

DESCRIPTION

Title of Invention

FILTER DEVICE AND GAS ANALYZING SYSTEM

[Technical Field]

[0001]

The present invention relates to a filter device and a gas analyzing system.

Priority is claimed on Japanese Patent Application No. 2018-025180 filed on Feb. 15, 2018, the contents of which are incorporated herein by reference.

[Background Art]

[0002]

Emission gas generated in incinerators and the like contains harmful components (dioxin, mercury, or the like). For that reason, a technique is known in which the emission gas is directly sampled from a duct, the content of harmful substances is continuously analyzed, and in-furnace combustion or the like is controlled depending on the analysis result.

[0003]

Patent Document 1 discloses a technique in which the mercury concentration in emission gas is analyzed as upstream as possible, and in a case where the

concentration is higher than a predetermined value, the concentration is reduced by spraying activated carbon or the like, and the emission gas is not discharged while the mercury concentration remains high.

In this technique, since the emission gas of an incinerator contains a large amount of dust, a pretreatment for removing the dust with a dust filter is performed. Then, in a case where the filter is clogged with the dust, backwashing is performed to eliminate the clogging.

[0004]

Additionally, Patent Document 2 discloses a technique for measuring the concentration of harmful substances in emission gas with a measuring device. In the technique disclosed in Patent Document 2, in view of the presence of harmful components and a large amount of the dust, the sampled emission gas is discharged into the furnace, and two systems of dust collection lines with a built-in filter are installed in parallel, and the backwashing is also performed.

[Citation List]

[Patent Document]

[0005]

[Patent Document 1] Japanese Unexamined Patent Application Publication No. 2017-205761

[Patent Document 2] Japanese Unexamined Patent
Application Publication No. 2003-121319

Summary of Invention

[Technical Subject]

[0006]

Meanwhile, in the above two techniques, in order to perform a prolonged period of analysis, a backwashing device for eliminating the clogging of the filter is required. As a result, there is a subject that initial costs and maintenance costs are increased.

[0007]

The present invention provides a filter device and a gas analyzing system that can prevent filter clogging at a low cost.

[Subject to be solved]

[0008]

According to the first aspect of the present invention, a filter device includes a filter unit that includes a gas introduction opening into which a dust-containing gas is introduced, a gas discharge opening for directly discharging the dust-containing gas introduced from the gas introduction opening, a filter, a first discharge opening for discharging the dust-containing gas via a portion of the filter, and a second discharge opening for discharging the dust-containing gas via

another portion of the filter different from the portion of the filter; a first valve that opens and closes the first discharge opening; a second valve that opens and closes the second discharge opening; and a control device that perform control to open and close the first valve and the second valve. The control device opens the first valve and closes the second valve, and closes the first valve and opens the second valve in a case where clogging of the filter has progressed or in a case where a predetermined time has elapsed.

[0009]

According to such a configuration, in a case where clogging of a portion of the filter has progressed by opening the first valve, the first valve is closed. For that reason, the flow of the dust-containing gas passing through a portion of the filter is stopped, and further deposition of the dust on a portion of the filter and entry of the dust into a surface layer of a portion of the filter can be stopped. That is, the progress of the clogging of the filter can be stopped. Moreover, while continuing the filtering using another portion of the filter different from the portion of the filter, the dust deposited on the portion of the filter can be removed by the flow of the dust-containing gas from the gas introduction opening to the gas discharge opening. That

is, self-cleaning of the filter becomes possible.

Accordingly, the clogging of the filter can be prevented at a low cost without adding a device such as a backwashing device.

[0010]

The filter device may further include a turbulence generating unit that changes a gas flow of the dust-containing gas introduced from the gas introduction opening into a turbulent flow, the filter may have a tubular shape, the gas introduction opening may be disposed to introduce the dust-containing gas to an inner peripheral side of the filter, and the turbulence generating unit may include a vortex flow generating mechanism that changes the gas flow in a spiral shape, or an orifice that changes the gas flow into a turbulent flow other than the spiral shape.

[0011]

According to such a configuration, by changing the gas flow into the spiral turbulent flow or by changing the gas flow into the turbulent flow other than the spiral shape, the flow effectively hits the dust deposited on the filter or the dust entering the surface layer of the filter. As a result, the dust deposited on the filter can be blown off. That is, the self-cleaning of the filter can be performed more effectively.

[0012]

In the above filter device, the filter unit may include an inner tube having a tubular punched metal and a first flange provided at one end of the punched metal, an outer tube having a tubular outer tube body disposed on an outer peripheral side of the inner tube body, a second flange provided at one end of the outer tube body and connected to the first flange, and a third flange provided at the other end of the outer tube body to form the gas discharge opening, a partition part that air-tightly partitions an outer peripheral surface of the punched metal and an inner peripheral surface of the outer tube to form a first chamber and a second chamber, a first pipe having a first pipe body, and a fourth flange provided at the other end of the first pipe body and connected to the first flange, and a second pipe having a second pipe body, and a fifth flange provided at one end of the second pipe body and connected to the third flange, the filter may be a tubular filter fabric that is disposed along an inner periphery of the punched metal, the first discharge opening may be disposed at a position of the outer tube corresponding to the first chamber, the second discharge opening may be disposed at a position of the outer tube corresponding to the second chamber, the first flange and the second flange may be connected to each other via an O-

ring or a gasket, the first flange and the fourth flange may be connected to each other via an O-ring or a gasket while sandwiching the filter fabric, and the third flange and the fifth flange may be connected to each other via an O-ring or a gasket while sandwiching the filter fabric.

[0013]

According to such a configuration, assembling and maintenance of the filter unit are facilitated. That is, the inner tube includes a flange only at one end and includes no flange at the other end. For that reason, the punched metal can be inserted into the outer tube in a state where the partition part is attached to the outer peripheral surface of the punched metal, and the filter unit having the first chamber and the second chamber can be easily assembled.

Additionally, the filter fabric can be fixed by being sandwiched between the flanges.

[0014]

The filter device may further include a vibrator that vibrates the outer tube; and a flexible tube that is disposed in the gas introduction opening, the gas discharge opening, the first discharge opening, and the second discharge opening, and the control device may drive the vibrator in a case where clogging of the filter has progressed or in a case where a predetermined time has

elapsed.

With this configuration, it is possible to vibrate the filter of the filter device to shake off the dust and the like deposited on the filter while avoiding or reducing the transmission of the vibration of the vibrator to other pipes and devices connected to the filter device. For that reason, the self-cleaning of the filter can be more effectively performed.

[0015]

According to a second aspect of the present invention, a gas analyzing system includes any one of the above filter devices; a duct through which the dust-containing gas flows; an intake port disposed in the duct; a boosting blower that is disposed between the intake port and the gas introduction opening port and feeds the dust-containing gas from the intake port to the gas introduction opening; a gas analyzer connected to a downstream side of the first valve and the second valve; a return line for returning the dust-containing gas discharged from the gas discharge opening to the duct.

According to such a gas analyzing system, the filter device capable of self-cleaning the filter is used. For that reason, there is no need to stop the gas analyzing system to clean the filter. Therefore, gas analysis can be performed not only at a desired timing but also

continuously.

[Advantageous Effects of Invention]

[0016]

According to the present invention, in a case where dust is deposited on a portion of a filter under filtering and clogging progresses, the filtering of the portion is stopped and filtering is started from another portion different from the portion. As a result, further deposition of dust and the like on the portion can be stopped, and dust and the like deposited on the portion can be removed by the flow of the dust-containing gas from the gas introduction opening to the gas discharge opening. That is, the filter can be self-cleaned while performing the filtering consecutively.

Accordingly, the clogging of the filter can be prevented at a low cost without adding a device such as a backwashing device, and the filtering can be consecutively and continuously performed.

[Brief Description of Drawings]

[0017]

Fig. 1 is a schematic diagram of a gas analyzing system according to an embodiment of the present invention.

Fig. 2 is a sectional view of a filter device according to the embodiment of the present invention.

Fig. 3 is a perspective view of a turbulence

generating unit according to the embodiment of the present invention.

Fig. 4 is a view for explaining a method of assembling the filter device according to the embodiment of the present invention, and is a view illustrating an aspect in which a partition part is wound around an outer peripheral surface of an inner tube.

Fig. 5 is a view illustrating the method of assembling the filter device according to the embodiment of the present invention, and is a view illustrating an aspect in which the inner tube into which a filter is inserted into the inner peripheral side of the outer tube.

Fig. 6 is a flowchart illustrating a method of controlling the gas analyzing system according to the embodiment of the present invention.

Fig. 7 is a perspective view of a turbulence generating unit according to a first modification of the embodiment of the present invention.

Fig. 8 is a perspective view of a turbulence generating unit according to a second modification of the embodiment of the present invention.

[Description of Embodiments]

[0018]

Hereinafter, a filter device according to an embodiment of the present invention and a gas analyzing

system including the filter device will be described in detail with reference to the drawings.

The gas analyzing system is a system that analyzes the content of harmful components (such as dioxin and mercury), which is contained in emission gas (dust-containing gas) generated in facilities such as an incinerator, using a gas analyzer. The emission gas is sampled directly from a duct through which the emission gas flows. The gas analyzing system includes a filter device that removes dust contained in the emission gas introduced into the gas analyzer.

[0019]

As illustrated in Fig. 1, a gas analyzing system 50 according to the present embodiment includes an intake port 52 that is disposed in a duct 51 through which emission gas "EG" flows, a filter device 1 that removes dust from the emission gas "EG" taken in from the intake port 52, and a gas analyzer 53 that analyzes the emission gas "EG" from which the dust has been removed by the filter device 1.

The emission gas "EG" is introduced into the filter device 1 via the intake port 52. A portion of the emission gas "EG" introduced into the filter device 1 is analyzed by the gas analyzer 53, and the other emission gas "EG" is returned to the duct 51.

[0020]

The gas analyzing system 50 is provided in an emission gas treatment device that removes harmful substances such as hydrogen chloride and sulfur oxide contained in the emission gas "EG" discharged from the incinerator. Specifically, the gas analyzing system 50 is provided in a duct 51 between a cooling tower for lowering the emission gas temperature and a dust collecting device such as a bag filter for collecting dust. By providing the gas analyzing system 50 at this position, gas analysis can be performed without separately providing a device that cools the emission gas "EG". The gas analyzing system 50 is not limited to the above position, and can be attached to various points.

[0021]

Although the gas analyzing system 50 of the present embodiment has two systems of filter devices 1A and 1B, the filter device 1 may be one system or three or more systems. By providing two or more systems of filter devices 1, continuous operation performance and maintainability of the systems can be improved.

[0022]

The intake port 52 and the filter device 1 are connected to each other via an intake line 54. The intake line 54 is provided with an electromagnetic valve 55 and a

boosting blower 56. By opening the electromagnetic valve 55, the emission gas "EG" can be taken into the intake line 54. The taken-in emission gas "EG" is boosted by the boosting blower 56 and fed into the filter device 1.

[0023]

The intake port 52 opens toward the downstream side of the emission gas "EG" within the duct 51. The intake line 54 branches into two systems on the downstream side of the boosting blower 56. The intake line 54 branches into a first intake line 54a connected to one filter device 1A and a second intake line 54b connected to the other filter device 1B.

[0024]

The first intake line 54a is provided with a first intake valve 45a. The second intake line 54b is provided with a second intake valve 45b. By operating the first intake valve 45a and the second intake valve 45b, the filter device 1 into which the emission gas "EG" is introduced can be selected.

The downstream side of the filter device 1 and the duct 51 are connected to each other by a return line 57. A return port 59 at the downstream end of the return line 57 opens toward the downstream side of the emission gas "EG" such that the emission gas "EG" does not flow in.

[0025]

The filter device 1 has a filter unit 2 having a gas introduction opening 3 for introducing the emission gas "EG", a gas discharge opening 4 for directly discharging the emission gas "EG" introduced from the gas introduction opening 3, a filter 5 that filters the dust, and discharge openings (a first discharge opening 6, a second discharge opening 7, and a third discharge opening 8) for discharging the emission gas "EG" via the filter 5.

[0026]

The filter device 1 has a first valve 9 that opens and closes the first discharge opening 6, a second valve 10 that opens and closes the second discharge opening 7, a third valve 11 that opens and closes the third discharge opening 8, a control device 12, and an analysis line 13 that connects the downstream sides of the first valve 9, the second valve 10, and the third valve 11 to the gas analyzer 53. The analysis line 13 is provided for the respective valves, and is united on the downstream side.

[0027]

The analysis line 13 is provided with a pump 14 having a function of suctioning the emission gas "EG" flowing through the filter device 1. The pump 14 may be built in the gas analyzer 53 to be described below. The emission gas "EG" that has passed through the gas analyzer 53 is returned to the duct 51 via a second return line 58.

A return port at the downstream end of the second return line 58 opens toward the downstream side of the emission gas "EG".

[0028]

The filter device 1 has a differential pressure gauge 15 that measures a differential pressure between the pressure of the emission gas "EG" flowing through the intake line 54 and the pressure of the emission gas "EG" flowing through the analysis line 13. The differential pressure gauge 15 and the control device 12 are electrically connected to each other. That is, the differential pressure measured by the differential pressure gauge 15 is input to the control device 12.

The control device 12, the first valve 9, the second valve 10, and the third valve 11 are electrically connected to each other. Additionally, the control device 12 is electrically connected to the electromagnetic valve 55, the boosting blower 56, the first intake valve 45a, the second intake valve 45b, the pump 14, and the gas analyzer 53. The control device 12 appropriately controls the first valve 9, the second valve 10, the third valve 11, the electromagnetic valve 55, the boosting blower 56, the first intake valve 45a, the second intake valve 45b, the pump 14, and the gas analyzer 53 to analyze the emission gas "EG".

[0029]

Next, a detailed structure of the filter device 1 will be described.

As illustrated in Fig. 2, the filter device 1 has a first pipe 17 connected to the intake line 54, the filter unit 2 connected to the downstream side of the first pipe 17, and a second pipe 20 connected to the downstream side of the filter unit 2.

The first pipe 17 is a pipe connected to the downstream side of the intake line 54. The first pipe 17 has a tubular first pipe body 18, and a first pipe flange 19 (fourth flange) that is provided at an end of the first pipe body 18 and protrudes radially outward.

[0030]

The first pipe 17 and the intake line 54 are connected to each other via the flexible tube 23. The flexible tube 23 is a joint having flexibility, and is formed of, for example, a fluororesin. The material for forming the flexible tube 23 is not limited to the fluororesin, and a material having pressure resistance, heat resistance, and pliability, such as a metal hose or rubber, can also be adopted.

[0031]

The first pipe 17 is provided with a turbulence generating unit 25. The turbulence generating unit 25 is

a part that changes the gas flow of the emission gas "EG" flowing via the intake line 54 into a turbulent flow. The emission gas "EG" flowing via the intake line 54 is in a state close to a laminar flow, but changes into a turbulent flow by passing through the turbulence generating unit 25.

[0032]

The turbulence generating unit 25 of the present embodiment is an orifice disposed in the first pipe 17. As illustrated in Fig. 3, the turbulence generating unit 25 has a body part 26 that is a plate-shaped member whose main surface is orthogonal to an extending direction of the first pipe 17, and a hole part 27 formed at the center of the body part 26. The hole part 27 has a circular shape and is formed at the center of the body part 26. The shape, position, and number of the hole part 27 are not limited to this, and for example, a plurality of rectangular holes may be formed.

[0033]

Additionally, the turbulence generating unit 25 need not be provided in the first pipe 17 as long as the turbulence generating unit is provided on the upstream side of the filter unit 2, and may be provided independently of the first pipe 17.

[0034]

The second pipe 20 is a pipe connected to the upstream side of the return line 57. The second pipe 20 has a second pipe body 21, and a second pipe flange 22 (fifth flange) that is provided at an end of the second pipe body 21 and protrudes radially outward. The second pipe body 21 is formed of a material having flexibility, similarly to the flexible tube 23.

[0035]

The filter unit 2 has a cylindrical inner tube 28, a cylindrical filter 5 disposed on an inner peripheral side of the inner tube 28, an outer tube 31 disposed on an outer peripheral side of the inner tube 28, and a partition part 35 that partitions the filter unit 2 into a plurality of chambers. The inner tube 28 and the outer tube 31 are coaxially disposed.

[0036]

The inner tube 28 has a tubular punched metal tube 29, and an inner tube flange 30 (first flange) provided at one end of the punched metal tube 29. The punched metal tube 29 is formed of a punched metal in which a plurality of through-holes 43 are regularly formed. No flange is provided at the other end of the punched metal tube 29.

[0037]

The filter 5 is a filtering member having a tubular shape. The filter 5 can be formed of, for example, a

filter fabric. The filter fabric is formed of, for example, glass fiber, a woven fabric or in which fibers formed of a resin such as PTFE are woven, or a nonwoven fabric.

The filter 5 is formed to be sufficiently longer than the inner tube 28. Both ends of the filter 5 have a shape that spreads toward the ends.

[0038]

The partition part 35 is a member that partitions a cylindrical space between the inner tube 28 and the outer tube 31 in the extending direction of the filter 5. The partition part 35 is an annular member formed so as to air-tightly contact an outer peripheral surface 28a of the inner tube 28 and an inner peripheral surface 31a of the outer tube 31. The partition part 35 can be formed of, for example, PTFE.

The filter unit 2 of the present embodiment has two partition parts 35. Accordingly, the space is partitioned into a first chamber 36, a second chamber 37, and a third chamber 38.

[0039]

The outer tube 31 has a tubular outer tube body 32, an upstream outer tube flange 33 (second flange) provided at one end of the outer tube body 32, and a downstream outer tube flange 34 (third flange) provided at the other

end of the outer tube body 32.

[0040]

The first discharge opening 6 is provided at the point of the outer tube body 32 corresponding to the first chamber 36. The first discharge opening 6 is connected to the gas analyzer 53 via a first analysis line 13a. A flexible tube 40 is interposed between the first analysis line 13a and the first discharge opening 6. The first valve 9 is provided on the first analysis line 13a.

The second discharge opening 7 is provided at the point of the outer tube body 32 corresponding to the second chamber 37. The second discharge opening 7 is connected to the gas analyzer 53 via a second analysis line 13b. A flexible tube 40 is interposed between the second analysis line 13b and the second discharge opening 7. The second valve 10 is provided on the second analysis line 13b.

The third discharge opening 8 is provided at the point of the outer tube body 32 corresponding to the third chamber 38. The third discharge opening 8 is connected to the gas analyzer 53 via a third analysis line 13c. A flexible tube 40 is interposed between the third analysis line 13c and the third discharge opening 8. The third valve 11 is provided on the third analysis line 13c.

[0041]

As described above, a flexible tube is interposed between the filter unit 2 and a pipe connected to the filter unit 2. Specifically, the flexible tube 23 is provided between the filter unit 2 and the intake line 54. The second pipe 20 functioning as a flexible tube is provided between the filter unit 2 and the return line 57. The flexible tube 40 is provided between the filter unit 2 and the analysis line 13.

[0042]

A vibrator 44 that vibrates the outer tube 31 is attached to the outer tube 31. As the vibrator 44, for example, a device including a motor and a weight attached to a shaft of the motor can be adopted. The vibrator 44 is electrically connected to the control device 12 and is driven by the control device 12. The vibrator 44 is attached to an outer peripheral surface of the outer tube body 32. By driving the vibrator 44, the filter 5 can be vibrated via the outer tube 31.

[0043]

Here, a method of assembling the filter device 1 will be described.

(1) First, as illustrated in Fig. 4, the partition part 35 is wound around the outer peripheral surface of the inner tube 28. The partition part 35 is disposed at a position such that the first chamber 36, the second

chamber 37, and the third chamber 38 have almost the same size in a length direction of the inner tube 28.

(2) Next, as illustrated in Fig. 5, the tubular filter 5 is inserted into the inner tube 28 from the inner tube flange 30 side. Next, both ends of the filter 5 are spread radially outward of the inner tube 28 over the entire circumference.

[0044]

(3) Next, as illustrated in Fig. 5, after a sealing device such as an O-ring 46 (or a gasket) is inserted into the outer peripheral surface of the inner tube 28, the inner tube 28 is inserted radially inward of the outer tube 31. Next, the ends of the filter 5 are pulled out to the outside of the outer tube 31.

(4) Next, as illustrated in Fig. 2, the inner tube flange 30 and the upstream outer tube flange 33 of the filter unit 2 and the first pipe flange 19 of the first pipe 17 are fastened by fastening members 47 such as bolts and nuts. In this case, the sealing device such as the O-ring 46 (or the gasket) is disposed between the inner tube flange 30 and the first pipe flange 19. Additionally, the inner tube flange 30 and the first pipe flange 19 are connected to each other while sandwiching the filter 5 between the inner tube flange 30 and the first pipe flange 19.

(5) Next, as illustrated in Fig. 2, the downstream outer tube flange 34 of the filter unit 2 and the second pipe flange 22 of the second pipe 20 are fastened by fastening members 47 such as bolts and nuts. In this case, the sealing device such as the O-ring 46 (or the gasket) is disposed between the downstream outer tube flange 34 and the second pipe flange 22. Additionally, the downstream outer tube flange 34 and the second pipe flange 22 are connected to each other while sandwiching the filter 5 between the downstream outer tube flange 34 and the second pipe flange 22.

[0045]

By implementing the above assembling method and further attaching the vibrator 44 to the outer tube 31, the filter device 1 as illustrated in Fig. 2 is completed.

[0046]

The control device 12 first performs control to open only one of the first valve 9, the second valve 10, and the third valve 11, for example, only the first valve 9. That is, control is performed to open only one of the plurality of valves.

Next, in a case where the differential pressure measured by the differential pressure gauge 15 is equal to or more than a predetermined value, the control device 12 controls to open only a valve different from the valve

that has already been opened, for example, only the second valve 10. That is, in a case where the differential pressure is equal to or more than the predetermined value, control is performed to open only a valve different from the valve that is open at that time. In other words, in a case where the differential pressure is equal to or more than the predetermined value and the clogging of the filter 5 is considered to be progressing, the control for changing the valve to be opened is performed.

[0047]

In the configuration having the three valves of the first valve 9, the second valve 10, and the third valve 11 as in the filter device 1 of the present embodiment, in a case where the differential pressure is equal to or more than the predetermined value in a state where the first valve 9 is open, for example, changes are made such that only the second valve 10 is opened and the first valve 9 is closed. Additionally, in a case where the differential pressure is equal to or more than the predetermined value in a state where the second valve 10 is open, changes are made such that only the third valve 11 other than the first valve and the second valve that have been open is opened and the second valve 10 is closed. Moreover, in a case where the differential pressure is equal to or more than the predetermined value in a state where the third

valve 11 is open, all the valves from the first valve to the third valve have been open once. Thus, the valve opening procedure is repeated again from the first valve 9. That is, changes are made such that only the first valve 9 is opened and the third valve 11 is closed. In this way, in a case where the differential pressure in the filter of a chamber corresponding to a valve that is open at this time is equal to or more than the predetermined value, the valve is closed, another valve is opened, and filtering is continued using the filter of another chamber. In the present embodiment, the valves to be opened are sequentially changed in the order of the first valve, the second valve, and the third valve. However, the order of opening the valves is not limited to this, and can be appropriately designed, such as opening the first valve, the third valve, and the second valve in this order.

Here, the timing of switching the valves is not strict, and may be, for example, a timing at which all the valves are closed.

In addition, although the filter device 1 is provided with the three valves of the first valve 9, the second valve 10, and the third valve 11 here, the number of valves is not limited to three, but may be two or four or more. Also in that case, the same operation as above is performed, and in a case the differential pressure in

the filter of a chamber corresponding to a valve that is open at this time is equal to or more than the predetermined value, the valve is closed, another valve is opened, and filtering is continued using the filter of another chamber.

[0048]

Next, a control method of the gas analyzing system 50 will be described. In addition, in the gas analyzing system 50, one filter device 1A of the two filter devices 1A and 1B is used, and a filter device 1 to be used is regularly changed, or a different filter device 1 is used during maintenance.

[0049]

As illustrated in Fig. 6, the method of controlling the gas analyzing system 50 has an emission gas introducing step S1 of opening the electromagnetic valve 55 and starting the boosting blower 56; a first valve opening step S2 of opening only one valve of the three valves and closing the other two valves; a differential pressure determining step S3 of determining whether or not the differential pressure measured by the differential pressure gauge 15 is equal to or more than the predetermined value; a valve changing step (second valve opening step) S4 of opening only one valve different from the one valve and closing the other two valves; a

differential pressure determining step S5 of determining whether or not the differential pressure measured by the differential pressure gauge 15 is equal to or more than the predetermined value; and a valve changing step (third valve opening step) S6 of opening one valve of the three valves that has not been opened in the first and second valve opening steps and closing the other two valves; and a differential pressure determining step S7 of determining whether or not the differential pressure measured by the differential pressure gauge 15 is equal to or more than the predetermined value.

[0050]

Hereinafter, the respective steps using the filter device 1A as the filter device 1 will be described. Although the description is omitted, the same applies to a case where the filter device 1B is used.

In the emission gas introducing step S1, the control device 12 opens the electromagnetic valve 55 and the first intake valve 45a, and starts the boosting blower 56. Accordingly, the emission gas "EG" is introduced into the filter device 1 via the intake port 52, the intake line 54, and the intake line 54a.

In the first valve opening step S2, the control device 12 opens, for example, only the first valve 9 among the first valve 9, the second valve 10, and the third

valve 11, and closes the second valve 10 and the third valve 11. In the intake line 54, the emission gas "EG" is boosted and fed into the filter device 1 by the boosting blower 56, and in the analysis line 13, the emission gas "EG" is suctioned by the pump 14. For that reason, the emission gas "EG" flows into the first chamber 36, and in that case, dust is removed by a portion of the filter 5 corresponding to the first chamber 36. The emission gas "EG" from which the dust has been removed is introduced into the gas analyzer 53. The gas analyzer 53 analyzes the content of harmful components of the introduced emission gas "EG".

[0051]

In the differential pressure determining step S3, the control device 12 determines whether or not the differential pressure between the pressure of the emission gas "EG", flowing through the intake line 54, measured by the differential pressure gauge 15 and the pressure of the emission gas "EG" flowing through the analysis line 13 is equal to or more than the predetermined value. In a case where the differential pressure is smaller than the predetermined value (No), the analysis is continued without changing the valve to be opened.

In a case where the differential pressure is equal to or more than the predetermined value (Yes), that is, in

a case where the clogging of the filter 5 is progressing, the process proceeds to the valve changing step (second valve opening step) S4, and a valve different from the first valve 9, for example, only the second valve 10 is opened, and the first valve 9 is closed. Similarly to the aforementioned case where the first valve 9 is opened, the emission gas "EG" flows into the second chamber 37 by the boosting blower 56 and the pump 14. In that case, dust is removed by a portion of the filter 5 corresponding to the second chamber 37.

In the differential pressure determining step S5, similarly to the differential pressure determining step S3, in a case where the differential pressure is smaller than the predetermined value (No), the control device 12 continues the analysis without changing a valve to be opened. In a case where the differential pressure is equal to or more than the predetermined value (Yes), the process proceeds to the valve changing step (third valve opening step) S6, and only a valve different from the first valve 9 and the second valve 10, that is, only the third valve 11 is opened, and the second valve 10 is closed. Similarly to the aforementioned case where the first valve 9 is opened, the emission gas "EG" flows into the third chamber 38 by the boosting blower 56 and the pump 14. In that case, dust is removed by a portion of

the filter 5 corresponding to the third chamber 38.

In the differential pressure determining step S7, similarly to the differential pressure determining steps S3 and S5, in a case where the differential pressure is smaller than the predetermined value (No), the control device 12 continues the analysis without changing a valve to be opened. In a case where the differential pressure is equal to or more than the predetermined value (Yes), the process proceeds to the first valve opening step S2.

[0052]

Next, the operation of the filter device 1 of the present embodiment will be described.

When the first valve 9 is opened, the emission gas "EG" is discharged from the first discharge opening 6 via a filter corresponding to the first chamber 36, that is, a portion 5a of the filter 5, and sent to the gas analyzer 53. Additionally, when the second valve 10 is opened, the emission gas "EG" is discharged from the second discharge opening 7 via other portion 5b different from the portion 5a of the filter 5 and sent to the gas analyzer 53. The other portion 5b is a filter corresponding to the second chamber 37 and is a portion of the filter 5. Moreover, when the third valve 11 is opened, the emission gas "EG" is discharged from the third discharge opening 8 via another portion 5c different from the portion 5a and the

other portion 5b of the filter 5, and is sent to the gas analyzer 53. The other portion 5c is a filter corresponding to the third chamber 38 and is a portion of the filter 5. That is, by switching a valve to be opened, the part of the filter 5 to be used for filtering is changed.

[0053]

A valve to be opened is switched by the control device 12. Accordingly, in a filter (a portion of the filter 5 and a point where the filtering is performed) corresponding to one of the first chamber 36, the second chamber 37, and the third chamber 38 where the filtering is performed, the filtering at the point can be stopped before the dust enters deep inside the filter 5. Moreover, filtering can be performed by a filter (a portion of the filter 5) corresponding to another chamber. The filtering of the filter (the portion of the filter 5) corresponding to the one chamber is stopped by switching a valve connected to the analysis line 13, and the suction force of the pump 14 does not reach. For this reason, the dust deposited or clogged on the portion can be easily blown off by the boosted flow of the gas "EG" from the gas introduction opening 3 to the gas discharge opening 4. That is, the filter can be self-cleaned without requiring a special device such as a backwashing device.

[0054]

Additionally, the emission gas "EG" changes into a turbulent flow by passing through the turbulence generating unit 25. The emission gas "EG" having the turbulent flow flows on the inner surface of the filter 5, so that the dust deposited on the filter 5 and the dust entering the surface layer of the filter 5 can be easily blown off.

Additionally, the vibrator 44 is driven by the control device 12, and the filter 5 vibrates via the outer tube 31. Accordingly, the dust deposited on the filter 5 and the dust entering the surface layer of the filter 5 can be shaken off.

[0055]

The embodiment of the present invention has been described in detail above with reference to the drawings. However, the specific configuration is not limited to the embodiment, and includes design changes or the like without departing from the spirit of the present invention.

In addition, the above embodiment has a configuration in which a valve is controlled on the basis of the differential pressure measured by the differential pressure gauge 15. However, the present invention is not limited to this. For example, a valve to be opened in a case where a predetermined time has elapsed may be changed.

That is, control may be performed to switch the valves to be sequentially opened without referring to the differential pressure between the pressure of the emission gas "EG" flowing through the intake line 54 and the pressure of the emission gas "EG" flowing through the analysis line 13. According to such a configuration, the self-cleaning of the filter 5 can be performed without providing the differential pressure gauge 15.

[0056]

Additionally, although the above embodiment has a configuration in which the three chambers (the first chamber 36, the second chamber 37, and the third chamber 38) are formed by the partition part 35, the number of the chambers is not limited to this. It is only necessary that a plurality of chambers are formed by the partition part 35. In that case, the discharge openings (the first discharge opening 6, the second discharge opening 7, the third discharge opening 8, and the like) and the valves (the first valve 9, the second valve 10, the third valve 11, and the like) corresponding to the respective chambers are disposed.

In addition, in the above embodiment, the turbulence generating unit 25 is an orifice. However, the present invention is not limited to this. For example, as in a first modification illustrated in Fig. 7, the turbulence

generating unit 25 may be used as a vortex flow generating mechanism to change the gas flow spirally. A turbulence generating unit 25B of the first modification has a columnar member 41 formed so as to close a pipe, and a spiral groove 42 formed on an outer peripheral surface of the columnar member 41. A gas flow that has passed through the turbulence generating unit 25B becomes a vortex flow by passing between the spiral groove 42 and an inner peripheral surface of the first pipe 17.

[0057]

Additionally, the turbulence generating unit 25 may have a form as in a second modification illustrated in Fig. 8. A turbulence generating unit 25C of the second modification includes a columnar member 41 that closes the first pipe 17 and a plurality of through-holes 43 that penetrate between one surface 41a and the other surface 41b of the columnar member 41. Each through-hole 43 is formed so as to be inclined with respect to the axial direction of a pipe such that the gas flow becomes a vortex flow.

[Industrial Applicability]

[0058]

According to the present invention, in a case where dust is deposited on a portion of a filter under filtering and clogging progresses, the filtering of the portion is

stopped and filtering is started from another portion different from the portion. As a result, further deposition of dust and the like on the portion can be stopped, and dust and the like deposited on the portion can be removed by the flow of the dust-containing gas from the gas introduction opening to the gas discharge opening. That is, the filter can be self-cleaned while performing the filtering consecutively.

Accordingly, the clogging of the filter can be prevented at low cost without adding a device such as a backwashing device, and the filtering can be consecutively and continuously performed.

[Reference Signs List]

[0059]

- 1: filter device
- 2: filter unit
- 3: gas introduction opening
- 4: gas discharge opening
- 5: filter
- 6: first discharge opening
- 7: second discharge opening
- 8: third discharge opening
- 9: first valve
- 10: second valve
- 11: third valve

12: control device

13: analysis line

13a: first analysis line

13b: second analysis line

13c: third analysis line

14: pump

15: differential pressure gauge

17: first pipe

18: first pipe body

19: first pipe flange (fourth flange)

20: second pipe

21: second pipe body

22: second pipe flange (fifth flange)

23 flexible tube

25: turbulence generating unit

26: body part

27: hole part

28: inner tube

29: punched metal tube

30: inner tube flange (first flange)

31: outer tube

32: outer tube body

33: upstream outer tube flange (second flange)

34: downstream outer tube flange (third flange)

35: partition part

36: first chamber
37: second chamber
38: third chamber
40: flexible tube
41: columnar member
42: groove
43: through-hole
44: vibrator
45a: first intake valve
45b: second intake valve
50: gas analyzing system
51: duct
52: intake port
53: gas analyzer
54: intake line
54a: first intake line
54b: second intake line
55: electromagnetic valve
56: boosting blower
57: return line
58: second return line
EG: emission gas

Claim(s)

[Claim 1]

A filter device comprising:

a filter unit that includes a gas introduction opening into which a dust-containing gas is introduced, a gas discharge opening for directly discharging the dust-containing gas introduced from the gas introduction opening, a filter, a first discharge opening for discharging the dust-containing gas via a portion of the filter, and a second discharge opening for discharging the dust-containing gas via another portion of the filter different from the portion of the filter;

a first valve that opens and closes the first discharge opening;

a second valve that opens and closes the second discharge opening; and

a control device that performs control to open and close the first valve and the second valve,

wherein the control device opens the first valve and closes the second valve, and closes the first valve and opens the second valve in a case where clogging of the filter has progressed or in a case where a predetermined time has elapsed.

[Claim 2]

The filter device according to claim 1, further

comprising:

a turbulence generating unit that changes a gas flow of the dust-containing gas introduced from the gas introduction opening into a turbulent flow,

wherein the filter has a tubular shape,

wherein the gas introduction opening is disposed to introduce the dust-containing gas to an inner peripheral side of the filter, and

wherein the turbulence generating unit includes a vortex flow generating mechanism that changes the gas flow in a spiral shape, or an orifice that changes the gas flow into a turbulent flow other than the spiral shape.

[Claim 3]

The filter device according to claim 2,

wherein the filter unit includes

an inner tube having a tubular punched metal and a first flange provided at one end of the punched metal,

an outer tube having a tubular outer tube body disposed on an outer peripheral side of the inner tube, a second flange provided at one end of the outer tube body and connected to the first flange, and a third flange provided at the other end of the outer tube body to from the gas discharge opening,

a partition part that air-tightly partitions an outer peripheral surface of the punched metal and an inner

peripheral surface of the outer tube to form a first chamber and a second chamber,

a first pipe having a first pipe body, and a fourth flange provided at the other end of the first pipe body and connected to the first flange, and

a second pipe having a second pipe body, and a fifth flange provided at one end of the second pipe body and connected to the third flange,

wherein the filter is a tubular filter fabric that is disposed along an inner periphery of the punched metal,

wherein the first discharge opening is disposed at a position of the outer tube corresponding to the first chamber,

wherein the second discharge opening is disposed at a position of the outer tube corresponding to the second chamber,

wherein the first flange and the second flange are connected to each other via an O-ring or a gasket,

wherein the first flange and the fourth flange are connected to each other via an O-ring or a gasket while sandwiching the filter fabric , and

wherein the third flange and the fifth flange are connected to each other via an O-ring or a gasket while sandwiching the filter fabric.

[Claim 4]

The filter device according to claim 3, further comprising:

a vibrator that vibrates the outer tube; and

a flexible tube that is disposed in the gas introduction opening, the gas discharge opening, the first discharge opening, and the second discharge opening,

wherein the control device drives the vibrator in a case where clogging of the filter has progressed or in a case where a predetermined time has elapsed.

[Claim 5]

A gas analyzing system comprising:

the filter device according to any one of claims 1 to 4,

a duct through which the dust-containing gas flows;

an intake port disposed in the duct;

a boosting blower that is disposed between the intake port and the gas introduction opening port and feeds the dust-containing gas from the intake port to the gas introduction opening;

a gas analyzer connected to a downstream side of the first valve and the second valve; and

a return line for returning the dust-containing gas discharged from the gas discharge opening to the duct.