

In the system of the related art described above, a certain small amount of activated carbon is continuously supplied to the exhaust gas regardless of the concentration of mercury contained in the exhaust gas (hereinafter, referred to as “exhaust gas mercury concentration”). Therefore, even if the exhaust gas mercury concentration is suddenly increased, it is not necessary to perform a special treatment up to the exhaust gas mercury concentration that can be adsorbed and removed by the activated carbon.

However, in a case where the exhaust gas mercury concentration exceeds the allowable adsorption amount of mercury of the activated carbon, that is, the treatment amount of the activated carbon, the exhaust gas containing mercury that has not been treated by the activated carbon may be discharged from a chimney to the outside of the plant.

[0005]

Therefore, in the system of the related art, the mercury concentration downstream of the dust-collecting device is measured by the mercury concentration meter, and in a case where the output value of the mercury concentration meter exceeds the allowable treatment amount of the activated carbon, the activated carbon in an amount that is increased accordingly (an amount necessary and sufficient to adsorb mercury at the concentration indicated by the output value) is supplied to the upstream of the dust-collecting device.

[0006]

However, since the mercury concentration in the exhaust gas is rapidly increased within a short period of time (a few tens of seconds to several minutes) in many cases, even if the activated carbon is supplied upstream of the dust-collecting device in the amount necessary and sufficient to treat mercury at the concentration measured downstream of the dust-collecting device, the mercury concentration, which has been sharply increased at the supply location, is much greater than the treatment amount of the activated carbon.

Consequently, mercury cannot be sufficiently treated, and there is a risk that the exhaust gas containing mercury in an amount exceeding the legal reference value may be discharged from the chimney.

[0007]

Unlike the certain small amount described above, when a certain large amount of activated carbon is continuously supplied to the exhaust gas, this risk is reduced. However, it is uneconomical.

That is, in the system in the related art, it has been difficult to economically and effectively reduce the discharge amount of mercury contained in the exhaust gas (the discharge amount of mercury discharged to the atmosphere).

[0008]

An object of this invention is to provide an exhaust gas mercury removal system which is a system having the same configuration as in the related art, that is, a system that measures the concentration of mercury contained in exhaust gas downstream of a dust-collecting device using a mercury

concentration meter and adjusts the supply amount of activated carbon supplied into a pipe upstream of the dust-collecting device in accordance with an output value of the mercury concentration meter, but can economically and effectively reduce the discharge amount of mercury emitted to the atmosphere compared to the related art.

Solution to Subject

[0009]

The exhaust gas mercury removal system of the present invention includes: a mercury concentration meter that measures a concentration of mercury contained in an exhaust gas discharged from a dust-collecting device that removes dust from the exhaust gas containing the mercury, and outputs an output value corresponding to a result of the measurement; an activated carbon-supplying device that supplies activated carbon to the exhaust gas upstream of the dust-collecting device; and a control device that controls the activated carbon-supplying device based on the output value, wherein the control device controls the activated carbon-supplying device to: in a case where the output value is less than a first threshold value, supply a predetermined amount of the activated carbon in an intermittent manner; in a case where the output value is more than or equal to the first threshold value, and a rate of increase of the output value is less than a first rate of increase, supply a first supply amount of the activated carbon, the first supply amount being larger than the predetermined amount, and in a case where the rate of increase of the output value becomes more than or equal to zero after supplying the first supply amount of the activated carbon, supply a second supply amount of the activated carbon, the second supply amount being larger than the first supply amount, in a case where the output value is more than or equal to the first threshold value, and the rate of increase of the output value is more than or equal to the first rate of increase and less than a second rate of increase, supply the second supply amount of the activated carbon, and in a case where the rate of increase of the output value is less than zero after supplying the first supply amount or the second supply amount of the activated carbon, maintain a supply amount of the activated carbon at that point in time until the output value becomes less than a second threshold value that is larger than the first threshold value, and when the output value becomes less than the second threshold value, reduce the supply amount of the activated carbon at that point in time, and when the output value becomes less than a third threshold value that is smaller than the

first threshold value, supply the predetermined amount of the activated carbon in the intermittent manner.

[0010]

According to such a configuration, the activated carbon can be
5 continuously supplied by changing the supply amount of the activated carbon in
accordance with the rate of change of the output value of the mercury
concentration meter. That is, it is possible to predict whether the
concentration of mercury in the exhaust gas flowing through the measurement
10 location of the mercury concentration meter increases rapidly, is steady, or
decreases after the measurement of the concentration of mercury based on the
rate of change of the output value of the mercury concentration meter, so that
the supply amount of the activated carbon supplied upstream of the dust-
collecting device can be greatly increased, gradually increased, maintained, or
15 decreased in accordance with the corresponding rate. In other words, since an
appropriate amount of the activated carbon is supplied in advance by predicting
a change in the mercury concentration at the activated carbon supply location,
it is possible to economically and effectively reduce the discharge amount of
mercury in the exhaust gas that is released to the atmosphere.

[0011]

20 In this configuration, in a case where the rate of increase rapidly
increases, the supply amount of the activated carbon can be increased greatly in
advance, and in a case where the rate of increase gradually increases, the
supply amount can be increase in advance in stages. Furthermore, in a case
where the rate of increase is more than or equal to zero even after the amount
25 of the activated carbon supplied is increased, the amount of the activated
carbon supplied is further increased. That is, since the amount of the
activated carbon supplied is increased in multiple stages in accordance with the
rate of increase of the exhaust gas mercury concentration, it is possible to
reduce the discharge amount of mercury in the exhaust gas more economically
30 and effectively.

[0012]

The exhaust gas mercury concentration may gradually decrease over a
long period of time (several tens of minutes to several hours) after reaching its
peak in a case where no special treatment is performed. Therefore, in this
35 configuration, regardless of the rate at which the exhaust gas mercury
concentration decreases (hereinafter, referred to as “rate in decrease”,
equivalent to a case where the rate of increase of the exhaust gas mercury
concentration is less than zero), until the exhaust gas mercury concentration

decreases to less than a predetermined value (the second threshold value, for example, a legal reference value), the supply of the activated carbon at that point in time is maintained to rapidly reduce the exhaust gas mercury concentration. In a case where the exhaust gas mercury concentration is less than the predetermined value, the amount of the activated carbon supplied is reduced in accordance with the rate of decrease of the exhaust gas mercury concentration. Therefore, the exhaust gas mercury concentration that gradually decreases over a long period of time (several tens of minutes to several hours) after reaching its peak can be rapidly reduced. Furthermore, when the exhaust gas mercury concentration is less than the predetermined value, the amount of the activated carbon is reduced in stages in accordance with the rate of decrease of the exhaust gas mercury concentration, and the activated carbon is ultimately supplied intermittently. Accordingly, it is possible to reduce the discharge amount of mercury in the exhaust gas more economically and effectively.

[0013]

In the exhaust gas mercury removal system, the result of the measurement may be a concentration of the mercury at a point in time when the measurement is performed.

[0014]

According to such a configuration, the output value corresponding to the result of the measurement of the mercury concentration meter is a value corresponding to the concentration of mercury itself at the point in time of the measurement. Therefore, compared to a case where a mercury concentration meter that uses the average value of mercury concentrations at multiple points in time of measurement as an output value, not only can the response speed when the activated carbon is supplied be increased, but also the rate of change of the output value of the mercury concentration meter is not evened out. Therefore, it is possible to reduce the discharge amount of mercury in exhaust gas more economically and effectively.

[0015]

In the exhaust gas mercury removal system, the activated carbon may be halogen-impregnated activated carbon.

[0016]

According to such a configuration, compared to normal activated carbon, the halogen-impregnated activated carbon is less likely to be affected by the presence form of mercury or coexisting gas, so that a stable, high

mercury removal performance can be obtained. Therefore, it is possible to reduce the discharge amount of mercury in exhaust gas more effectively.

[0017]

The exhaust gas mercury removal system may further include: a waste incinerator; and a temperature reduction column disposed downstream of the waste incinerator and upstream of the dust-collecting device, in which the dust-collecting device is a bag filter, the exhaust gas is discharged from the waste incinerator, and in a case where the output value is more than or equal to the first threshold value, the control device controls the temperature reduction column to decrease a temperature of the exhaust gas.

[0018]

According to such a configuration, the temperature of the exhaust gas can be reduced by controlling the temperature reduction column, whereby the amount of mercury removed can be increased. Therefore, it is possible to reduce the discharge amount of mercury in exhaust gas more economically and effectively.

[0019]

The exhaust gas mercury removal system may further include: a fly ash-circulating device transports fly ash discharged from the bag filter to an upstream side of the bag filter and a downstream side of the temperature reduction column to supply the fly ash toward the exhaust gas.

[0020]

According to such a configuration, unreacted activated carbon contained in the fly ash discharged from the bag filter can be reused, so that the supply amount of new activated carbon can be reduced. Therefore, it is possible to reduce the discharge amount of mercury in exhaust gas more economically.

Advantageous Effects of Invention

[0021]

According to the present invention, an appropriate amount of activated carbon is supplied in advance by predicting a change in mercury concentration based on the rate of change of the output value of the mercury concentration meter, and therefore, it is possible to economically and effectively reduce the discharge amount of mercury in exhaust gas discharged to the atmosphere.

Brief Description of Drawings

[0022]

Fig. 1 is a schematic configuration view of an exhaust gas mercury removal system illustrating an embodiment of the present invention.

Fig. 2 is a flowchart describing control of the exhaust gas mercury removal system of the embodiment of the present invention.

5 Fig. 3 is a schematic configuration view of an exhaust gas mercury removal system illustrating a modified example of the present invention.

Fig. 4 is a schematic configuration view of an exhaust gas mercury removal system illustrating a modified example of the present invention.

10 Description of Embodiments

[0023]

Hereinafter, an exhaust gas mercury removal system according to an embodiment of the present invention will be described in detail with reference to the drawings. The exhaust gas mercury removal system according to the
15 present invention can be applied to any plant including a waste incineration plant provided with a waste incinerator or a coal-fired power plant provided with a boiler as long as the plant discharges exhaust gas containing mercury. Hereinafter, a waste incineration plant provided with a waste incinerator (waste treatment plant) will be described below as an embodiment.

20 [0024]

As illustrated in Fig. 1, a waste treatment plant 1 (exhaust gas mercury treatment system) includes: a waste incinerator 3 (for example, a transfer type stoker incinerator) that incinerates materials to be incinerated, such as waste; a boiler 4 that exchanges heat with exhaust gas “E” generated in the waste
25 incinerator 3; a temperature reduction column 6 that sprays water or the like onto the exhaust gas “E” that has passed through the boiler 4 to reduce the temperature thereof; a dust-collecting device (bag filter) 7 that removes soot and dust contained in the exhaust gas “E” that has passed through the temperature reduction column 6; a pipe (duct) 9a that connects the temperature
30 reduction column 6 to the dust-collecting device 7 to pass the exhaust gas “E” ; a chimney 8 that discharges, to the atmosphere, the exhaust gas “E” from which dust has been removed by the dust-collecting device 7; a pipe (duct) 9b that connects the dust-collecting device 7 to the chimney 8 to pass the exhaust gas “E” ; a mercury concentration meter 11 disposed in the pipe 9b to measure the
35 concentration of mercury contained in the exhaust gas “E” (exhaust gas mercury concentration) flowing through the inside of the pipe 9b; an activated carbon-supplying device 12 that supplies activated carbon to the inside of the pipe 9a; and a control device 13 that controls the activated carbon-supplying

device 12 in accordance with an output value of the mercury concentration meter 11.

[0025]

The activated carbon-supplying device 12 includes: a hopper 14 that stores the activated carbon; and a feeder 15 that quantitatively supplies the activated carbon from the hopper 14 to the inside of the pipe 9a. The feeder 15 is, for example, a rotary feeder. In a case where the feeder 15 is a rotary feeder, the control device 13 can control the supply amount of the activated carbon by increasing or decreasing the rotational speed of the rotary feeder.

[0026]

The mercury concentration meter 11 is a continuous mercury concentration meter that automatically and continuously outputs an output value at predetermined time intervals (for example, at intervals of 20 seconds). Alternatively, the mercury concentration meter 11 may be a mercury concentration meter that uses multiple measurement values measured at a predetermined time interval as a result of the measurement, and transmits an output value corresponding to the average value of the plurality of measurement values to the control device 13, or may be a mercury concentration meter that does not use an average value as an output value but uses a single measurement value itself at the point in time of measurement as a result of the measurement, and transmits an output value corresponding thereto to the control device 13. Therefore, in any case, the output value of the mercury concentration meter 11 can be referred to as a “value corresponding to the result of the measurement”. In addition, the output value of the mercury concentration meter 11 is generally a digital value, and there are cases where (1) the output value represents the value of the exhaust gas mercury concentration itself, and (2) the output value is encrypted and output by the mercury concentration meter 11 and decrypted by the control device 13 to obtain the value of the mercury concentration. In any case, the output value is a value equivalent to or corresponding to the exhaust gas mercury concentration.

[0027]

However, since the mercury concentration meter that uses only a single measurement value at the point in time of measurement and treats that value itself as an output value does not average multiple measurement values, the output value can be output at a high speed from the start of an operation. Therefore, from the viewpoint of more rapidly and effectively reducing the exhaust gas mercury concentration, in the exhaust gas mercury treatment

system of the present invention, it is desirable to use the mercury concentration meter that uses only a single measurement value at the point in time of measurement and treats that value itself as an output value instead of the mercury concentration meter that uses the average value of mercury concentrations at multiple points in time of measurement as an output value.
[0028]

The activated carbon-supplying device 12 is exemplified by a device having an activated carbon maximum supply capacity of 800 mg/Nm³. In addition, the activated carbon-supplying device 12 can change the supply amount of activated carbon in multiple stages. Here, an example with five stages is the following: Specifically, the activated carbon-supplying device 12 can change the supply amount in five stages including setting a supply amount (40 mg/Nm³) of 5% of the maximum supply capacity to a predetermined amount A0, setting a supply amount (200 mg/Nm³) of 25% of the maximum supply capacity to a first supply amount A1, setting a supply amount (400 mg/Nm³) of 50% of the maximum supply capacity to a second supply amount A2, setting a supply amount (600 mg/Nm³) of 75% of the maximum supply capacity to a third supply amount A3, and setting a supply amount (800 mg/Nm³) of 100% of the maximum supply capacity to a fourth supply amount A4.
[0029]

The control of the waste treatment plant 1 (exhaust gas mercury treatment system) will be described in detail using Fig. 2.

First, when an operation of the waste treatment plant 1 is started, the control device 13 controls the activated carbon-supplying device 12 to supply the predetermined amount A0 of activated carbon into the pipe 9a at a predetermined time interval in an intermittent manner (step S1). Here, as an example, the activated carbon is intermittently supplied at intervals of five minutes. In other words, the supply of the activated carbon and suspension of the supply of the activated carbon are alternately repeated every five minutes.

This is because by intermittently supplying a small amount of activated carbon, the dust-collecting device 7 removes dioxins and the like in addition to mercury.
[0030]

The control device 13 continuously receives output values transmitted by the mercury concentration meter 11 at predetermined intervals (for example, intervals of 20 seconds), and determines whether the received output value is less than a first threshold value C1 or more than or equal to the first threshold

value C1 (step S2). In a case where the received output value is less than the first threshold value C1, the control device 13 continues the execution of step S1, that is, intermittent supply of the activated carbon. In a case where the received output value is more than or equal to the first threshold value C1, as described below, the control device 13 starts control of increasing the supply amount of the activated carbon to more than the predetermined amount A0 in accordance with the rate of change of the output value and supplying the activated carbon continuously rather than intermittently.

[0031]

In addition, the control device 13 calculates the rate of change of the output value each time a new output value is received. The rate can be calculated by dividing the difference between the new output value and the output value received immediately therebefore (that is, the most recent output value) by 20 seconds, which is the predetermined interval described above.

That is, the following can be set:

$$(\text{Rate of change of output value}) = ((\text{new output value}) - (\text{most recent output value})) / (\text{predetermined interval})$$

In addition, in the amendment to the Air Pollution Control Act that came into effect as of April 1, 2018, the emission reference value of mercury in a new waste incinerator is set to 30 $\mu\text{g}/\text{Nm}^3$ on the average per unit time. Therefore, here, the first threshold value C1 is set to a value equivalent to 20 $\mu\text{g}/\text{Nm}^3$ as one example in order to reduce the exhaust gas mercury concentration at an early stage from the stage of the exhaust gas mercury concentration which is slightly smaller than a legal reference value.

[0032]

Next, in step S2, the description proceeds to the case where the received output value of the control device 13 is more than or equal to the first threshold value C1.

First, the control device 13 calculates the rate of change (rate of increase) of the output value using the received new output value, and determines whether the rate of increase is less than a first rate of increase V1 (step S31), more than or equal to the first rate of increase V1 and less than a second rate of increase V2 (step S32), more than or equal to the second rate of increase V2 and less than a third rate of increase V3 (step S33), and more than or equal to the third rate of increase V3 (step S34). Here, as an example, the first rate of increase V1 is set to a value equivalent to 1 $\mu\text{g}/\text{Nm}^3 \cdot \text{s}$, the second

rate of increase V2 is a value equivalent to $3 \mu\text{g}/\text{Nm}^3\cdot\text{s}$, and the third rate of increase V3 is a value equivalent to $5 \mu\text{g}/\text{Nm}^3\cdot\text{s}$.

[0033]

In a case where the rate of increase is less than the first rate of increase V1, the control device 13 controls the activated carbon-supplying device 12 to continuously supply the first supply amount A1 of the activated carbon (step S41). In a case where the rate of increase is more than or equal to the first rate of increase V1 and less than the second rate of increase V2, the second supply amount A2 of the activated carbon is continuously supplied (step S42).

In a case where the rate of increase is more than or equal to the second rate of increase V2 and less than the third rate of increase V3, the third supply amount A3 of the activated carbon is continuously supplied (step S43). In a case where the rate of increase is more than or equal to the third rate of increase V3, the fourth supply amount A4 of the activated carbon is continuously supplied (step S44).

That is, in a case where the output value is more than or equal to the first threshold value C1, the supply amount of the activated carbon can be immediately increased significantly when the rate of increase of the exhaust gas mercury concentration increases rapidly, and can be slightly increased when the rate of increase of the exhaust gas mercury concentration increases gradually.

[0034]

Next, after the execution of step S41, S42, S43, or S44, the control device 13 receives a new output value from the mercury concentration meter 11. Then, as described above, the control device 13 calculates the rate of increase, and determines whether the rate of increase is less than 0 or more than or equal to 0. In Fig. 2, the determination executed after step S41 is indicated as step S51, the determination executed after step S42 is indicated as step S52, the determination executed after step S43 is indicated as step S53, and the determination executed after step S44 is indicated as step S54.

[0035]

In step S51, in a case where the rate of increase is determined to be 0 or higher, the exhaust gas mercury concentration is in a state of increasing or being balanced with the supply amount of the activated carbon. In order to reduce the exhaust gas mercury concentration at an early stage, the supply amount of the activated carbon that has been supplied at the present point in time needs to be further increased, but it is increased in stages in consideration of economy. Thus, the control device 13 executes step S42. That is, the control device 13 controls the activated carbon-supplying device 12 to supply

the second supply amount A2, which is a supply amount that is one stage above the first supply amount A1.

[0036]

Similarly, in step S52, in a case where the rate of increase is determined
 5 to be more than or equal to zero, since the exhaust gas mercury concentration is in a state of increasing or being balanced with the supply amount of the activated carbon, the control device 13 executes step S43. That is, the control device 13 controls the activated carbon-supplying device 12 to supply the third supply amount A3, which is a supply amount that is one stage above the second
 10 supply amount A2. In step S53, in a case where the rate of increase is determined to be more than or equal to zero, the control device 13 executes step S44. That is, the control device 13 controls the activated carbon-supplying device 12 to supply the fourth supply amount A4, which is a supply amount that is one stage above the third supply amount A3.

15 However, in step S54, in a case where the rate of increase is determined to be more than or equal to zero, although the exhaust gas mercury concentration is in a state of increasing or being balanced with the supply amount of the activated carbon, the supply amount of the activated carbon that has been supplied at this point in time is the fourth supply amount A4, which is
 20 the maximum supply amount of the activated carbon-supplying device 12. Therefore, the control device 13 continues with step S44.

[0037]

In step S51, S52, S53, or S54, in a case where the rate of increase is determined to be less than zero, the exhaust gas mercury concentration is
 25 decreasing (falling). Then, the control device 13 determines whether the received output value is less than the second threshold value C2 or more than or equal to the second threshold value C2. In Fig. 2, the determination executed after step S51 is indicated as step S61, the determination executed after step S52 is indicated as step S62, the determination executed after step
 30 S53 is indicated as step S63, the determination executed after step S54 is indicated as step S64.

[0038]

Here, as an example, the second threshold value C2 is a value equivalent to a legal reference value, and is set to a value equivalent to $30 \mu\text{g}/\text{Nm}^3$
 35 (average value per unit time), which is a reference value of mercury in a new waste incinerator.

In step S61, S62, S63, or S64, in a case where the output value is determined to be more than or equal to the second threshold value C2, the

exhaust gas mercury concentration is decreasing. However, in a case where this continues for a long period of time, there is a possibility that the output value may exceed the reference value. Therefore, even if the exhaust gas mercury concentration is decreasing, when the supply amount of the activated carbon is reduced at this point in time, it is difficult to reduce the exhaust gas mercury concentration at an early stage.

[0039]

Therefore, the control device 13 controls the activated carbon-supplying device 12 to maintain the supply amount of the activated carbon that has been supplied at the present point in time. That is, in step S61, in a case where the output value is determined to be more than or equal to the second threshold value C2, the control device 13 continues with step S41. Similarly, in step S62, in a case where the output value is determined to be more than or equal to the second threshold value C2, the control device 13 continues with step S42. In step S63, in a case where the output value is determined to be more than or equal to the second threshold value C2, the control device 13 continues with step S43. In step S64, in a case where the output value is determined to be more than or equal to the second threshold value C2, the control device 13 continues with step S44.

[0040]

In step S61, S62, S63, or S64, in a case where the output value is determined to be less than the second threshold value C2, the exhaust gas mercury concentration is decreasing, and the exhaust gas mercury concentration has already fallen below the legal reference value. Therefore, in view of economy, the control device 13 gradually decreases the supply amount of the activated carbon that has been supplied at the present point in time, in stages.

[0041]

That is, in step S64, in a case where the output value is determined to be less than the second threshold value C2, the control device 13 executes step S74. In step S74, the control device 13 controls the activated carbon-supplying device 12 to supply the third supply amount A3, which is a supply amount that is one stage below the fourth supply amount A4. At this time, the control device 13 receives a new output value from the mercury concentration meter 11, and it determines whether the rate of increase is less than zero or more than or equal to zero. In a case where the rate of increase is determined to be more than or equal to zero, there is a possibility that the exhaust gas mercury concentration may increase again. Therefore, the control device 13

executes step S44 to return to the fourth supply amount A4, which is the original supply amount of the activated carbon. On the other hand, in a case where the rate of increase is determined to be less than zero, the exhaust gas mercury concentration continues to decrease, and thus the control device 13
5 executes step S63.

[0042]

Similarly, in step S63, in a case where the output value is determined to be less than the second threshold value C2, the control device 13 executes step S73. In step S73, the control device 13 controls the activated carbon-
10 supplying device 12 to supply the second supply amount A2, which is a supply amount that is one stage below the third supply amount A3. At this time, the control device 13 receives a new output value from the mercury concentration meter 11, and it determines whether the rate of increase is less than zero or more than or equal to zero. In a case where the rate of increase is determined
15 to be more than or equal to zero, there is a possibility that the exhaust gas mercury concentration may increase again. Therefore, the control device 13 executes step S43 to return to the third supply amount A3, which is the original supply amount of the activated carbon. On the other hand, in a case where the rate of increase is determined to be less than zero, the exhaust gas mercury
20 concentration continues to decrease, and thus the control device 13 executes step S62.

[0043]

Also, in step S62, in a case where the output value is determined to be less than the second threshold value C2, the control device 13 executes step
25 S72. In step S72, the control device 13 controls the activated carbon-supplying device 12 to supply the first supply amount A1, which is a supply amount that is one stage below the second supply amount A2. At this time, the control device 13 receives a new output value from the mercury concentration meter 11, and it determines whether the rate of increase is less
30 than zero or more than or equal to zero. In a case where the rate of increase is determined to be more than or equal to zero, there is a possibility that the exhaust gas mercury concentration may increase again. Therefore, the control device 13 executes step S42 to return to the second supply amount A2, which is the original supply amount of the activated carbon. On the other hand, in a
35 case where the rate of increase is determined to be less than zero, the exhaust gas mercury concentration continues to decrease, and thus the control device 13 executes step S61.

[0044]

Furthermore, in step S61, in a case where the most recent output value is determined to be less than the second threshold value C2, the control device 13 executes step S71. At this point in time, the first supply amount A1, which is the minimum amount of the activated carbon continuously supplied, is
5 supplied. Therefore, in order to further reduce the amount of the activated carbon to be supplied, the control device 13 needs to determine whether or not to execute S1 as intermittent supply.

[0045]

Thus, after the execution of S61, the control device 13 determines
10 whether the most recent output value is less than the third threshold value C3 or more than or equal to the third threshold value C3. Here, the third threshold value C3 is set to a value equivalent to $10 \mu\text{g}/\text{Nm}^3$ that is smaller than the first threshold value C1. That is, the third threshold value C3 is set to a value that is smaller than a value equivalent to the first threshold value C1 at
15 which the exhaust gas mercury concentration at this point in time is sufficiently smaller than the legal reference value and continuous supply of the activated carbon is started.

[0046]

In step S71, in a case where the output value is determined to be less
20 than the third threshold value C3, the control device 13 executes step S1. In this case, the exhaust gas mercury concentration is significantly lower than the reference value, and considering economy, normal control under which the supply amount of the activated carbon does not need to be increased is returned.

25 In step S71, in a case where the output value is determined to be more than or equal to the third threshold value C3, the control device 13 executes step S31. In addition, it is checked again whether there is indication for increasing the exhaust gas mercury concentration.

[0047]

30 According to the above embodiment, it is possible to predict whether the concentration of mercury in the exhaust gas flowing through the measurement location of the mercury concentration meter 11 increases rapidly, is steady, or decreases, after the measurement by the mercury concentration meter 11, based on the rate of change of the output value of the mercury concentration meter
35 11, so that the supply amount of the activated carbon supplied upstream of the dust-collecting device 7 can be greatly increased, gradually increased, maintained, or decreased in accordance with the corresponding rate. In other words, since an appropriate amount of the activated carbon is supplied in

advance by predicting a change in the mercury concentration at the activated carbon supply location, it is possible to economically and effectively reduce the discharge amount of mercury in the exhaust gas that is released to the atmosphere.

5 [0048]

In addition, in the present embodiment, in a case where the rate of increase rapidly increases, the supply amount of the activated carbon can be increased greatly in advance, in a case where the rate of increase gradually increases, the supply amount can be increased in advance in stages, and in a
10 case where there is a rate of change of more than or equal to zero even after the amount of the activated carbon supplied is increased, the amount of the activated carbon supplied is further increased. That is, since the amount of the activated carbon supplied is increased in multiple stages in accordance with the rate of increase of the exhaust gas mercury concentration, it is possible to
15 reduce the discharge amount of mercury in the exhaust gas more economically and effectively.

[0049]

Furthermore, in the present embodiment, regardless of the rate at which the exhaust gas mercury concentration decreases, until the exhaust gas mercury
20 concentration decreases below a predetermined value (second threshold value, for example, the legal reference value), the amount of the activated carbon supplied at that point in time is maintained to rapidly reduce the exhaust gas mercury concentration. In a case where the exhaust gas mercury concentration is less than the predetermined value, the amount of the activated
25 carbon supplied is reduced in accordance with the rate of decrease of the exhaust gas mercury concentration. Therefore, the exhaust gas mercury concentration can be rapidly reduced. In addition, when the exhaust gas mercury concentration is less than the predetermined value, the amount of the activated carbon is reduced in accordance with the rate at which the exhaust gas
30 mercury concentration decreases, and the activated carbon is eventually supplied in an intermittent manner. Accordingly, it is possible to reduce the discharge amount of mercury in the exhaust gas more economically and effectively.

[0050]

35 In the present embodiment, activated carbon may be a halogen-impregnated activated carbon. The halogen-impregnated activated carbon can obtain a more stable, high mercury removal performance compared to normal activated carbon.

[0051]

(Modified Example 1)

Hereinafter, a modified example of the embodiment of the present invention will be described in detail with reference to the drawings. In Modified Example 1, differences from the above-described embodiment will be mainly described, and description of similarities will be omitted.

As illustrated in Fig. 3, an exhaust gas mercury removal system 1B of the present modified example is characterized in that a control device 13B controls not only the activated carbon-supplying device 12 but also the temperature reduction column 6.

[0052]

In a case where the output value of the mercury concentration meter 11 becomes more than or equal to the first threshold value C1, the control device 13B of the present modified example increases the amount of water to be sprayed by controlling the temperature reduction column 6 to decrease the temperature of the exhaust gas “E” entering the dust-collecting device 7 from the normal temperature. However, the temperature is such that low-temperature corrosion does not occur.

Since the amount of mercury removed increases when the temperature of the exhaust gas “E” is low, the discharge amount of mercury in the exhaust gas can be reduced more economically and effectively according to Modified Example 1.

[0053]

(Modified Example 2)

Hereinafter, a modified example of the embodiment of the present invention will be described in detail with reference to the drawings. In Modified Example 2, differences from the above-described embodiment will be mainly described, and description of similarities will be omitted.

As illustrated in Fig. 4, an exhaust gas mercury removal system 1C of the present modified example is characterized by being provided with a fly ash-circulating device 27.

[0054]

The fly ash-circulating device 27 includes a transporting unit 28 transports fly ash discharged from the bottom of the dust-collecting device 7 by backwashing of the dust-collecting device 7, and an ejecting unit 29 ejects (spray) and supplies the transported fly ash into the pipe 9a, which is upstream of the dust-collecting device 7 and downstream of the temperature reduction column 6.

According to Modified Example 2, unreacted activated carbon contained in the fly ash discharged from the dust-collecting device 7 can be reused, and therefore, the supply amount of fresh activated carbon can be reduced, and the discharge amount of mercury in the exhaust gas can be more economically reduced.

[0055]

While the embodiments of the present invention have been described above with reference to the drawings, the specific configurations are not limited to those embodiments, and design changes and the like that do not depart from the gist of the present invention are also included. For example, the exhaust gas mercury treatment system of the embodiment may include the characteristics of both Modified Example 1 and Modified Example 2.

Industrial Applicability

[0056]

The present invention relates to a mercury removal system that removes mercury from exhaust gas discharged from a plant such as a waste incineration plant provided with a waste incinerator or a coal-fired power plant provided with a boiler. According to the present invention, it is possible to economically and effectively reduce the discharge amount of mercury in the exhaust gas that is discharged to the atmosphere.

Reference Signs List

[0057]

1, 1B, 1C Waste treatment plant (exhaust gas mercury removal system)

3 Waste incinerator

4 Boiler

6 Temperature reduction column

7 Dust-collecting device

8 Chimney

9a Pipe

9b Pipe

11 Mercury concentration meter

12 Activated carbon-supplying device

13, 13B Control device

14 Hopper

15 Feeder

28 Transporting unit

29 Ejecting unit

E Exhaust Gas

Claims

[Claim 1]

An exhaust gas mercury removal system comprising:

a mercury concentration meter that measures a concentration of mercury contained in an exhaust gas discharged from a dust-collecting device that removes dust from the exhaust gas containing the mercury and outputs an output value corresponding to a result of the measurement;

an activated carbon-supplying device that supplies activated carbon to the exhaust gas upstream of the dust-collecting device; and

a control device that controls the activated carbon-supplying device based on the output value,

wherein the control device controls the activated carbon-supplying device to: in a case where the output value is less than a first threshold value, supply a predetermined amount of the activated carbon in an intermittent manner;

in a case where the output value is more than or equal to the first threshold value, and a rate of increase of the output value is less than a first rate of increase, supply a first supply amount of the activated carbon, the first supply amount being larger than the predetermined amount, and in a case where the rate of increase of the output value becomes more than or equal to zero after supplying first supply amount of the activated carbon, supply a second supply amount of the activated carbon, the second supply amount being larger than the first supply amount;

in a case where the output value is more than or equal to the first threshold value, and the rate of increase of the output value is more than or equal to the first rate of increase and is less than a second rate of increase, supply the second supply amount of the activated carbon; and

in a case where the rate of increase of the output value is less than zero after supplying the first supply amount or the second supply amount of the activated carbon, maintain a supply amount of the activated carbon at that point in time until the output value becomes less than a second threshold value that is larger than the first threshold value, and when the output value becomes less than the second threshold value, reduce the supply amount of the activated carbon at that point in time, and when the output value becomes less than a third threshold value that is smaller than the first threshold value, supply the predetermined amount of the activated carbon in the intermittent manner.

[Claim 2]

The exhaust gas mercury removal system according to claim 1, wherein the result of the measurement is a concentration of the mercury at a point in time when the measurement is performed.

[Claim 3]

The exhaust gas mercury removal system according to claim 1 or 2, wherein the activated carbon is halogen-impregnated activated carbon.

[Claim 4]

The exhaust gas mercury removal system according to any one of claims 1 to 3, further comprising:

- a waste incinerator; and

- a temperature reduction column disposed downstream of the waste incinerator and upstream of the dust-collecting device,

wherein the dust-collecting device is a bag filter, the exhaust gas is discharged from the waste incinerator, and in a case where the output value is more than or equal to the first threshold value, the control device controls the temperature reduction column to decrease a temperature of the exhaust gas.

[Claim 5]

The exhaust gas mercury removal system according to claim 4, further comprising a fly ash-circulating device that transports fly ash discharged from the bag filter to an upstream side of the bag filter and a downstream side of the temperature reduction column so as to supply the fly ash toward the exhaust gas.