the ozone supply apparatus (100,200,300,400),

a first gas circuit of adsorption recovery use (R1a) which passes a gas discharged from the first adsorption - desorption tower (3a), to the second adsorption - desorption tower (3b), and then, discharges the gas to an outside portion of the ozone supply apparatus,

a circuit switching device (5) which switches a flow path of the first gas circuit of exhaust use (R0a) and the first gas circuit of adsorption recovery use (R1a), and

a control part (6) which controls, in an ozone adsorption process, an opening and closing of the circuit switching device (5), according to a state of the first adsorption - desorption tower (3a) and a state of the second adsorption - desorption tower (3b).

[Claim 2]

The ozone supply apparatus (100,200,300,400) according to Claim 1, further comprising:

a first concentration measurement part (7a) which measures a state on an inside of the first adsorption - desorption tower (3a), and

a second concentration measurement part (7b) which measures a state on an inside of the second adsorption - desorption tower (3b),

wherein the circuit switching device (5) is controlled according to a concentration of ozone or a concentration of oxygen.

[Claim 3]

The ozone supply apparatus (100,200,300,400) according to Claim 1, further comprising:

a first temperature measurement part (8a) which measures a temperature state of an upper portion of the adsorbent on the inside of the first adsorption - desorption tower (3a), and

a second temperature measurement part (8b) which measures a temperature state of an upper portion of the adsorbent on the inside of the second adsorption - desorption tower (3b),

wherein the circuit switching device (5) is controlled according to the temperature state.

[Claim 4]

The ozone supply apparatus (100,200,300,400) according to Claim 1 or Claim 2,

wherein, in a case where, in the ozone adsorption process, a concentration of ozone of an ozone discharged from the first adsorption - desorption tower (3a) is higher than a concentration of ozone of the second adsorption - desorption tower (3b), the control part (6) controls to switch the flow path from the first gas circuit of exhaust use (R0a) of the first adsorption - desorption tower (3a) to the first gas circuit of adsorption recovery use, and

in a case where, in the ozone adsorption process, the concentration of ozone of the ozone discharged from the first adsorption - desorption tower (3a) is lower than the concentration of ozone of the second adsorption - desorption tower (3b), the control part (6) controls to switch the flow path from the first gas circuit of adsorption recovery use (R1a) of the first adsorption - desorption tower (3a) to the first gas circuit of exhaust use (R0a).

[Claim 5]

The ozone supply apparatus (100,200,300,400) according to Claim 1 or Claim 2,

wherein, in a case where, in the ozone adsorption process, an oxygen concentration of an ozone discharged from the first adsorption - desorption tower (3a) is higher than an oxygen concentration of an ozone of the second adsorption - desorption tower (3b), the control part (6) controls to switch the flow path from the first gas circuit of exhaust use (R0a) of the first adsorption - desorption tower (3a) to the first gas circuit of adsorption recovery use (R1a), and

in a case where, in the ozone adsorption process, the oxygen concentration of the ozone discharged from the first adsorption - desorption tower (3a) is lower than the oxygen concentration of the ozone of the second adsorption - desorption tower (3b), the control part (6) controls to switch the flow path from the first gas circuit of adsorption recovery use (R1a) of the first adsorption - desorption tower (3a) to the first gas circuit of exhaust use (R0a).

[Claim 6]

The ozone supply apparatus (100,200,300,400) according to Claim 1 or Claim 2,

wherein, in the ozone adsorption process, after a concentration of ozone or a concentration of oxygen, which is leaked out from the first adsorption - desorption tower (3a) reaches a value which is set up beforehand, or a time relevant to adsorption elapses a time which is set up beforehand, the control part (6) starts a control for the opening and closing of the circuit switching device (5).

[Claim 7]

The ozone supply apparatus (100,200,300,400) according to Claim 2, further comprising:

a second gas circuit of exhaust use (R0b) which discharges a gas discharged from the second adsorption - desorption tower (3b), to an outside of the ozone supply apparatus (100,200,300,400), and

a second gas circuit of adsorption recovery use (R1b) which passes a gas discharged from the second adsorption - desorption tower (3b), to the first adsorption - desorption tower (3a), and then, discharges the gas to an outside portion of the ozone supply apparatus (100,200,300,400),

wherein the circuit switching device (5) switches a flow path of the first gas circuit of exhaust use (R0a), the second gas circuit of exhaust use (R0b), the first gas circuit of adsorption recovery use (R1a), and the second gas circuit of adsorption recovery use (R1b),

the first concentration measurement part (7a) is installed between a branching point of the first gas circuit of adsorption recovery use (R1a) and the first gas circuit of exhaust use (R0a), and the first adsorption - desorption tower (3a), and

the second concentration measurement part (7b) is installed between a branching point of the second gas circuit of adsorption recovery use (R1b) and the second gas circuit of exhaust use (R0b)

and the second adsorption - desorption tower (3b).

[Claim 8]

The ozone supply apparatus (100,200,300,400) according to Claim 1,

wherein an amount of ozone to be supplied can be varied, whereby ozone absorbed is made to remain on an inside of an adsorption - desorption tower (3a,3b), at an end time of ozone desorption.

[Claim 9]

The ozone supply apparatus (100,200,300,400) according to Claim 3, further comprising:

a second gas circuit of exhaust use (R0b), which discharges a gas discharged from the second adsorption - desorption tower (3b), to an outside of the ozone supply apparatus (100,200,300,400), and

a second gas circuit of adsorption recovery use (R1b), which passes a gas discharged from the second adsorption - desorption tower (3b), to the first adsorption - desorption tower (3a), and then, discharges the gas to an outside portion of the ozone supply apparatus (100,200,300,400),

wherein the circuit switching device (5) switches a flow path of the first gas circuit of exhaust use (R0a), the second gas circuit of exhaust use (R0b), the first gas circuit of adsorption recovery use (R1a), and the second gas circuit of adsorption recovery use (R1b), and

the state of the first adsorption - desorption tower (3a) and the state of the second adsorption - desorption tower (3b) are the temperature state on the inside of the first adsorption - desorption tower (3a) and the temperature state on the inside of the second adsorption - desorption tower (3b), and

in a case where the temperature on the inside of the first adsorption - desorption tower (3a) is lower than the temperature on the inside of the second adsorption - desorption tower (3b), the flow path is switched from the second gas circuit of exhaust use (R0b) to the second gas circuit of adsorption recovery use (R1b), and

in a case where the temperature on the inside of the first adsorption - desorption tower (3a) is higher than the temperature on the inside of the second adsorption - desorption tower (3b), the flow path is switched from the gas circuit of adsorption recovery use to the gas circuit of exhaust use.

[Claim 10]

The ozone supply apparatus (100,200,300,400) according to Claim 3 or Claim 8,

wherein, after the temperature on an inside of the first adsorption - desorption tower (3a) reaches a value which is set up beforehand, the control part (6)

starts a control for the opening and closing of the circuit switching device (5) .

[Claim 11]

The ozone supply apparatus (100,200,300,400) according to Claim 1, further comprising:

an ozone decomposing installation (9) which conducts a decomposing processing of the ozone gas discharged from the first adsorption - desorption tower (3a) and the second adsorption - desorption tower (3b), and

a temperature measurement part (8c) which measures a temperature of a gas discharged from the ozone decomposing installation (9),

wherein in a case where a gas temperature by the temperature measurement part (8c) reaches a first predetermined value, the flow path is switched from the first gas circuit of exhaust use (R0a) to the first gas circuit of adsorption recovery use (R1a), and

in a case where the gas temperature by the temperature measurement part (8c) reaches a second redetermined value, the flow path is switched from the first gas circuit of adsorption recovery use (R1a) to the first gas circuit of exhaust use (R0a).

[Claim 12]

The ozone supply apparatus (100,200,300,400) according to Claim 1, further comprising:

a flow rate measurement part (10) which measures a flow rate of a desorption ozone, at an ozone desorption time, and

a concentration measurement part (7c) which measures a concentration of ozone of a desorption ozone,

wherein, in the ozone adsorption process, the control part (6) determines a timing for switching a flow path from the first gas circuit of exhaust use (R0a) to the first gas circuit of adsorption recovery use (R1a), and a timing for switching a flow path from the gas circuit of adsorption recovery use to the gas circuit of exhaust use, according to a desorption amount of ozone, calculated from

the flow rate and the concentration of the desorption ozone, which are measured by the flow rate measurement part (10) and the concentration measurement part (7c).

[Claim 13]

An ozone supply method, comprising:

using an ozone supply apparatus (100,200,300,400) which condenses and supplies an ozone gas by use of a first adsorption - desorption tower (3a) storing an adsorbent on an inside thereof and a second adsorption - desorption tower (3b) storing an adsorbent on an inside thereof,

discharging a gas which is discharged from the first adsorption - desorption tower (3a), to an outside of the ozone supply apparatus (100,200,300,400), in a case where a concentration of ozone discharged from the first adsorption - desorption tower (3a) is higher than a concentration of ozone discharged from the second adsorption - desorption tower (3b), and

controlling for discharging the gas which is discharged from the first adsorption - desorption tower (3a) to an outside portion of the ozone supply apparatus (100,200,300,400), after passing the gas through the second adsorption - desorption tower (3b), in a case where the concentration of ozone discharged from the first adsorption - desorption tower (3a) is lower than the concentration of ozone discharged from the second adsorption - desorption tower (3b).

[Claim 14]

An ozone supply method, comprising:

using an ozone supply apparatus (100,200,300,400) which condenses and supplies an ozone gas by use of a first adsorption - desorption tower (3a) storing an adsorbent on an inside thereof and a second adsorption - desorption tower (3b) storing an adsorbent on an inside thereof,

discharging a gas which is discharged from the first

adsorption - desorption tower (3a), to an outside of the ozone supply apparatus (100,200,300,400), in a case where a concentration of oxygen discharged from the first adsorption - desorption tower (3a) is higher than a concentration of oxygen discharged from the second adsorption - desorption tower (3b), and

controlling for discharging the gas discharged from the first adsorption - desorption tower (3a), to an outside portion of the ozone supply apparatus (100,200,300,400), after passing the gas through the second adsorption - desorption tower (3b), in a case where the concentration of oxygen discharged from the first adsorption - desorption tower (3a) is lower than the concentration of oxygen discharged from the second adsorption - desorption tower (3b).

[Claim 15]

The ozone supply method according to Claim 13 or Claim 14,

wherein absorbed ozone is made to remain on the inside of the second adsorption - desorption tower (3b), at an end time of ozone desorption, and an amount of ozone to be supplied is controlled.

[Claim 16]

An ozone supply apparatus (100,200,300,400), comprising:

a first adsorption - desorption tower (3a) in which an adsorbent is stored,

a second adsorption - desorption tower (3b) in which an adsorbent is stored,

a gas circuit of exhaust use which discharges a gas discharged from the first adsorption - desorption tower (3a), to an outside of the ozone supply apparatus (100,200,300,400),

a gas circuit of adsorption recovery use, unlike the gas circuit of exhaust use, which passes a gas discharged from the first adsorption - desorption tower (3a), to the second adsorption - desorption tower (3b), and then, discharges the gas to an outside portion of the ozone supply apparatus (100,200,300,400),

a circuit switching device (5) which switches a flow path of the gas circuit of exhaust use and the gas circuit of adsorption recovery use,

a control part (6) which controls an opening and closing of the circuit switching device (5), according to a state of the first adsorption - desorption tower (3a) and a state of the second adsorption - desorption tower (3b).

a first temperature measurement part (8a) which measures a temperature state of an upper portion of the adsorbent on the inside of the first adsorption - desorption tower (3a), and

a second temperature measurement part (8b) which measures a temperature state of an upper portion of the adsorbent on the inside of the second adsorption - desorption tower (3b),

wherein the circuit switching device (5) is controlled according to temperature states.

[Claim 17]

An ozone supply apparatus (100,200,300,400), comprising:

a first adsorption - desorption tower (3a) in which an adsorbent is stored,

a second adsorption - desorption tower (3b) in which an adsorbent is stored,

a gas circuit of exhaust use which discharges a gas discharged from the first adsorption - desorption tower (3a), to an outside of the ozone supply apparatus (100,200,300,400),

a gas circuit of adsorption recovery use, unlike the gas circuit of exhaust use, which passes a gas discharged from the first adsorption - desorption tower (3a), to the second adsorption - desorption tower (3b), and then, discharges the gas to an outside portion of the ozone supply apparatus (100,200,300,400),

a circuit switching device (5) which switches a flow path of the gas circuit of exhaust use and the gas circuit of adsorption recovery use,

a control part (6) which controls an opening and closing of the circuit switching device (5), according to a state of the first adsorption - desorption tower (3a) and a state of the second adsorption - desorption tower (3b).

a first temperature measurement part (8c) which measures a temperature state of an upper portion of the adsorbent on the inside of the first adsorption - desorption tower (3a), and

a second temperature measurement part (8c) which measures a temperature state of an upper portion of the adsorbent on the inside of the second adsorption - desorption tower (3b),

wherein the control part (6) starts a control for the opening and closing of the circuit switching device (5), after a temperature on the inside of the first adsorption - desorption tower (3a) reaches a value which is set beforehand, and

an amount of ozone to be supplied can be varied, whereby absorbed ozone is made to remain on the inside of the second adsorption - desorption tower (3b), at an end time of ozone desorption.

[Claim 18]

An ozone supply apparatus (100,200,300,400), comprising:

a first adsorption - desorption tower (3a) in which an adsorbent is stored,

a second adsorption - desorption tower (3b) in which an adsorbent is stored,

a gas circuit of exhaust use which discharges a gas discharged from the first adsorption - desorption tower (3a), to an outside of the ozone supply apparatus (100,200,300,400),

a gas circuit of adsorption recovery use, unlike the gas circuit of exhaust use, which passes a gas discharged from the first adsorption - desorption tower (3a , to the second adsorption - desorption tower (3b), and then, discharges the gas to an outside portion of the ozone supply apparatus (100,200,300,400),

a circuit switching device (5) which switches a flow path of the gas circuit of exhaust use and the gas circuit of adsorption recovery use,

a control part (6) which controls an opening and closing of the circuit switching device (5), according to a state of the first adsorption - desorption tower (3a) and a state of the second adsorption - desorption tower (3b).

an ozone decomposing installation (9) which conducts a decomposing processing of an ozone gas, discharged from the first adsorption - desorption tower (3a) and the second adsorption - desorption tower (3b),

a temperature measurement part (8c) which measures a temperature of a gas discharged from the ozone decomposing installation (9),

wherein, when a gas temperature by the temperature measurement part (8c) reaches a first predetermined value, the flow path is switched from the gas circuit of exhaust use to the gas circuit of adsorption recovery use, and

when the gas temperature by the temperature measurement part (8c) reaches a second predetermined value, the flow path is switched from the gas circuit of adsorption recovery use to the gas circuit of exhaust use.

[Claim 19]

An ozone supply apparatus (100,200,300,400), comprising:

a first adsorption - desorption tower (3a) in which an adsorbent is stored,

a second adsorption - desorption tower (3b) in which an adsorbent is stored,

a first gas circuit of exhaust use (R0a) which discharges a gas discharged from the 3a), to an outside of the ozone supply apparatus (100,200,300,400),

a second gas circuit of exhaust use (R0b) which discharges a gas discharged from the second adsorption - desorption tower (3b), to an outside of the ozone supply apparatus (100,200,300,400),

a first gas circuit of adsorption recovery use (R1a), unlike the first gas circuit of

exhaust use (R0a), which passes a gas discharged from the first adsorption - desorption tower (3a), to the second adsorption - desorption tower (3b), and then, discharges the gas to an outside portion of the ozone supply apparatus (100,200,300,400),

a second gas circuit of adsorption recovery use (R1b), unlike the second gas circuit of exhaust use (R0b), which passes a gas discharged from the second adsorption - desorption tower (3b), to the first adsorption - desorption tower (3a), and then, discharges the gas to an outside portion of the ozone supply apparatus (100,200,300,400),

a circuit switching device (5) which switches a flow path of the first gas circuit of exhaust use (R0a) and the first gas circuit of adsorption recovery use (R1a),

a control part (6) which controls an opening and closing of the circuit switching device (5) according to a state of the first adsorption - desorption tower (3a) and a state of the second adsorption - desorption tower (3b),

a first temperature measurement part (8a) which is installed between a branching point of the first gas circuit of adsorption recovery use (R1a) and the first gas circuit of exhaust use (R0a), and the first adsorption - desorption tower (3a), and measures a state on the inside of the first adsorption - desorption tower (3a), and

a second temperature measurement part (8b) which is installed between a branching point of the second gas circuit of adsorption recovery use (R1b) and the second gas circuit of exhaust use (R0b), and the second adsorption - desorption tower (3b), and measures a state on the inside of the second adsorption - desorption tower (3b),

wherein the circuit switching device (5) is controlled according to a concentration of ozone or a concentration of oxygen.