

DESCRIPTION

APPARATUS FOR TREATMENT OF WASTE GAS AND METHOD FOR TREATING THE SAME

Technical Field

[0001] The present invention relates to an apparatus for treatment of a mercury-containing waste gas that is discharged from various plants, such as a waste incineration facility, a cement manufacturing plant, a thermal power station, and a nonferrous metal smelting plant, and a method of treating the same.

Background Art

[0002] Mercury may be contained in a waste gas that is discharged from a cement kiln furnace or a nonferrous metal smelting furnace, or a waste gas that is discharged after a mercury-containing waste having been incinerated in a waste incinerator, and if such a waste gas is discharged into the atmosphere as it is, air pollution will be caused, which can be a problem. Then, it is demanded to remove the mercury in the waste gas.

[0003] Further, in 2013, "the Minamata Convention on Mercury" was adopted, and now the movement of strengthening the mercury management is being progressed all over the world. After this treaty having come into force, a policy to control the discharge of mercury has been considered that is to be applied to the facilities which are subject to regulation of mercury emission. The facilities which are subject to regulation of mercury emission include coal thermal power stations, coal fired boilers, nonferrous metal smelting facilities, waste incineration facilities, and cement manufacturing facilities. In such a situation, there is an increasing demand for a treating method that allows effectively removing the mercury in the waste gases discharged from these facilities.

[0004] For example, as a general method for removing the mercury in the waste gases that are discharged from waste incinerators or boiler furnaces, methods as disclosed in Patent Documents 1 and 2 are known; with them, particulate activated carbon is injected into a duct that conducts the waste gas to a bag filter or an electric dust collector to remove the dust in the waste gas, the injection being performed in a location on the upstream side of the bag filter or the electric dust collector, such that the mercury is adsorbed to the particulate activated carbon, and the bag filter or the electric dust collector collects the particulate activated carbon to which the mercury has been adsorbed, together with the dust, thereby the mercury being removed from the waste gas.

[0005] In addition, a method may be used which prepares a powder mixture by mixing activated carbon with slaked lime for neutralizing and removing the acid gas in the waste gas, and injects the powder mixture into the waste gas in the duct on the upstream side of a bag filter to collect the reaction product between the acid gas and the slaked lime, and the activated carbon to which the mercury has been adsorbed, together with the dust, by means of a bag filter, or the like, for treating them. In this way, the mercury in the waste gas is adsorbed to the activated carbon before being removed by means of a dust collector, such as the bag filter.

[0006] The Patent Document 2 discloses a system for removing the mercury in the waste gas in which a dust collector is provided in the middle of a duct through which a mercury-containing waste gas is passed; on the upstream side of the dust collector, an activated carbon charging apparatus that charges activated carbon is additionally provided; and upon the concentration of mercury in the waste gas exceeding a predetermined concentration, the activated carbon is momentarily charged in quantity.

Citation List

Patent Literature

[0007] [Patent Document 1] Japanese Unexamined Patent

Application Publication No. 2010-221085

[Patent Document 2] Japanese Unexamined Patent
Application Publication No. 2014-213308

Disclosure of the Invention

Problems to be Solved by the Invention

[0008] Depending upon the type of a waste that is incineration-treated with an incinerator, or the type of a raw material that is smelted by a cement kiln furnace or a nonferrous metal smelting furnace, the concentration of mercury in the waste gas may be temporarily raised. Even in such an event, in order to assure that the concentration of mercury in the waste gas that is discharged from the chimney is maintained at a low value, there is the need for always injecting a large quantity of activated carbon into the duct or always injecting a large quantity of a powder mixture produced by mixing slaked lime with activated carbon into the duct.

[0009] However, in preparation for an event that the mercury concentration may be temporarily raised, always injecting a large quantity of activated carbon or a powder mixture into the duct will result in an excessive quantity of activated carbon or a powder mixture being supplied in a number of time zones other than that in which the concentration of mercury in the waste gas is temporarily raised, thereby the quantity of use of activated carbon or a powder mixture being largely increased, resulting in there occurring a problem that the waste gas treatment cost is increased, or the quantity of dust and others collected being largely increased, resulting in there being presented a problem that the dust removal treatment cost being increased. For the system for removing the mercury in the waste gas that is disclosed in the Patent Document 2, it is stated that, only when the concentration of mercury in the waste gas exceeds a predetermined concentration, activated carbon is charged to be deposited on the filter cloth in the dust collector for causing the mercury to be adsorbed thereto, whereby the wasteful use of activated carbon can be avoided, however, there

is the possibility that, by simply charging activated carbon in a momentary manner, no sufficient layer of activated carbon can be formed on the filter cloth, and thus the mercury cannot be removed by adsorption.

[0010] The present invention has been made in view of such a situation, and it is intended to provide a waste gas treatment apparatus and a waste gas treating method that reliably remove the mercury in the waste gas by adsorption, and that, even when the concentration of mercury in the waste gas is varied, activated carbon is supplied thereto at an appropriate activated carbon supply rate.

Means for Solving the Problems

[0011] In accordance with the present invention, the above problems will be solved by the apparatuses for treatment of waste gas and further the methods of treating the same that will be described below.

[0012] Waste gas treatment apparatuses

The waste gas treatment apparatuses in the present invention are constituted by the waste gas treatment apparatuses of the first invention, the second invention and the third invention that will be described below, any one of which can solve the above problems.

[0013] Waste gas treatment apparatus of first invention

A waste gas treatment apparatus having a dust collector for dust removal treatment of a mercury-containing waste gas that is discharged from a furnace, and an activated carbon supply device that injects activated carbon into a waste gas flow path conducting the waste gas from the furnace to the dust collector, the waste gas treatment apparatus including a downstream side mercury concentration meter that measures the concentration of mercury in the waste gas on the downstream side of the dust collector, and a controller that controls the activated carbon supply rate of the activated carbon supply device, the controller maintaining the activated carbon supply rate at a value equal to or greater than a predetermined minimum

value, while controlling the activated carbon supply rate such that, on the basis of a mercury concentration measurement that is given by the downstream side mercury concentration meter, the concentration of mercury in the waste gas on the downstream side of the dust collector is held at a value equal to or smaller than a set value.

[0014] Waste gas treatment apparatus of second invention

A waste gas treatment apparatus having a dust collector for dust removal treatment of a mercury-containing waste gas that is discharged from a furnace, and an activated carbon supply device that injects activated carbon into a waste gas flow path conducting the waste gas from the furnace to the dust collector, the waste gas treatment apparatus including an upstream side mercury concentration meter that measures the concentration of mercury in the waste gas on the downstream side of the furnace and on the upstream side of the dust collector, and a controller that controls the activated carbon supply rate of the activated carbon supply device, the controller maintaining the activated carbon supply rate at a value equal to or greater than a predetermined minimum value, while controlling the activated carbon supply rate such that, on the basis of a mercury concentration measurement that is given by the upstream side mercury concentration meter, the concentration of mercury in the waste gas on the downstream side of the dust collector is held at a value equal to or smaller than a set value.

[0015] Waste gas treatment apparatus of third invention

A waste gas treatment apparatus having a dust collector for dust removal treatment of a mercury-containing waste gas that is discharged from a furnace, and an activated carbon supply device that injects activated carbon into a waste gas flow path conducting the waste gas from the furnace to the dust collector, the waste gas treatment apparatus including an upstream side mercury concentration meter that measures the concentration of mercury in the waste gas on the downstream side of the furnace and on the upstream side of the dust collector,

a downstream side mercury concentration meter that measures the concentration of mercury in the waste gas on the downstream side of the dust collector, and a controller that controls the activated carbon supply rate of the activated carbon supply device, the controller maintaining the activated carbon supply rate at a value equal to or greater than a predetermined minimum value, while controlling the activated carbon supply rate such that, on the basis of a mercury concentration measurement that is given by the upstream side mercury concentration meter, and a mercury concentration measurement that is given by the downstream side mercury concentration meter, the concentration of mercury in the waste gas on the downstream side of the dust collector is held at a value equal to or smaller than a set value.

[0016] With the waste gas treatment apparatuses of the first to third inventions, it is preferable that, when a mercury concentration measurement that is given by the upstream side mercury concentration meter or the downstream side mercury concentration meter is equal to or greater than a predetermined mercury concentration, the controller control the activated carbon supply rate so as for it to be kept at a predetermined maximum value. When the mercury concentration is abruptly and temporarily increased under a situation in which the mercury concentration is not so high in terms of average for one hour, supplying a large quantity of activated carbon in correspondence with such a high mercury concentration will result in an excessive quantity of activated carbon being supplied over a subsequent period of time. Such an excessive supply being caused can be avoided by controlling the activated carbon supply rate so as for it to be kept at a predetermined maximum value.

[0017] In addition, with the waste gas treatment apparatus of the first invention, when a value of the ratio of a mercury concentration measurement in the waste gas on the downstream side of the dust collector that is given by the downstream side mercury concentration meter to a set value of the concentration of mercury in the waste gas on the downstream side of the dust

collector is equal to or greater than a predetermined value of the ratio, the controller can control the activated carbon supply rate so as for it to be kept at a predetermined maximum value, specifying the predetermined value of the ratio in the range of 0.4 to 0.8. In this way, when the value of the ratio is equal to or greater than the predetermined value of the ratio in the range of 0.4 to 0.8, the timing of holding the activated carbon supply rate at a predetermined maximum value is determined. The reason why the range of the predetermined value of the ratio is thus defined is that, if the predetermined value of the ratio is smaller than 0.4, there arises a problem that a large quantity of activated carbon that is more than necessary will be supplied, thereby the activated carbon being excessively used, and thus the treatment cost being increased, and if the predetermined value of the ratio is greater than 0.8, there arises a problem that the activated carbon supply rate will be insufficient, thereby the mercury being not be able to be sufficiently removed by adsorption, and thus the mercury concentration being unable to be lowered to under a set value of mercury concentration.

[0018] In addition, with the waste gas treatment apparatus of the second invention, when a value of the ratio of a mercury concentration measurement on the upstream side of the dust collector that is given by the upstream side mercury concentration meter to a set value of the concentration of mercury in the waste gas on the downstream side of the dust collector is equal to or greater than a predetermined value of the ratio, the controller can control the activated carbon supply rate so as for it to be kept at a predetermined maximum value, specifying the predetermined value of the ratio in the range of 20 to 200. In this way, when the value of the ratio is equal to or greater than the predetermined value of the ratio in the range of 20 to 200, the timing of holding the activated carbon supply rate at a predetermined maximum value is determined. The reason why the range of the predetermined value of the ratio is thus defined is that, if the predetermined value

of the ratio is smaller than 20, there arises a problem that a large quantity of activated carbon that is more than necessary will be supplied, thereby the activated carbon being excessively used, and thus the treatment cost being increased, and if the predetermined value of the ratio is greater than 200, there arises a problem that the activated carbon supply rate will be insufficient, thereby the mercury being not be able to be sufficiently removed by adsorption, and thus the mercury concentration being unable to be lowered to under a set value of mercury concentration.

[0019] In addition, with the waste gas treatment apparatus of the third invention, when a value of the downstream side mercury concentration ratio of a mercury concentration measurement in the waste gas on the downstream side of the dust collector that is given by the downstream side mercury concentration meter to a set value of the concentration of mercury in the waste gas on the downstream side of the dust collector is equal to or greater than a predetermined value of the ratio, or when a value of the upstream side mercury concentration ratio of a mercury concentration measurement on the upstream side of the dust collector that is given by the upstream side mercury concentration meter to a set value of the concentration of mercury in the waste gas on the downstream side of the dust collector is equal to or greater than a predetermined value of the ratio, the controller can control the activated carbon supply rate so as for it to be kept at a predetermined maximum value, specifying the predetermined value of the downstream side mercury concentration ratio in the range of 0.4 to 0.8, while specifying the predetermined value of the upstream side mercury concentration ratio in the range of 20 to 200. In this way, firstly, when the value of the downstream side mercury concentration ratio is equal to or greater than the predetermined value of the downstream side mercury concentration ratio in the range of 0.4 to 0.8, the timing of holding the activated carbon supply rate at a predetermined maximum value is determined. The reason why the range of the

predetermined value of the downstream side mercury concentration ratio is thus defined is that, if the predetermined value of the downstream side mercury concentration ratio is smaller than 0.4, there arises a problem that a large quantity of activated carbon that is more than necessary will be supplied, thereby the activated carbon being excessively used, and thus the treatment cost being increased, and if the predetermined value of the downstream side mercury concentration ratio is greater than 0.8, there arises a problem that the activated carbon supply rate will be insufficient, thereby the mercury being not be able to be sufficiently removed by adsorption, and thus the mercury concentration being unable to be lowered to under a set value of mercury concentration. In this way, secondly, when the value of the upstream side mercury concentration ratio is equal to or greater than the predetermined value of the upstream side mercury concentration ratio in the range of 20 to 200, the timing of holding the activated carbon supply rate at a predetermined maximum value is determined. The reason why the range of the predetermined value of the upstream side mercury concentration ratio is thus defined is that, if the predetermined value of the upstream side mercury concentration ratio is smaller than 20, there arises a problem that a large quantity of activated carbon that is more than necessary will be supplied, thereby the activated carbon being excessively used, and thus the treatment cost being increased, and if the predetermined value of the upstream side mercury concentration ratio is greater than 200, there arises a problem that, the activated carbon supply rate will be insufficient, thereby the mercury being not be able to be sufficiently removed by adsorption, and thus the mercury concentration being unable to be lowered to under a set value of mercury concentration.

[0020] Further, with the waste gas treatment apparatuses of the first to third inventions, the controller can control the activated carbon supply rate, setting the predetermined minimum value of the activated carbon supply rate, which is defined as

a weight of the activated carbon injected per hour per unit flow rate of the waste gas under treatment, at 10 to 200 mg/Nm³. In this way, in the range of 10 to 200 mg/Nm³, the predetermined minimum value of the activated carbon supply rate may be set at a value in the lower region of that range in the case where the concentration of mercury in the waste gas is low, while it may be set at a value in the higher region of that range in the case where the concentration of mercury is high. In the case where the concentration of mercury in the waste gas is lower than the predetermined value, the activated carbon supply rate is kept at a predetermined minimum value, thereby an adsorption layer of activated carbon being always formed on the bag filter of the dust collector, and thus even upon a waste gas containing mercury at a concentration higher than the predetermined value being discharged, the adsorption removal action by the adsorption layer that has been already formed, and the adsorption removal action by the activated carbon that is injected at the time of the waste gas being discharged allow the mercury to be rapidly and reliably removed by adsorption, whereby the mercury concentration of the waste gas after the dust collection can be lowered to a sufficiently low concentration. Setting the predetermined minimum value at a value under 10 mg/Nm³ makes it difficult to sufficiently form the activated carbon adsorption layer on the bag filter of the dust collector, thereby being inadequate, while setting the predetermined minimum value at a value over 200 mg/Nm³ will make the activated carbon supply rate excessive, and thus increase the cost, being disadvantageous.

[0021] Further, with the waste gas treatment apparatuses of the first to third inventions, the controller can control the activated carbon supply rate, setting the predetermined maximum value of the activated carbon supply rate, which is defined as a weight of the activated carbon injected per hour per unit flow rate of the waste gas under treatment, at 300 to 1000 mg/Nm³. In this way, in the range of 300 to 1000 mg/Nm³, the predetermined maximum value of the activated carbon supply rate may be set

at a value in the lower region of that range in the case where the concentration of mercury in the waste gas is low, while it may be set at a value in the higher region of that range in the case where the concentration of mercury is high. Setting the maximum setting value at a value under 300 mg/Nm³ may cause a trouble of the activated carbon being incapable of removing the mercury in the waste gas by adsorption, thereby being inadequate, while setting the predetermined maximum value at a value over 1000 mg/Nm³ will make the activated carbon supply rate excessive, and thus increase the cost, being disadvantageous.

[0022] In addition, with the waste gas treatment apparatuses of the first to third inventions, in terms of the capability of increasing the activated carbon supply rate from a minimum value to a maximum value, the controller can control the activated carbon supply rate such that, in the range of the measurement of the concentration of mercury in the waste gas from zero or a value smaller than the measurable limit minimum value to a first predetermined mercury concentration, activated carbon is supplied at a predetermined minimum value of activated carbon supply rate, and after the measurement of the mercury concentration has reached the first predetermined mercury concentration, the activated carbon supply rate is linearly increased from the predetermined minimum value in accordance with an increase in the concentration of mercury in the waste gas, and when the measurement of the mercury concentration has reached a second predetermined mercury concentration, the activated carbon supply rate is set at a predetermined maximum value of supply rate, then, after the activated carbon supply rate having been increased to the predetermined maximum value, the activated carbon supply rate is constantly kept at the predetermined maximum value for an increase in the concentration of mercury in the waste gas.

[0023] Further, with the waste gas treatment apparatuses of the first to third inventions, in terms of the capability of increasing the activated carbon supply rate from a minimum value to a maximum value, the controller can control the activated

carbon supply rate such that, in the range of the measurement of the concentration of mercury in the waste gas from zero or a value smaller than the measurable limit minimum value to a first predetermined mercury concentration, activated carbon is supplied at a predetermined minimum value of activated carbon supply rate that provides a first activated carbon supply rate, and after the measurement of the mercury concentration has reached the first predetermined mercury concentration, the activated carbon supply rate is increased in a step-like manner to a second supply rate, thereafter, for an increase in the concentration of mercury in the waste gas, the activated carbon supply rate is constantly kept at the second supply rate, then, when the measurement of the mercury concentration has reached the second predetermined mercury concentration, the activated carbon supply rate is increased to a third predetermined activated carbon supply rate, thereafter, in this way, constantly keeping the activated carbon supply rate and then increasing it in a stepwise manner for an increase in the concentration of mercury in the waste gas is repeated, then, after the activated carbon supply rate having been increased to a predetermined maximum value, the activated carbon supply rate is constantly kept at the predetermined maximum value for an increase in the concentration of mercury in the waste gas.

[0024] As described above, by increasing the activated carbon supply rate from a minimum value to a maximum value on the basis of a measurement of the concentration of mercury in the waste gas, the activated carbon supply rate can be smoothly controlled with no trouble being caused in the supply rate adjusting mechanism in the activated carbon supply device.

[0025] Waste gas treating method

The waste gas treatment methods in the present invention are constituted by the waste gas treating methods of the fourth invention, the fifth invention and the sixth invention that will be described below, any one of which can solve the above problems.

[0026] Fourth invention

A waste gas treating method that uses a dust collector to perform dust removal treatment of a mercury-containing waste gas that is discharged from a furnace, and that injects activated carbon from an activated carbon supply device into a waste gas flow path conducting the waste gas from the furnace to the dust collector, the waste gas treating method including a measurement step of measuring the concentration of mercury in the waste gas on the downstream side of the dust collector using a downstream side mercury concentration meter, and a control step of controlling the activated carbon supply rate of the activated carbon supply device with a controller, in the control step, the controller maintaining the activated carbon supply rate at a value equal to or greater than a predetermined minimum value, while controlling the activated carbon supply rate such that, on the basis of a mercury concentration measurement that is given by the downstream side mercury concentration meter, the concentration of mercury in the waste gas on the downstream side of the dust collector is held at a value equal to or smaller than a set value.

[0027] Fifth invention

A waste gas treating method that uses a dust collector to perform dust removal treatment of a mercury-containing waste gas that is discharged from a furnace, and that injects activated carbon from an activated carbon supply device into a waste gas flow path conducting the waste gas from the furnace to the dust collector, the waste gas treating method including a measurement step of measuring the concentration of mercury in the waste gas on the downstream side of the furnace and on the upstream side of the dust collector using an upstream side mercury concentration meter, and a control step of controlling the activated carbon supply rate of the activated carbon supply device with a controller, in the control step, the controller maintaining the activated carbon supply rate at a value equal to or greater than a predetermined minimum value, while controlling the activated carbon supply rate such that, on the basis of a mercury concentration measurement that is given by

the upstream side mercury concentration meter, the concentration of mercury in the waste gas on the downstream side of the dust collector is held at a value equal to or smaller than a set value.

[0028] Sixth invention

A waste gas treating method that uses a dust collector to perform dust removal treatment of a mercury-containing waste gas that is discharged from a furnace, and that injects activated carbon from an activated carbon supply device into a waste gas flow path conducting the waste gas from the furnace to the dust collector, the waste gas treating method including a measurement step of measuring the concentration of mercury in the waste gas on the downstream side of the furnace and on the upstream side of the dust collector using an upstream side mercury concentration meter, and measuring the concentration of mercury in the waste gas on the downstream side of the dust collector using a downstream side mercury concentration meter, and a control step of controlling the activated carbon supply rate of the activated carbon supply device with a controller, in the control step, the controller maintaining the activated carbon supply rate at a value equal to or greater than a predetermined minimum value, while controlling the activated carbon supply rate such that, on the basis of a mercury concentration measurement that is given by the upstream side mercury concentration meter, and a mercury concentration measurement that is given by the downstream side mercury concentration meter, the concentration of mercury in the waste gas on the downstream side of the dust collector is held at a value equal to or smaller than a set value.

[0029] With the waste gas treating methods according the fourth to sixth inventions, it is preferable that, when a mercury concentration measurement that is given by the upstream side mercury concentration meter or the downstream side mercury concentration meter is equal to or greater than a predetermined mercury concentration, the controller control the activated carbon supply rate so as for it to be kept at a predetermined

maximum value in the control step. When the mercury concentration is abruptly and temporarily increased under a situation in which the mercury concentration is not so high in terms of average for one hour, supplying a large quantity of activated carbon in correspondence with such a high mercury concentration will result in an excessive quantity of activated carbon being supplied over a subsequent period of time. Such an excessive supply being caused can be avoided by controlling the activated carbon supply rate so as for it to be kept at a predetermined maximum value.

[0030] In addition, with the waste gas treating method according to the fourth invention, when a value of the ratio of a mercury concentration measurement in the waste gas on the downstream side of the dust collector that is given by the downstream side mercury concentration meter to a set value of the concentration of mercury in the waste gas on the downstream side of the dust collector is equal to or greater than a predetermined value of the ratio, the controller can control the activated carbon supply rate so as for it to be kept at a predetermined maximum value, specifying the predetermined value of the ratio in the range of 0.4 to 0.8. In this way, when the value of the ratio is equal to or greater than the predetermined value of the ratio in the range of 0.4 to 0.8, the timing of holding the activated carbon supply rate at a predetermined maximum value is determined. The reason why the range of the predetermined value of the ratio is thus defined is that, if the predetermined value of the ratio is smaller than 0.4, there arises a problem that a large quantity of activated carbon that is more than necessary will be supplied, thereby the activated carbon being excessively used, and thus the treatment cost being increased, and if the predetermined value of the ratio is greater than 0.8, there arises a problem that the activated carbon supply rate will be insufficient, thereby the mercury being not be able to be sufficiently removed by adsorption, and thus the mercury concentration being unable to be lowered to under a set value of mercury concentration.

[0031] In addition, with the waste gas treatment method of the fifth invention, when a value of the ratio of a mercury concentration measurement on the upstream side of the dust collector that is given by the upstream side mercury concentration meter to a set value of the concentration of mercury in the waste gas on the downstream side of the dust collector is equal to or greater than a predetermined value of the ratio, the controller can control the activated carbon supply rate so as for it to be kept at a predetermined maximum value, specifying the predetermined value of the ratio in the range of 20 to 200. In this way, when the value of the ratio is equal to or greater than the predetermined value of the ratio in the range of 20 to 200, the timing of holding the activated carbon supply rate at a predetermined maximum value is determined. The reason why the range of the predetermined value of the ratio is thus defined is that, if the predetermined value of the ratio is smaller than 20, there arises a problem that a large quantity of activated carbon that is more than necessary will be supplied, thereby the activated carbon being excessively used, and thus the treatment cost being increased, and thus the treatment cost being increased, and if the predetermined value of the ratio is greater than 200, there arises a problem that the activated carbon supply rate will be insufficient, thereby the mercury being not be able to be sufficiently removed by adsorption, and thus the mercury concentration being unable to be lowered to under a set value of mercury concentration.

[0032] In addition, with the waste gas treatment method of the sixth invention, when a value of the downstream side mercury concentration ratio of a mercury concentration measurement in the waste gas on the downstream side of the dust collector that is given by the downstream side mercury concentration meter to a set value of the concentration of mercury in the waste gas on the downstream side of the dust collector is equal to or greater than a predetermined value of the ratio, or when a value of the upstream side mercury concentration ratio of a mercury

concentration measurement on the upstream side of the dust collector that is given by the upstream side mercury concentration meter to a set value of the concentration of mercury in the waste gas on the downstream side of the dust collector is equal to or greater than a predetermined value of the ratio, the controller can control the activated carbon supply rate so as for it to be kept at a predetermined maximum value, specifying the predetermined value of the downstream side mercury concentration ratio in the range of 0.4 to 0.8, while specifying the predetermined value of the upstream side mercury concentration ratio in the range of 20 to 200. In this way, firstly, when the value of the downstream side mercury concentration ratio is equal to or greater than the predetermined value of the downstream side mercury concentration ratio in the range of 0.4 to 0.8, the timing of holding the activated carbon supply rate at a predetermined maximum value is determined. The reason why the range of the predetermined value of the downstream side mercury concentration ratio is thus defined is that, if the predetermined value of the downstream side mercury concentration ratio is smaller than 0.4, there arises a problem that a large quantity of activated carbon that is more than necessary will be supplied, thereby the activated carbon being excessively used, and thus the treatment cost being increased, and if the predetermined value of the downstream side mercury concentration ratio is greater than 0.8, there arises a problem that the activated carbon supply rate will be insufficient, thereby the mercury being not be able to be sufficiently removed by adsorption, and thus the mercury concentration being unable to be lowered to under a set value of mercury concentration. In this way, secondly, when the value of the upstream side mercury concentration ratio is equal to or greater than the predetermined value of the upstream side mercury concentration ratio in the range of 20 to 200, the timing of holding the activated carbon supply rate at a predetermined maximum value is determined. The reason why the range of the predetermined

value of the upstream side mercury concentration ratio is thus defined is that, if the predetermined value of the upstream side mercury concentration ratio is smaller than 20, there arises a problem that a large quantity of activated carbon that is more than necessary will be supplied, thereby the activated carbon being excessively used, and thus the treatment cost being increased, and if the predetermined value of the upstream side mercury concentration ratio is greater than 200, there arises a problem that the activated carbon supply rate will be insufficient, thereby the mercury being not be able to be sufficiently removed by adsorption, and thus the mercury concentration being unable to be lowered to under a set value of mercury concentration.

[0033] Further, with the waste gas treating methods of the fourth to sixth inventions, the controller can control the activated carbon supply rate, setting the predetermined minimum value of the activated carbon supply rate, which is defined as a weight of the activated carbon injected per hour per unit flow rate of the waste gas under treatment, at 10 to 200 mg/Nm³. In this way, in the range of 10 to 200 mg/Nm³, the predetermined minimum value of the activated carbon supply rate may be set at a value in the lower region of that range in the case where the concentration of mercury in the waste gas is low, while it may be set at a value in the higher region of that range in the case where the concentration of mercury is high. In the case where the concentration of mercury in the waste gas is lower than the predetermined value, the activated carbon supply rate is kept at a predetermined minimum value, thereby an adsorption layer of activated carbon being always formed on the bag filter of the dust collector, and thus even upon a waste gas containing mercury at a concentration higher than the predetermined value being discharged, the adsorption removal action by the adsorption layer that has been already formed, and the adsorption removal action by the activated carbon that is injected at the time of the waste gas being discharged allow the mercury to be rapidly and reliably removed by adsorption,

whereby the mercury concentration of the waste gas after the dust collection can be lowered to a sufficiently low concentration. Setting the predetermined minimum value at a value under 10 mg/Nm^3 makes it difficult to sufficiently form the activated carbon adsorption layer on the bag filter of the dust collector, thereby being inadequate, while setting the predetermined minimum value at a value over 200 mg/Nm^3 will make the activated carbon supply rate excessive, and thus increase the cost, being disadvantageous.

[0034] Further, with the waste gas treating methods of the fourth to sixth inventions, the controller can control the activated carbon supply rate, setting the predetermined maximum value of the activated carbon supply rate, which is defined as a weight of the activated carbon injected per hour per unit flow rate of the waste gas under treatment, at 300 to 1000 mg/Nm^3 . In this way, in the range of 300 to 1000 mg/Nm^3 , the predetermined maximum value of the activated carbon supply rate may be set at a value in the lower region of that range in the case where the concentration of mercury in the waste gas is low, while it may be set at a value in the higher region of that range in the case where the concentration of mercury is high. Setting the maximum setting value at a value under 300 mg/Nm^3 may cause a trouble of the activated carbon being incapable of removing the mercury in the waste gas by adsorption, thereby being inadequate, while setting the predetermined maximum value at a value over 1000 mg/Nm^3 will make the activated carbon supply rate excessive, and thus increase the cost, being disadvantageous.

[0035] In addition, with the waste gas treating methods of the fourth to sixth inventions, in terms of the capability of increasing the activated carbon supply rate from a minimum value to a maximum value, the controller can control the activated carbon supply rate such that, in the range of the measurement of the concentration of mercury in the waste gas from zero or a value smaller than the measurable limit minimum value to a first predetermined mercury concentration, activated carbon is supplied at a predetermined minimum value of activated carbon

supply rate, and after the measurement of the mercury concentration has reached the first predetermined mercury concentration, the activated carbon supply rate is linearly increased from the predetermined minimum value in accordance with an increase in the concentration of mercury in the waste gas, and when the measurement of the mercury concentration has reached a second predetermined mercury concentration, the activated carbon supply rate is set at a predetermined maximum value of supply rate, then, after the activated carbon supply rate having been increased to the predetermined maximum value, the activated carbon supply rate is constantly kept at the predetermined maximum value for an increase in the concentration of mercury in the waste gas.

[0036] Further, with the waste gas treating methods of the fourth to sixth inventions, in terms of the capability of increasing the activated carbon supply rate from a minimum value to a maximum value, the controller can control the activated carbon supply rate such that, in the range of the measurement of the concentration of mercury in the waste gas from zero or a value smaller than the measurable limit minimum value to a first predetermined mercury concentration, activated carbon is supplied at a predetermined minimum value of activated carbon supply rate that provides a first activated carbon supply rate, and after the measurement of the mercury concentration has reached the first predetermined mercury concentration, the activated carbon supply rate is increased in a step-like manner to a second supply rate, thereafter, for an increase in the concentration of mercury in the waste gas, the activated carbon supply rate is constantly kept at the second supply rate, then, when the measurement of the mercury concentration has reached the second predetermined mercury concentration, the activated carbon supply rate is increased to a third predetermined activated carbon supply rate, thereafter, in this way, constantly keeping the activated carbon supply rate and then increasing it in a stepwise manner for an increase in the concentration of mercury in the waste gas is repeated, then,

after the activated carbon supply rate having been increased to a predetermined maximum value, the activated carbon supply rate is constantly kept at the predetermined maximum value for an increase in the concentration of mercury in the waste gas. [0037] As described above, by increasing the activated carbon supply rate from a minimum value to a maximum value on the basis of a measurement of the concentration of mercury in the waste gas, the activated carbon supply rate can be smoothly controlled with no trouble being caused in the supply rate adjusting mechanism in the activated carbon supply device.

[0038] In accordance with the present invention as described above, with the waste gas treatment apparatus of the first invention, and the waste gas treating method of the fourth invention, on the downstream side of the dust collector, the actual mercury concentration in the waste gas after removing the mercury by adsorption thereof with the use of activated carbon is measured with a mercury concentration meter to adjust the activated carbon supply rate, thereby the activated carbon supply rate being adjusted with no excess or deficiency, and thus the mercury concentration can be brought to under a set value that is tolerated.

[0039] With the waste gas treatment apparatus of the second invention, and the waste gas treating method of the fifth invention, the mercury concentration is measured with a mercury concentration meter on the downstream side of the furnace and on the upstream side of the dust collector to adjust the activated carbon supply rate on the basis of the measurement obtained to thereby bring the concentration of mercury in the waste gas on the downstream side of the dust collector to under a set value that is tolerated. In the event that the concentration of mercury in the waste gas from the furnace is varied, the mercury concentration is measured before the waste gas flowing into the dust collector, and on the basis of the measurement obtained, the activated carbon supply rate can be rapidly adjusted to an appropriate rate, whereby the concentration of mercury in the waste gas that is discharged

from the chimney can be reliably brought to under a set value that is tolerated, with no delay being caused with respect to a variation in the mercury concentration.

[0040] Further, with the waste gas treatment apparatus of the third invention, and the waste gas treating method of the sixth invention, the mercury concentration is measured on the downstream side of the furnace and on the upstream side of the dust collector with a mercury concentration meter, and also on the downstream side of the dust collector, the mercury concentration is measured with a mercury concentration meter, thus, on the basis of these two measurements, the activated carbon supply rate is controlled such that the mercury concentration on the downstream side of the dust collector is brought to under a set value that is tolerated. On the basis of the mercury concentration measurement on the downstream side of the furnace and on the upstream side of the dust collector, the controller performs a control to determine a base value of the activated carbon supply rate, and further on the basis of the mercury concentration measurement on the downstream side of the dust collector, the controller performs a complementation control of the activated carbon supply rate by increasing or decreasing the base value of the activated carbon supply rate to tune up the activated carbon supply rate. In this way, the concentration of mercury in the waste gas that is discharged from the chimney can be more reliably brought to under a set value that is tolerated, with no delay being caused with respect to a variation in the mercury concentration.

[0041] With the waste gas treatment apparatus of the first invention, and the waste gas treating method of the fourth invention, the actual mercury concentration on the downstream side of the dust collector is measured, thereby the concentration of mercury in the waste gas that is discharged from the chimney being reliably brought to under a set value, however, in the event that there occurs a variation in the concentration of mercury in the waste gas from the furnace, a delay is involved in tuning up the activated carbon supply rate

with respect to that variation. On the other hand, with the waste gas treatment apparatus of the second invention, and the waste gas treating method of the fifth invention, the mercury concentration is measured on the upstream side of the dust collector, thereby the variation being able to be rapidly accommodated. Further, with the waste gas treatment apparatus of the third invention, and the waste gas treating method of the sixth invention, the mercury concentration is measured on the upstream side of the dust collector, and further the mercury concentration is measured on the downstream side of the dust collector, thus on the basis of these two measurements, the activated carbon supply rate being tuned up, whereby the concentration of mercury in the waste gas that is discharged from the chimney can be more reliably brought to under a set value that is tolerated, with no delay being caused with respect to a variation in the mercury concentration.

Advantages of the Invention

[0042] In this way, in accordance with the present invention, the concentration of mercury in the waste gas is measured in a location on the downstream side of the dust collector, or is measured on the upstream side of the dust collector, or is measured on the upstream side of the dust collector and on the downstream side of the dust collector, the activated carbon supply rate being maintained at a value equal to or greater than a predetermined minimum value, while the supply rate for the activated carbon that is injected being tuned up on the basis of a mercury concentration measurement, whereby the concentration of mercury in the waste gas that is discharged from the chimney can be reliably brought to under a predetermined value, yet the activated carbon being supplied with no excess or deficiency, and thus the quantity of use of the activated carbon can be suppressed with the waste gas treatment cost being reduced.

Brief Description of the Drawing

[0043] Figures 1A and 1B show an apparatus according to a first embodiment of the present invention, Figure 1A giving a schematic configuration drawing therefor, while Figure 1B a schematic configuration drawing for an activated carbon supply device;

Figure 2 is a drawing illustrating a schematic configuration of an apparatus according to a second embodiment of the present invention;

Figure 3 is a drawing illustrating a schematic configuration of an apparatus according to a third embodiment of the present invention;

Figures 4A to 4H show various patterns that can be adopted as a relationship between the concentration of mercury in the waste gas and the activated carbon supply rate;

Figure 5 is a drawing showing a relationship between the mercury concentration in the chimney and the activated carbon supply rate that was used in an Example of the present invention; and

Figure 6 is a drawing showing a relationship between the mercury concentration at the bag filter inlet and the activated carbon supply rate that was used in an Example of the present invention.

Best Mode for Carrying Out the Invention

[0044] Hereinbelow, embodiments of the present invention will be explained with reference to the attached drawings.

[0045] In the present embodiments as described below, an incinerator that incinerates wastes will be explained as a discharge furnace that discharges a mercury-containing waste gas, however, the application for the present invention is not limited to this, but the present invention is applicable to an apparatus for treatment of a mercury-containing waste gas that is discharged from various furnaces, such as a cement kiln furnace, and a nonferrous metal smelting furnace, and is applicable as a method for treating the same.

[0046] For a waste gas from the incinerator that incinerates

the waste, by injecting activated carbon into a flow path of the waste gas at a location on the upstream side of a bag filter that is installed for dust collection, the mercury concentration on the downstream side of the bag filter can be controlled to an extremely low level of concentration, however, conventionally, in consideration of a possible case in which, due to a variation in the type or quantity of the waste, the concentration of mercury in the waste gas from the incinerator is varied, resulting in the mercury concentration on the downstream side of the bag filter being temporarily raised, there has been always a need for injecting the activated carbon in quantity, thereby the waste gas treatment cost having been increased. Then, in the present embodiments, by means of a mercury concentration meter, the mercury concentration is measured, and on the basis of a mercury concentration that has been measured, the activated carbon is injected into the waste gas flow path by a quantity that is not excessive or deficient. The mercury concentration meter is preferably of the type that is suitable for continuous measurement.

[0047] First Embodiment

In Figures 1A and 1B showing a schematic configuration of an apparatus according to a first embodiment, in the waste gas flow path for conducting the waste gas from the incinerator 1 to the chimney 6, a boiler 2 and a bag filter 4 as a dust collector are disposed in this order from the upstream side; in a location on the upstream side of the bag filter 4, there are provided an activated carbon supply device 3 that injects activated carbon into the flow path of the waste gas for removal of the mercury in the waste gas by adsorption, and a controller 7 that controls the activated carbon supply device 3; at the outlet of the bag filter 4 that is located on the downstream side thereof, or in the chimney 6, a mercury concentration meter 5 is provided which measures the concentration of mercury in the waste gas; and the mercury concentration meter 5 is connected to the controller 7 such that it sends the measurement of the mercury concentration meter 5 as an output signal to the

controller 7.

[0048] With such an apparatus according to the first embodiment, the mercury concentration meter 5 measures the concentration of mercury in the waste gas on the downstream side of the bag filter 4.

[0049] The measurement of the mercury concentration meter 5 is sent to the controller 7, and this measurement is compared to a predetermined value of mercury concentration for controlling of the activated carbon supply device 3.

[0050] If the measured mercury concentration is higher than the predetermined value of mercury concentration, the activated carbon supply rate is increased. Then, after the activated carbon supply rate having been increased, if the state in which the mercury concentration is equal to or smaller than the predetermined value of mercury concentration is maintained, the activated carbon supply rate is controlled so as to be decreased.

[0051] Specifically, the activated carbon supply device 3 is comprised of a hopper 3A, which accommodates activated carbon, a dispensing member 3B of rotary type, which is provided in the outlet at the bottom of the hopper 3A, and a valve or damper 3C, which is provided under the dispensing member 3B. With such an activated carbon supply device 3, upon a command signal from the controller 7 having been received, at least one of the number of revolutions of the rotary of the dispensing member 3B, and the opening of the valve or the damper 3C is adjusted to correct the activated carbon supply rate; then the activated carbon being supplied to the flow path of waste gas.

[0052] Second Embodiment

A second embodiment shown in Figure 2 is the same as the above-described first embodiment, except that, when compared thereto, the mercury concentration meter 5 is disposed in a different location. Therefore, in Figure 2, the components that are common to those in the first embodiment in Figure 1A will be provided with the same symbols, the explanation thereof being omitted.

[0053] In the second embodiment, as shown in Figure 2, the mercury concentration meter 5 is disposed so as to measure the concentration of mercury in the waste gas in a location on the downstream side of the incinerator 1 and on the upstream side of the bag filter 4, and on the upstream side of the location where the activated carbon is injected by the activated carbon supply device 3. In the second embodiment, with the controller 7, the relationship among the mercury concentration at this measuring point, the activated carbon supply rate, and the mercury concentration in a location on the downstream side of the bag filter 4 has been grasped on the basis of the accumulated data. Therefore, from the measurement of the mercury concentration on the upstream side of the activated carbon injection location, and the activated carbon supply rate, the mercury concentration on the downstream side of the bag filter 4 can be estimated. In other words, with the controller 7, on the basis of the measurement of the mercury concentration on the upstream side of the activated carbon injection location, the mercury concentration on the downstream side of the bag filter 4 is estimated, and the activated carbon supply rate that is required to lower such estimated mercury concentration to a value equal to or smaller than a predetermined mercury concentration value can be determined, then on the basis of the activated carbon supply rate determined, the activated carbon supply rate of the activated carbon supply device 3 being controlled. As a result of this, the mercury concentration on the downstream side of the bag filter 4 is lowered to a value equal to or smaller than the predetermined mercury concentration value.

[0054] In such second embodiment, in the event that there occurs a variation in concentration of mercury in the waste gas from the incinerator 1, the mercury concentration meter 5 measures and detects the variation in mercury concentration in a location on the downstream side of the incinerator 1 and on the upstream side of the location where activated carbon is injected by the activated carbon supply device 3, and thus the

activated carbon supply rate can be rapidly corrected, whereby the concentration of mercury in the waste gas in the chimney can be reliably maintained at a value equal to or smaller than a set value with no time lag. In an example shown in Figure 2, the point of measuring the mercury concentration by the mercury concentration meter 5 is located on the upstream side of the location where activated carbon is injected, however, the mercury concentration measuring point is not limited to such location, and it may be on the upstream side of the bag filter 4, and yet on the downstream side of the location where activated carbon is injected.

[0055] Third Embodiment

A third embodiment shown in Figure 3 is different from the above-described second embodiment in that, in addition to a first mercury concentration meter 5A, which is disposed on the upstream side of the location where activated carbon is injected by the activated carbon supply device 3, a second mercury concentration meter 5B to measure the concentration of mercury in the waste gas is provided at the outlet of the bag filter 4 or in the chimney 6, which is located on the downstream side of the bag filter 4, and the measurement of the second mercury concentration meter 5B is sent to the controller 7 as an output signal. Except for such point, the third embodiment is the same as the second embodiment. Therefore, in Figure 3, the components that are common to those in the second embodiment in Figure 2 will be provided with the same symbols, the explanation thereof being omitted.

[0056] With the third embodiment, as shown in Figure 3, in addition to the first mercury concentration meter 5A, which is disposed on the upstream side of the location where activated carbon is injected by the activated carbon supply device 3 in the second embodiment, a second mercury concentration meter 5B is provided at the outlet of the bag filter 4 or in the chimney 6. As in the second embodiment, on the basis of the measurement that is given by the first mercury concentration meter 5A, which is located on the upstream side of the location where activated

carbon is injected by the activated carbon supply device 3, the base value of the activated carbon supply rate is controlled, and further, on the basis of the measurement that is given by the second mercury concentration meter 5B at the outlet of the bag filter 4 or in the chimney, the control on the basis of the measurement by the first mercury concentration meter 5A is complemented, the base value of the activated carbon supply rate being increased or decreased.

[0057] There is a time lag from the moment when a phenomenon with which the mercury concentration measurement that is given by the first mercury concentration meter 5A on the upstream side of the location where activated carbon is injected by the activated carbon supply device 3 is increased in a short period of time (which is called a measurement peak) is detected to the moment when, at the outlet of the bag filter 4 or in the chimney, a measurement peak of mercury concentration is detected by the second mercury concentration meter 5B, and therefore, even when the measurement peak of mercury concentration on the upstream side of the location where activated carbon is injected by the activated carbon supply device 3 has been sufficiently smoothed, there is the possibility that, at the outlet of the bag filter 4 or in the chimney, a measurement peak of mercury concentration may be detected. Then, the second mercury concentration meter 5B is provided to control the activated carbon supply rate on the basis of the mercury concentration measurement at the outlet of the bag filter 4 or in the chimney to thereby complement the control on the basis of the measurement of the first mercury concentration meter 5A, whereby the concentration of mercury in the waste gas in the chimney can be more reliably lowered to a value equal to or smaller than a set value.

[0058] In the first to third embodiments of the present invention, the controller may be adapted so as to control the activated carbon supply rate, being based on the prescribed correspondence relation between the mercury concentration measurement that is given by the mercury concentration meter and the activated carbon supply rate. As the prescribed

correspondence relation between the mercury concentration measurement and the activated carbon supply rate, various forms can be applied.

[0059] As the prescribed correspondence relation between the mercury concentration measurement and the activated carbon supply rate, a form of correspondence relation in which, as the concentration of mercury in the waste gas that has been measured is increased, the activated carbon supply rate is gradually increased to a predetermined maximum value, starting from a predetermined minimum value, may be applied. As the predetermined minimum value of activated carbon supply rate, such a value of activated carbon supply rate is established which, during the operation in which the waste gas is discharged from the incinerator 1, by always injecting activated carbon at that minimum value of supply rate as a lower limit value, the concentration of mercury in the waste gas in the chimney can be reliably maintained at a value equal to or smaller than a set value even in the case where the concentration of mercury in the waste gas is extremely low. As the measurement of the concentration of mercury in the waste gas is increased, the activated carbon supply rate is gradually increased from the predetermined minimum value, thereby activated carbon being supplied at an appropriate rate for a particular concentration of mercury in the waste gas. In the form of correspondence relation with which the activated carbon supply rate is gradually increased from a predetermined minimum value, the activated carbon supply rate may be linearly increased in accordance with an increase in mercury concentration, or may be stepwise increased, the overall increment being divided into a plurality of increments, thus various forms of correspondence relation being allowed to be adopted. As the means for adjusting the activated carbon supply rate, the number of revolutions of the rotary of the rotary type dispensing member, the opening of the valve, that of the damper in the activated carbon supply device, etc. can be used singly or in combination, however, it is preferable to adopt the form of correspondence

relation that is suited for the adjustable range and the adjustment feature of a specific adjusting mechanism (such as the capability of increasing and decreasing of the supply rate in a continuous manner or a stepwise manner).

[0060] Figures 4A to 4H show examples of various forms of correspondence relation between the mercury concentration measurement and the activated carbon supply rate.

[0061] With the form shown in Figure 4A, in the range of the measurement of the concentration of mercury in the waste gas from zero or a value smaller than the measurable limit minimum value to a predetermined mercury concentration, activated carbon is supplied at a predetermined minimum value of activated carbon supply rate, and when the measurement of the mercury concentration has reached the predetermined mercury concentration, the activated carbon supply rate is increased in a step-like manner to a predetermined maximum value, and further, for an increase in the concentration of mercury in the waste gas, the activated carbon supply rate is constantly kept at the predetermined maximum value. With this form of correspondence relation, in the case where the measurement of the mercury concentration is lower than the predetermined mercury concentration, the activated carbon supply rate is set at the predetermined minimum value, while, in the case where the measurement of the mercury concentration is higher than the predetermined mercury concentration, the activated carbon supply rate is set at the predetermined maximum value, whereby the activated carbon supply rate can be controlled with a simple control mechanism, .

[0062] With the form shown in Figure 4B, in the range of the measurement of the concentration of mercury in the waste gas from zero or a value smaller than the measurable limit minimum value to a first predetermined mercury concentration, activated carbon is supplied at a predetermined minimum value of activated carbon supply rate (a first activated carbon supply rate), and when the measurement of the mercury concentration has reached the first predetermined mercury concentration, the activated

carbon supply rate is increased in a step-like manner to a second predetermined activated carbon supply rate, and for an increase in the concentration of mercury in the waste gas, the activated carbon supply rate is constantly kept at the second predetermined activated carbon supply rate, then, when the measurement of the mercury concentration has reached the second predetermined mercury concentration, the activated carbon supply rate is increased to a third predetermined activated carbon supply rate, thereafter, in this way, in accordance with an increase in the concentration of mercury in the waste gas, increasing the activated carbon supply rate in a fine stepwise manner is repeated, then, after the activated carbon supply rate having been increased to a predetermined maximum value, the activated carbon supply rate is constantly kept at the predetermined maximum value for an increase in the concentration of mercury in the waste gas. As the concentration of mercury in the waste gas is increased, the activated carbon supply rate is increased in a stepwise manner from the predetermined minimum value to the predetermined maximum value, whereby the activated carbon supply rate can be controlled such that the activated carbon is supplied at a more appropriate rate for a particular concentration of mercury in the waste gas.

[0063] With the form shown in Figure 4C, the activated carbon supply rate is linearly increased from a predetermined minimum value in accordance with an increase in the concentration of mercury in the waste gas. In addition, with the form shown in Figure 4D, in the range before the measurement of the concentration of mercury in the waste gas reaching a predetermined mercury concentration, the activated carbon supply rate is linearly increased from a predetermined minimum value in accordance with an increase in the concentration of mercury in the waste gas, and when the measurement of the mercury concentration has reached the predetermined concentration of mercury in the waste gas, the activated carbon supply rate is set at a predetermined maximum value, then, after the activated carbon supply rate having been increased to the predetermined

maximum value, the activated carbon supply rate is constantly kept at the predetermined maximum value for an increase in the concentration of mercury in the waste gas. With the forms shown in Figures 4C and 4D, as the concentration of mercury in the waste gas is increased, the activated carbon supply rate is continuously increased from a predetermined minimum value, whereby the activated carbon supply rate can be finely controlled such that the activated carbon is supplied at a more appropriate rate for a particular concentration of mercury in the waste gas.

[0064] With the form shown in Figure 4E, in the range of the measurement of the concentration of mercury in the waste gas from zero or a value smaller than the measurable limit minimum value to a first predetermined mercury concentration, activated carbon is supplied at a predetermined minimum value of activated carbon supply rate, and after the measurement of the mercury concentration has reached the first predetermined mercury concentration, the activated carbon supply rate is linearly increased from the predetermined minimum value in accordance with an increase in the concentration of mercury in the waste gas, and when the measurement of the mercury concentration has reached a second predetermined mercury concentration, the activated carbon supply rate is set at a predetermined maximum value of supply rate, then, after the activated carbon supply rate having been increased to the predetermined maximum value, the activated carbon supply rate is constantly kept at the predetermined maximum value for an increase in the concentration of mercury in the waste gas. The form shown in Figure 4E is a form in which the forms shown in Figures 4A and 4C are combined with each other, thereby the form shown in Figure 4E having the features and advantages of the respective forms.

[0065] With the form shown in Figure 4F, in the range of the measurement of the concentration of mercury in the waste gas from zero or a value smaller than the measurable limit minimum value to a first predetermined mercury concentration, activated carbon is supplied at a predetermined minimum value of activated

carbon supply rate that provides a first activated carbon supply rate, and after the measurement of the mercury concentration has reached the first predetermined mercury concentration, in accordance with an increase in the concentration of mercury in the waste gas, the activated carbon supply rate is linearly increased from the first supply rate to a second supply rate, which corresponds to a second predetermined mercury concentration, thereafter, for an increase in the concentration of mercury in the waste gas, the activated carbon supply rate is constantly kept at the second supply rate, further, when a third predetermined mercury concentration has been reached, the activated carbon supply rate is linearly increased from the second supply rate to a third supply rate, which corresponds to a fourth predetermined mercury concentration, then for an increase in the concentration of mercury in the waste gas, the activated carbon supply rate is constantly kept at the third supply rate, thereafter, in this way, constantly keeping the activated carbon supply rate and then increasing it for an increase in the concentration of mercury in the waste gas is repeated, then, after the activated carbon supply rate having been increased to a predetermined maximum value, the activated carbon supply rate is constantly kept at the predetermined maximum value for an increase in the concentration of mercury in the waste gas. The form shown in Figure 4F is a form in which the forms shown in Figures 4B and 4D are combined with each other, thereby the form shown in Figure 4F having the features and advantages of the respective forms.

[0066] With the form shown in Figure 4G, during the time period before the measurement of the concentration of mercury in the waste gas reaches a predetermined mercury concentration, the activated carbon supply rate is linearly increased from a predetermined minimum value in accordance with an increase in the concentration of mercury in the waste gas, and when the measurement of the mercury concentration has reached the predetermined mercury concentration, the activated carbon supply rate is increased to a predetermined maximum value in

a step-like manner, then after the activated carbon supply rate having been increased to the predetermined maximum value, the activated carbon supply rate is constantly kept at the predetermined maximum value for an increase in the concentration of mercury in the waste gas. With this form of correspondence relation, in the case where the measurement of the concentration of mercury in the waste gas is lower than a relatively moderate predetermined value, the activated carbon supply rate is continuously increased from a predetermined minimum value in accordance with an increase in the concentration of mercury in the waste gas, whereby the activated carbon supply rate can be finely controlled such that the activated carbon is supplied at a more appropriate rate for a particular concentration of mercury in the waste gas, while, in the case where the measurement of the concentration of mercury in the waste gas is higher than the relatively moderate predetermined mercury concentration, the activated carbon supply rate is set at a predetermined maximum value, and thus a plurality of means for adjusting the activated carbon supply rate are effectively utilized to allow controlling the activated carbon supply rate to an appropriate value.

[0067] With the form shown in Figure 4H, during the time period before the measurement of the concentration of mercury in the waste gas reaches a first predetermined mercury concentration, the activated carbon supply rate is linearly increased from a predetermined minimum value in accordance with an increase in the concentration of mercury in the waste gas, and when the measurement of the mercury concentration has reached the first predetermined mercury concentration, the activated carbon supply rate is set at a predetermined first supply rate, then, during the time period before the measurement of the mercury concentration reaches a second predetermined mercury concentration, the activated carbon supply rate is constantly kept at the predetermined first supply rate, and when the measurement of the mercury concentration has reached the second predetermined mercury concentration, the activated carbon

supply rate is increased in a step-like manner to a predetermined maximum value, then, after the activated carbon supply rate having been increased to the predetermined maximum value, the activated carbon supply rate is constantly kept at the predetermined maximum value for an increase in the concentration of mercury in the waste gas. With the form shown in Figure 4H, the form shown in Figure 4G is combined with a matter of the activated carbon supply rate being constantly kept at a first predetermined supply rate in a predetermined range where the measurement of the concentration of mercury in the waste gas is relatively moderate (the range from the first predetermined mercury concentration to the second predetermined mercury concentration), whereby the activated carbon supply rate can be controlled such that the activated carbon is supplied at a more appropriate rate.

[0068] In addition, when the controller controls the activated carbon supply rate on the basis of the prescribed correspondence relation between the mercury concentration measurement that is given by the mercury concentration meter and the activated carbon supply rate, it may take, as a form of the prescribed correspondence relation between the mercury concentration measurement and the activated carbon supply rate, a form of correspondence relation in which, in the case where the value of the concentration of mercury in the waste gas that has been measured is under zero or smaller than the measurable limit minimum value for the mercury concentration meter, or smaller than a predetermined value, activated carbon will not be supplied, while, in the case where the value of the concentration of mercury in the waste gas is equal to or greater than zero or the measurable limit minimum value, or the predetermined value, the activated carbon supply rate will be gradually increased in accordance with an increase in the concentration of mercury in the waste gas. In addition, upon the activated carbon supply rate being increased in accordance with an increase in the concentration of mercury in the waste gas, the activated carbon supply rate may be linearly increased

or increased in a stepwise manner.

[0069] In addition, as a form of correspondence relation alternative to the above-described one, a form of correspondence relation may be taken in which, in the case where the value of the concentration of mercury in the waste gas that has been measured is zero or smaller than the measurable limit minimum value for the mercury concentration meter, or smaller than a first determined value, activated carbon will not be supplied, while, in the range in which the value of the concentration of mercury in the waste gas is greater than zero or the measurable limit minimum value, or the first predetermined value, and smaller than a second predetermined value, the activated carbon supply rate will be gradually increased in accordance with an increase in the concentration of mercury in the waste gas, and in the range in which the value of the concentration of mercury in the waste gas is greater than the second predetermined value of mercury concentration, the activated carbon supply rate is constantly kept at the predetermined supply quantity. In addition, upon the activated carbon supply rate being increased in accordance with an increase in the concentration of mercury in the waste gas, the activated carbon supply rate may be linearly increased or increased in a stepwise manner.

[0070] In the present invention, in the case where the activated carbon supply rate is to be controlled on the basis of the prescribed correspondence relation between the concentration of mercury in the waste gas and the activated carbon supply rate, various forms can be taken for an increase in the activated carbon supply rate from a minimum value to a maximum value as described with reference to Figures 4A to 4H, and here how the predetermined minimum value and the predetermined maximum value are to be established will be explained by using the case in which the activated carbon supply rate is increased in the form shown in Figure 4E as an example. Specifically, in this case, the correspondence relation between the mercury concentration measurement and the activated carbon

supply rate takes the following form: in the range of the measurement of the concentration of mercury in the waste gas from zero or a value smaller than the measurable limit minimum value to a first predetermined mercury concentration, activated carbon is supplied at a predetermined minimum value of activated carbon supply rate, and after the measurement of the mercury concentration has reached the first predetermined mercury concentration, the activated carbon supply rate is linearly increased from the predetermined minimum value in accordance with an increase in the concentration of mercury in the waste gas, and when the measurement of the mercury concentration has reached a second predetermined mercury concentration, the activated carbon supply rate is set at a predetermined maximum value of supply rate, then, after the activated carbon supply rate having been increased to a predetermined maximum value, the activated carbon supply rate is constantly kept at the predetermined maximum value for an increase in the concentration of mercury in the waste gas.

[0071] Using the waste gas treatment apparatus shown in Figure 2, the inventor et al. examined the various conditions for establishing the predetermined minimum value and the predetermined maximum value in treating the waste gas that contains mercury. In making such examination, the concentration of mercury in the waste gas at the inlet of the dust collector (on the upstream side thereof) was measured, and about the case where the value of the ratio of such mercury concentration measurement to a set value of the concentration of mercury in the waste gas on the downstream side of the dust collector (referred to as the value of the upstream side mercury concentration ratio) was varied in the range of 20 to 200, the mercury adsorption removing process with the use of activated carbon was simulated to determine appropriate ranges of the predetermined minimum value and the predetermined maximum value of the activated carbon supply rate. The range of the value of the upstream side mercury concentration ratio of 20 to 200 was divided into a plurality of ranges, and for each of the ranges,

appropriate ranges of the predetermined minimum value and the predetermined maximum value were determined. Table 1 gives the results that were obtained.

[0072] In Table 1, for example, in the case where it is predicted that the furnace will discharge a mercury-containing waste gas with which the value of the upstream side mercury concentration ratio is in the range of from 100 to under 120, the predetermined minimum value of the activated carbon supply rate, which is defined as a weight of the activated carbon injected per hour per unit flow rate of the waste gas under treatment, is set at 60 to 200 mg/Nm³, while the predetermined maximum value of the activated carbon supply rate is set at 300 to 1000 mg/Nm³.

[0073]

Table 1

Value of upstream side mercury concentration ratio	Predetermined minimum value of activated carbon supply rate in mg/Nm ³	Predetermined maximum value of activated carbon supply rate in mg/Nm ³
20 to under 40	10 to 160	300 to 1000
40 to under 60	20 to 200	300 to 1000
60 to under 80	30 to 200	300 to 1000
80 to under 100	40 to 200	300 to 1000
100 to under 120	60 to 200	300 to 1000
120 to under 140	70 to 200	350 to 1000
140 to under 160	80 to 200	380 to 1000
160 to under 180	90 to 200	450 to 1000
180 to under 200	100 to 200	500 to 1000

[0074] In this Table 1, in each division of the range of the value of the upstream side mercury concentration ratio, the lower limit of the predetermined minimum value corresponds to the case where the measurement of the concentration of mercury in the waste gas is low or the case where the mercury

concentration set value on the downstream side of the dust collector is high, while the upper limit of the predetermined minimum value corresponds to the case where the measurement of the concentration of mercury in the waste gas is high or the case where the mercury concentration set value on the downstream side of the dust collector is low.

[0075] Further, in Table 1, in each division of the range of the value of the upstream side mercury concentration ratio, the lower limit of the predetermined maximum value corresponds to the case where the measurement of the concentration of mercury in the waste gas is low or the case where the mercury concentration set value on the downstream side of the dust collector is high, while the upper limit of the predetermined maximum value corresponds to the case where the measurement of the concentration of mercury in the waste gas is high or the case where the mercury concentration set value on the downstream side of the dust collector is low.

[0076] In this way, by establishing the predetermined minimum value of the activated carbon supply rate, the activated carbon is deposited to the bag filter as a dust collector to sufficiently form an adsorption layer previously, and upon a mercury-containing waste gas at a high concentration being discharged, the activated carbon adsorption layer that has been already formed and the activated carbon that is injected at the time of the waste gas being discharged allow the mercury to be rapidly removed by adsorption, whereby the mercury concentration can be lowered to a sufficiently low concentration.

[0077] In addition, by establishing the predetermined maximum value of the activated carbon supply rate, excessive supply of activated carbon can be avoided, while the mercury at a high concentration can be sufficiently removed by adsorption.

[0078] Hereinbelow, Examples for the present invention will be explained with a Comparative Example.

[0079] Examples

The waste gas that was discharged from the waste

incinerator was subjected to a mercury removal treatment by means of the waste gas treatment apparatuses shown in Figures 1A, 1B, 2, and 3 for confirmation of the effects. The waste gas that was discharged from the waste incinerator ran at a flow rate of 10,000 Nm³/h in the chimney, and the concentration of mercury in the waste gas in the chimney was held to a value equal to or smaller than 50 µg/Nm³ as an average for one hour. Further, it was desired that the maximum instantaneous value of mercury concentration (referred to as the peak measurement), which is given in a phenomenon where the mercury concentration measurement is abruptly increased in a short time, be held to a minimum. The activated carbon supply rate is defined as a weight of activated carbon injected per hour per unit flow rate of the waste gas under treatment, being expressed in mg/Nm³. [0080] Table 2 gives the peak measurements of the mercury concentration at the bag filter inlet and the peak measurements of the mercury concentration in the chimney in the Examples and the Comparative Example.

[0081] Comparative Example

The activated carbon was always injected into the waste gas flow path on the upstream side of the bag filter at 50 mg/Nm³ as a fixed supply rate for any given value of flow rate (in Nm³/h) of the waste gas, the concentration of mercury in the waste gas in the chimney being held to a value equal to or smaller than 5 µg/Nm³-dry in the normal operation. However, due to a variation in the characteristics of the rubbish that is supplied to the incinerator, the mercury concentration at the inlet of the bag filter was sometimes varied, resulting in the mercury concentration in the chimney being raised. In the chimney, a peak measurement of mercury concentration of up to 90 µg/Nm³-dry was observed.

[0082] Example 1

In Example 1, the waste gas treatment apparatus shown in Figures 1A and 1B was used to treat a mercury-containing waste gas. The concentration of mercury in the waste gas in the chimney, as an element located on the downstream side of the

dust collector, was measured, and using the correspondence relation between the mercury concentration in the chimney and the activated carbon supply rate that is given in Figure 5, the activated carbon supply rate was determined before supplying the activated carbon. As shown in Figure 5, in the case where the mercury concentration in the chimney is lower than 10 $\mu\text{g}/\text{Nm}^3\text{-dry}$, the activated carbon supply rate was set at 50 mg/Nm^3 as a fixed minimum value, while, in the case where the mercury concentration in the chimney is higher than 10 $\mu\text{g}/\text{Nm}^3\text{-dry}$ and lower than 40 $\mu\text{g}/\text{Nm}^3\text{-dry}$, the activated carbon supply rate was gradually increased in accordance with an increase in the mercury concentration, and while, in the case where the mercury concentration in the chimney is higher than 40 $\mu\text{g}/\text{Nm}^3\text{-dry}$, the activated carbon supply rate was set at 500 mg/Nm^3 as a fixed maximum value.

[0083] The mercury concentration at the inlet of the bag filter was caused to be varied due to a variation in the characteristics of the rubbish that was supplied to the incinerator, however, even when the variation was at a maximum, the peak measurement of the mercury concentration in the chimney could be held to 70 $\mu\text{g}/\text{Nm}^3\text{-dry}$.

[0084] Example 2

In Example 2, the waste gas treatment apparatus shown in Figure 2 was used to treat a mercury-containing waste gas. The concentration of mercury in the waste gas at the inlet of the bag filter was measured, and using the correspondence relation between the mercury concentration at the inlet of the bag filter and the activated carbon supply rate that is given in Figure 6, the activated carbon supply rate was determined before supplying the activated carbon. As shown in Figure 6, in the case where the mercury concentration at the inlet of the bag filter is lower than 100 $\mu\text{g}/\text{Nm}^3\text{-dry}$, the activated carbon supply rate was set at 50 mg/Nm^3 as a fixed minimum value, while, in the case where the mercury concentration at the inlet of the bag filter is higher than 100 $\mu\text{g}/\text{Nm}^3\text{-dry}$ and lower than 700 $\mu\text{g}/\text{Nm}^3\text{-dry}$, the activated carbon supply rate was gradually

increased in accordance with an increase in the mercury concentration, and while, in the case where the mercury concentration at the inlet of the bag filter is higher than 700 $\mu\text{g}/\text{Nm}^3\text{-dry}$, the activated carbon supply rate was set at 500 mg/Nm^3 as a fixed maximum value.

[0085] The mercury concentration at the inlet of the bag filter was caused to be varied due to a variation in the characteristics of the rubbish that was supplied to the incinerator, however, even when the variation was at a maximum, the peak measurement of the mercury concentration in the chimney could be held to 25 $\mu\text{g}/\text{Nm}^3\text{-dry}$.

[0086] Example 3

In Example 3, the waste gas treatment apparatus shown in Figure 3 was used to treat a mercury-containing waste gas. The concentration of mercury in the waste gas at the inlet of the bag filter was measured; the base value of the activated carbon supply rate was controlled, using the correspondence relation between the concentration of mercury at the inlet of the bag filter and the activated carbon supply rate that is given in Figure 6; the concentration of mercury in the waste gas in the chimney was measured; and using the correspondence relation between the mercury concentration in the chimney and the activated carbon supply rate that is given in Figure 5, the base value of the activated carbon supply rate was increased or decreased such that the activated carbon supply rate is complemented.

[0087] The mercury concentration at the inlet of the bag filter was caused to be varied due to a variation in the characteristics of the rubbish that was supplied to the incinerator, however, even when the variation was at a maximum, the peak measurement of the mercury concentration in the chimney could be held to 15 $\mu\text{g}/\text{Nm}^3\text{-dry}$.

[0088] Table 2

Unit: $\mu\text{g}/\text{Nm}^3\text{-dry}$

Concentration is given as equivalent to value on the basis of

12% oxygen.

		Peak measurement of mercury concentration at inlet of bag filter	Peak measurement of mercury concentration in chimney
Compara- tive Example	At time of peak detection, 1	360	17
	At time of peak detection, 2	780	40
	At time of peak detection, 3	1,420	90
Example 1	At time of peak detection, 1	710	25
	At time of peak detection, 2	1,350	50
	At time of peak detection, 3	1,600	70
Example 2	At time of peak detection, 1	780	9
	At time of peak detection, 2	1,500	15
	At time of peak detection, 3	1,850	25
Example 3	At time of peak detection, 1	710	5
	At time of peak detection, 2	1,350	10
	At time of peak detection, 3	1,780	15

Description of Symbols

[0089] The symbol 1 denotes a furnace (incinerator); 2 a boiler; 3 an activated carbon supply device; 4 a dust collector

(bag filter); 5 a mercury concentration meter; 5A a first mercury concentration meter; 5B a second mercury concentration meter; 6 a chimney; and 7 a controller.

CLAIMS

1. A waste gas treatment apparatus having a dust collector for dust removal treatment of a mercury-containing waste gas that is discharged from a furnace, and an activated carbon supply device that injects activated carbon into a waste gas flow path conducting the waste gas from the furnace to the dust collector,

the waste gas treatment apparatus comprising an upstream side mercury concentration meter that measures the concentration of mercury in the waste gas on the downstream side of the furnace and on the upstream side of the location where activated carbon is injected, and a controller that controls the activated carbon supply rate of the activated carbon supply device,

the controller maintaining the activated carbon supply rate at a value equal to or greater than a predetermined minimum value of activated carbon supply rate, while controlling the activated carbon supply rate such that, on the basis of the mercury concentration measurement that is given by the upstream side mercury concentration meter, the concentration of mercury in the waste gas on the downstream side of the dust collector is held at a value equal to or smaller than a set value,

controlling by the controller being performed such that, in the range of the measurement of the concentration of mercury in the waste gas from zero or a value smaller than the measurable limit minimum value to a first predetermined mercury concentration, activated carbon is supplied at a predetermined minimum value of activated carbon supply rate, and after the measurement of the mercury concentration has reached the first predetermined mercury concentration, the activated carbon supply rate is linearly increased from the predetermined minimum value of activated carbon supply rate in accordance with

an increase in the concentration of mercury in the waste gas, then, upon the measurement of the mercury concentration having reached a second predetermined mercury concentration, the activated carbon supply rate is set at a predetermined maximum value of activated carbon supply rate, and then, after the activated carbon supply rate having been increased to the predetermined maximum value of activated carbon supply rate, the activated carbon supply rate is constantly kept at the predetermined maximum value of activated carbon supply rate for an increase in the concentration of mercury in the waste gas.

2. A waste gas treatment apparatus having a dust collector for dust removal treatment of a mercury-containing waste gas that is discharged from a furnace, and an activated carbon supply device that injects activated carbon into a waste gas flow path conducting the waste gas from the furnace to the dust collector,

the waste gas treatment apparatus comprising an upstream side mercury concentration meter that measures the concentration of mercury in the waste gas on the downstream side of the furnace and on the upstream side of the location where activated carbon is injected, and a controller that controls the activated carbon supply rate of the activated carbon supply device,

the controller maintaining the activated carbon supply rate at a value equal to or greater than a predetermined minimum value of activated carbon supply rate, while controlling the activated carbon supply rate such that, on the basis of the mercury concentration measurement that is given by the upstream side mercury concentration meter, the concentration of mercury in the waste gas on the downstream side of the dust collector is held at a value equal to or smaller than a set value,

controlling by the controller being performed such that,

in the range of the measurement of the concentration of mercury in the waste gas from zero or a value smaller than the measurable limit minimum value to a first predetermined mercury concentration, activated carbon is supplied at a predetermined minimum value of activated carbon supply rate that provides a first activated carbon supply rate, and after the measurement of the mercury concentration has reached the first predetermined mercury concentration, the activated carbon supply rate is increased in a step-like manner to a second supply rate, thereafter, for an increase in the concentration of mercury in the waste gas, the activated carbon supply rate is constantly kept at the second supply rate, then, upon the measurement of the mercury concentration having reached the second predetermined mercury concentration, the activated carbon supply rate is increased to a third predetermined activated carbon supply rate, thereafter, in this way, an operation of constantly keeping the activated carbon supply rate and then increasing it in a stepwise manner for an increase in the concentration of mercury in the waste gas is repeated, then, after the activated carbon supply rate having been increased to a predetermined maximum value of activated carbon supply rate, the activated carbon supply rate is constantly kept at the predetermined maximum value of activated carbon supply rate for an increase in the concentration of mercury in the waste gas.

3. A waste gas treatment apparatus having a dust collector for dust removal treatment of a mercury-containing waste gas that is discharged from a furnace, and an activated carbon supply device that injects activated carbon into a waste gas flow path conducting the waste gas from the furnace to the dust collector,

the waste gas treatment apparatus comprising an upstream

side mercury concentration meter that measures the concentration of mercury in the waste gas on the downstream side of the furnace and on the upstream side of the location where activated carbon is injected, and a controller that controls the activated carbon supply rate of the activated carbon supply device,

the controller maintaining the activated carbon supply rate at a value equal to or greater than a predetermined minimum value of activated carbon supply rate, while controlling the activated carbon supply rate such that, on the basis of the mercury concentration measurement that is given by the upstream side mercury concentration meter, the concentration of mercury in the waste gas on the downstream side of the dust collector is held at a value equal to or smaller than a set value,

the predetermined minimum value of activated carbon supply rate being established on the basis of a correspondence relationship that, for a value of the upstream side mercury concentration ratio, which is a value of the ratio of the mercury concentration measurement that is given by the upstream side mercury concentration meter to a set value of the concentration of mercury in the waste gas on the downstream side of the dust collector, establishes a predetermined minimum value of activated carbon supply rate for each division of the range of the value of the upstream side mercury concentration ratio, and

as the correspondence relationship between the value of the upstream side mercury concentration ratio and the predetermined minimum value of activated carbon supply rate, a correspondence relationship as given in Table 1 below being specified, thereby, upon the value of the upstream side mercury concentration ratio being in the range of 20 to 200, the predetermined minimum value of activated carbon supply rate being established within the range of 10 to 200 mg/Nm³.

Table 1

Value of upstream side mercury concentration ratio	Predetermined minimum value of activated carbon supply rate in mg/Nm ³
20 to under 40	10 to 160
40 to under 60	20 to 200
60 to under 80	30 to 200
80 to under 100	40 to 200
100 to under 120	60 to 200
120 to under 140	70 to 200
140 to under 160	80 to 200
160 to under 180	90 to 200
180 to under 200	100 to 200

4. A waste gas treatment apparatus having a dust collector for dust removal treatment of a mercury-containing waste gas that is discharged from a furnace, and an activated carbon supply device that injects activated carbon into a waste gas flow path conducting the waste gas from the furnace to the dust collector,

the waste gas treatment apparatus comprising an upstream side mercury concentration meter that measures the concentration of mercury in the waste gas on the downstream side of the furnace and on the upstream side of the location where activated carbon is injected, and a controller that controls the activated carbon supply rate of the activated carbon supply device,

the controller maintaining the activated carbon supply rate at a value equal to or greater than a predetermined minimum value of activated carbon supply rate, while controlling the activated carbon supply rate such that, on the basis of the mercury concentration measurement that is given by the upstream

side mercury concentration meter, the concentration of mercury in the waste gas on the downstream side of the dust collector is held at a value equal to or smaller than a set value, and further, upon the value of the upstream side mercury concentration ratio, which is a value of the ratio of the mercury concentration measurement that is given by the upstream side mercury concentration meter to a set value of the concentration of mercury in the waste gas on the downstream side of the dust collector, being equal to or greater than a predetermined value of the ratio, controlling the activated carbon supply rate so as for it to be kept at a predetermined maximum value of activated carbon supply rate,

the predetermined maximum value of activated carbon supply rate being established on the basis of a correspondence relationship that, for a value of the upstream side mercury concentration ratio, establishes a predetermined maximum value of activated carbon supply rate for each division of the range of the value of the upstream side mercury concentration ratio, and

as the correspondence relationship between the value of the upstream side mercury concentration ratio and the predetermined maximum value of activated carbon supply rate, a correspondence relationship as given in Table 2 below being specified, thereby, upon the value of the upstream side mercury concentration ratio being in the range of 20 to 200, the predetermined maximum value of activated carbon supply rate being established within the range of 300 to 1000 mg/Nm³.

Table 2

Value of upstream side mercury concentration ratio	Predetermined maximum value of activated carbon supply rate in mg/Nm ³
---	---

20 to under 40	300 to 1000
40 to under 60	300 to 1000
60 to under 80	300 to 1000
80 to under 100	300 to 1000
100 to under 120	300 to 1000
120 to under 140	350 to 1000
140 to under 160	380 to 1000
160 to under 180	450 to 1000
180 to under 200	500 to 1000

5. A waste gas treating method that uses a dust collector to perform dust removal treatment of a mercury-containing waste gas that is discharged from a furnace, and that injects activated carbon from an activated carbon supply device into a waste gas flow path conducting the waste gas from the furnace to the dust collector,

the waste gas treating method comprising a measurement step of measuring the concentration of mercury in the waste gas on the downstream side of the furnace and on the upstream side of the location where activated carbon is injected, using a upstream side mercury concentration meter, and a control step of controlling the activated carbon supply rate of the activated carbon supply device with a controller,

in the control step, the controller maintaining the activated carbon supply rate at a value equal to or greater than a predetermined minimum value of activated carbon supply rate, while controlling the activated carbon supply rate such that, on the basis of the mercury concentration measurement that is given by the upstream side mercury concentration meter, the concentration of mercury in the waste gas on the downstream side of the dust collector is held at a value equal to or smaller than a set value,

further, the controller controlling the activated carbon

supply rate such that, in the range of the measurement of the concentration of mercury in the waste gas from zero or a value smaller than the measurable limit minimum value to a first predetermined mercury concentration, activated carbon is supplied at a predetermined minimum value of activated carbon supply rate, and after the measurement of the mercury concentration has reached the first predetermined mercury concentration, the activated carbon supply rate is linearly increased from the predetermined minimum value of activated carbon supply rate in accordance with an increase in the concentration of mercury in the waste gas, then, upon the measurement of the mercury concentration having reached a second predetermined mercury concentration, the activated carbon supply rate is set at a predetermined maximum value of activated carbon supply rate, and then, after the activated carbon supply rate having been increased to the predetermined maximum value, the activated carbon supply rate is constantly kept at the predetermined maximum value of activated carbon supply rate for an increase in the concentration of mercury in the waste gas.

6. A waste gas treating method that uses a dust collector to perform dust removal treatment of a mercury-containing waste gas that is discharged from a furnace, and that injects activated carbon from an activated carbon supply device into a waste gas flow path conducting the waste gas from the furnace to the dust collector,

the waste gas treating method comprising a measurement step of measuring the concentration of mercury in the waste gas on the downstream side of the furnace and on the upstream side of the location where activated carbon is injected, using a upstream side mercury concentration meter, and a control step of controlling the activated carbon supply rate of the activated

carbon supply device with a controller,

in the control step, the controller maintaining the activated carbon supply rate at a value equal to or greater than a predetermined minimum value of activated carbon supply rate, while controlling the activated carbon supply rate such that, on the basis of the mercury concentration measurement that is given by the upstream side mercury concentration meter, the concentration of mercury in the waste gas on the downstream side of the dust collector is held at a value equal to or smaller than a set value,

further, the controller controlling the activated carbon supply rate such that, in the range of the measurement of the concentration of mercury in the waste gas from zero or a value smaller than the measurable limit minimum value to a first predetermined mercury concentration, activated carbon is supplied at a predetermined minimum value of activated carbon supply rate that provides a first activated carbon supply rate, and after the measurement of the mercury concentration has reached the first predetermined mercury concentration, the activated carbon supply rate is increased in a step-like manner to a second supply rate, thereafter, for an increase in the concentration of mercury in the waste gas, the activated carbon supply rate is constantly kept at the second supply rate, then, upon the measurement of the mercury concentration having reached the second predetermined mercury concentration, the activated carbon supply rate is increased to a third predetermined activated carbon supply rate, thereafter, in this way, an operation of constantly keeping the activated carbon supply rate and then increasing it in a stepwise manner for an increase in the concentration of mercury in the waste gas is repeated, then, after the activated carbon supply rate having been increased to a predetermined maximum value of activated carbon supply rate, the activated carbon supply rate is

constantly kept at the predetermined maximum value of activated carbon supply rate for an increase in the concentration of mercury in the waste gas.

7. A waste gas treating method that uses a dust collector to perform dust removal treatment of a mercury-containing waste gas that is discharged from a furnace, and that injects activated carbon from an activated carbon supply device into a waste gas flow path conducting the waste gas from the furnace to the dust collector,

the waste gas treating method comprising a measurement step of measuring the concentration of mercury in the waste gas on the downstream side of the furnace and on the upstream side of the location where activated carbon is injected, using a upstream side mercury concentration meter, and a control step of controlling the activated carbon supply rate of the activated carbon supply device with a controller,

in the control step, the controller maintaining the activated carbon supply rate at a value equal to or greater than a predetermined minimum value of activated carbon supply rate, while controlling the activated carbon supply rate such that, on the basis of the mercury concentration measurement that is given by the upstream side mercury concentration meter, the concentration of mercury in the waste gas on the downstream side of the dust collector is held at a value equal to or smaller than a set value,

the predetermined minimum value of activated carbon supply rate being established on the basis of a correspondence relationship that, for a value of the upstream side mercury concentration ratio, which is a value of the ratio of the mercury concentration measurement that is given by the upstream side mercury concentration meter to a set value of the concentration of mercury in the waste gas on the downstream side of the dust

collector, establishes a predetermined minimum value of activated carbon supply rate for each division of the range of the value of the upstream side mercury concentration ratio, and as the correspondence relationship between the value of the upstream side mercury concentration ratio and the predetermined minimum value of activated carbon supply rate, a correspondence relationship as given in Table 3 below being specified, thereby, upon the value of the upstream side mercury concentration ratio being in the range of 20 to 200, the predetermined minimum value of activated carbon supply rate being established within the range of 10 to 200 mg/Nm³.

Table 3

Value of upstream side mercury concentration ratio	Predetermined minimum value of activated carbon supply rate in mg/Nm ³
20 to under 40	10 to 160
40 to under 60	20 to 200
60 to under 80	30 to 200
80 to under 100	40 to 200
100 to under 120	60 to 200
120 to under 140	70 to 200
140 to under 160	80 to 200
160 to under 180	90 to 200
180 to under 200	100 to 200

8. A waste gas treating method that uses a dust collector to perform dust removal treatment of a mercury-containing waste gas that is discharged from a furnace, and that injects activated carbon from an activated carbon supply device into a waste gas flow path conducting the waste gas from the furnace to the dust collector,

the waste gas treating method comprising a measurement step of measuring the concentration of mercury in the waste gas on the downstream side of the furnace and on the upstream side of the location where activated carbon is injected, using a upstream side mercury concentration meter, and a control step of controlling the activated carbon supply rate of the activated carbon supply device with a controller,

in the control step, the controller maintaining the activated carbon supply rate at a value equal to or greater than a predetermined minimum value of activated carbon supply rate, while controlling the activated carbon supply rate such that, on the basis of the mercury concentration measurement that is given by the upstream side mercury concentration meter, the concentration of mercury in the waste gas on the downstream side of the dust collector is held at a value equal to or smaller than a set value, and further, upon the value of the upstream side mercury concentration ratio, which is a value of the ratio of the mercury concentration measurement that is given by the upstream side mercury concentration meter to a set value of the concentration of mercury in the waste gas on the downstream side of the dust collector, being equal to or greater than a predetermined value of the ratio, controlling the activated carbon supply rate so as for it to be kept at a predetermined maximum value of activated carbon supply rate,

the predetermined maximum value of activated carbon supply rate being established on the basis of a correspondence relationship that, for a value of the upstream side mercury concentration ratio, establishes a predetermined maximum value of activated carbon supply rate for each division of the range of the value of the upstream side mercury concentration ratio, and

as the correspondence relationship between the value of the upstream side mercury concentration ratio and the

predetermined maximum value of activated carbon supply rate, a correspondence relationship as given in Table 4 below being specified, thereby, upon the value of the upstream side mercury concentration ratio being in the range of 20 to 200, the predetermined maximum value of activated carbon supply rate being established within the range of 300 to 1000 mg/Nm³.

Table 4

Value of upstream side mercury concentration ratio	Predetermined maximum value of activated carbon supply rate in mg/Nm ³
20 to under 40	300 to 1000
40 to under 60	300 to 1000
60 to under 80	300 to 1000
80 to under 100	300 to 1000
100 to under 120	300 to 1000
120 to under 140	350 to 1000
140 to under 160	380 to 1000
160 to under 180	450 to 1000
180 to under 200	500 to 1000