

DESCRIPTION

Title of Invention

CORROSION PREVENTION DEVICE AND CORROSION PREVENTION METHOD

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Technical Field

[0001]

The present invention relates to a corrosion prevention device and a corrosion prevention method in which it is possible to measure the concentration of a substance in a mixture containing two or more substances.

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Background Art

[0002]

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In recent years, in order to secure fuel, a demand for power generation using biomass fuel other than a construction waste wood-based material and a wood-based material, or waste fuel such as a waste tire or a waste plastic has been increased. In such a power generation mechanism, a technique using a boiler provided with a combustion furnace that burns a combustion object and produces saturated vapor, and a superheater which is connected to the combustion furnace to superheat the saturated vapor produced in the combustion furnace by using a combustion gas produced in the combustion furnace and use it for power generation can be given as an example.

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[0003]

On the other hand, in future, many situations in which low-grade biomass fuel or the like is used due to the depletion of a petroleum resource or biomass fuel itself are expected.

5 However, the low-grade biomass fuel or the waste fuel contains a large amount of impurities such as alkal components such as Na or K, for example. In this manner, in a case where the low-grade fuel containing impurities such as alkal components is used, there is a concern that heat exchange efficiency may
10 be lowered due to a poor flow of a circulating material or ash adhesion inside a device such as a heat exchanger in a power generation facility, or the inside of the device may be corroded by alkal salts produced by the combustion of fuel. As a technique for improving such problems, for example, a method and an device
15 for measuring the concentration of a toxic gas in a flue gas by spectrophotometry have been proposed (refer to, for example, PTL 1 below).

Citation List

20 [0004]

Patent Literature

[PTL 1] PCT Japanese Translation Patent Publication No.
2003-511692

25 Summary of Invention

Technical Problem

[0005]

As in the technique described in PTL 1, in general ultraviolet absorptiometry, a high-voltage lamp such as a xenon lamp or a mercury lamp is used as a white light source. However, the high-voltage lamp has a short life, and the high-voltage lamp has a problem in that the stability of light emitting intensity is low. Therefore, it is conceivable to use a light emitting diode (LED) having a long light source life and being excellent in light emitting intensity. Here, since the LED has a narrow wavelength width of an emission spectrum and is monochromatic light, a light source having a wavelength corresponding to the absorption spectrum of a measurement target is selected. However, in a case where substances having the same absorption wavelength band as the absorption wavelength band of the measurement target are mixed, in the technique using a monochromatic LED, it is not possible to accurately measure the concentration of the measurement target because the light absorption by the measurement target and the light absorption by the mixture cannot be separated.

[0006]

In order to solve the problem described above, the present invention has an object to provide a corrosion prevention device and a corrosion prevention method in which a light source life is long and it is possible to measure the absorbance and/or the

transmittance of a substance in a mixture containing two or more substances having similar absorption wavelengths.

Solution to Problem

5 [0007]

That is, the present invention is as shown below.

<1> A corrosion prevention device including:

a first light source unit provided with a light emitting diode that emits irradiation light in an absorption wavelength band that includes an absorption spectrum of a first measurement target produced by combustion of a combustion object;

a second light source unit provided with a light emitting diode that emits irradiation light in an absorption wavelength band that includes an absorption spectrum which is an absorption spectrum of a second measurement target produced by combustion of the combustion object and is different from the absorption spectrum of the first measurement target;

a first light receiving unit that receives the irradiation light emitted from the first light source unit;

20 a second light receiving unit that receives the irradiation light emitted from the second light source unit; and

a calculation unit that calculates absorbance and/or transmittance of the first measurement target in a combustion gas generated by combustion of the combustion object, based on

transmitted light intensity I_1 of the irradiation light received by the first light receiving unit and transmitted light intensity I_2 of the irradiation light received by the second light receiving unit.

5 <2> The corrosion prevention device according to the above <1>, further including: a corrosion inhibitor supply unit that supplies a corrosion inhibitor that reacts with the first measurement target to the combustion gas; and a supply amount control unit that controls a supply amount of the corrosion
10 inhibitor that is supplied from the corrosion inhibitor supply unit.

 <3> The corrosion prevention device according to the above <2>, wherein the supply amount control unit controls the supply amount of the corrosion inhibitor, based on the absorbance and/or
15 the transmittance of the first measurement target calculated by the calculation unit.

 <4> The corrosion prevention device according to the above <2>, further including: a third light source unit provided with a light emitting diode that emits irradiation light in an
20 absorption wavelength band that includes an absorption spectrum which is an absorption spectrum of a third measurement target produced from the corrosion inhibitor and is different from the absorption spectra of the first and second measurement targets;
and a third light receiving unit that receives the irradiation
25 light emitted from the third light source unit,

wherein the calculation unit calculates absorbance and/or transmittance of the third measurement target in the combustion gas, based on transmitted light intensity I_3 of the irradiation light received by the third light receiving unit and the
5 transmitted light intensity I_2 of the irradiation light received by the second light receiving unit, and

the supply amount control unit controls the supply amount of the corrosion inhibitor, based on the absorbance and/or the transmittance of the first and third measurement targets
10 calculated by the calculation unit.

<5> A corrosion prevention method including:

emitting irradiation light in an absorption wavelength band that includes an absorption spectrum of a first measurement target produced by combustion of a combustion object, and
15 irradiation light in an absorption wavelength band that includes an absorption spectrum which is an absorption spectrum of a second measurement target produced by combustion of the combustion object and is different from the absorption spectrum of the first measurement target, from a first light source unit
20 or a second light source unit each provided with a light emitting diode toward a combustion gas generated by combustion of the combustion object;

receiving the irradiation light emitted from the first light source unit and the irradiation light emitted from the

second light source unit by a first light receiving unit or a second light receiving unit; and

calculating absorbance and/or transmittance of the first measurement target by a calculation unit, based on transmitted
5 light intensity I_1 of the irradiation light received by the first light receiving unit and transmitted light intensity I_2 of the irradiation light received by the second light receiving unit.

<6> The corrosion prevention method according to the above
<5>, further including: controlling a supply amount of a
10 corrosion inhibitor that reacts with the first measurement target, based on the absorbance and/or the transmittance of the first measurement target calculated by the calculation unit; and supplying the corrosion inhibitor to the combustion gas.

<7> The corrosion prevention method according to the above
15 <6>, further including:

emitting irradiation light in an absorption wavelength band that includes an absorption spectrum which is an absorption spectrum of a third measurement target produced from the corrosion inhibitor and is different from the absorption spectra
20 of the first and second measurement targets, from a third light source unit provided with a light emitting diode toward the combustion gas;

receiving the irradiation light emitted from the third light source unit by a third light receiving unit;

calculating absorbance and/or transmittance of the third measurement target by the calculation unit, based on transmitted light intensity I_3 of the irradiation light received by the third light receiving unit and the transmitted light intensity I_2 of the irradiation light received by the second light receiving unit;

controlling the supply amount of the corrosion inhibitor that reacts with the first measurement target, based on the absorbance and/or the transmittance of the first and third measurement targets calculated by the calculation unit; and supplying the corrosion inhibitor to the combustion gas.

Advantageous Effects of Invention

[0008]

According to the present invention, it is possible to provide a corrosion prevention device and a corrosion prevention method in which a light source life is long and it is possible to measure the absorbance and/or transmittance of a substance in a mixture containing two or more substances having similar absorption wavelengths.

Brief Description of Drawings

[0009]

Fig. 1 is a schematic diagram showing a first embodiment of the present invention.

Fig. 2 is a schematic diagram for explaining a configuration of a measurement unit in the first embodiment.

Fig. 3 is a schematic diagram showing a second embodiment of the present invention.

5 Fig. 4 is a schematic diagram showing an aspect of a measurement unit in the second embodiment.

Fig. 5 is a schematic diagram showing another aspect of the measurement unit in the second embodiment.

10 Description of Embodiments

[0010]

Hereinafter, embodiments for carrying out the present invention (hereinafter, simply referred to as the "present embodiment") will be described in detail with reference to the
15 drawings. However, the following embodiments are exemplification for describing the present invention, and are not intended to limit the present invention to the following contents. The present invention can be appropriately modified and implemented within the scope of the concept thereof. The
20 same elements are denoted by the same reference numerals, and overlapping description is omitted. Further, the positional relationship such as up, down, left, and right shall be based on the positional relationship shown in the drawings unless otherwise specified. Further, the dimensional ratios in the
25 drawings are not limited to the ratios shown in the drawings.

[0011]

(First Embodiment)

A combustion facility provided with a corrosion prevention device in a first embodiment will be described with reference to Fig. 1. Fig. 1 is a schematic diagram showing the first embodiment of the present invention.

[0012]

As shown in Fig. 1, a combustion facility 10 includes a combustion furnace 20 to which a combustion object is supplied and in which the combustion object is burned in the furnace, a measurement unit 30 that measures each component in a combustion gas generated by the combustion of the combustion object, and a superheater 40 which is superheated by heat exchange with the combustion gas produced in the combustion furnace 20. Further, the combustion furnace 20 is provided with a combustion object feeder 22 that supplies the combustion object into the furnace. The measurement unit 30 is provided with a corrosion inhibitor supply device 31 that supplies a corrosion inhibitor to the combustion gas, and the combustion facility 10 is further provided with a control unit 50 electrically connected to each of the measurement unit 30 and the corrosion inhibitor supply device 31. In the present embodiment, the measurement unit 30, the corrosion inhibitor supply device 31, and the control unit 50 serve as the corrosion prevention device. In Fig. 1, a thick arrow indicates a flow direction of the

combustion gas. Further, in each of the following drawings, one-dot chain line indicates a path of an electric signal.

[0013]

As the combustion facility 10, although not particularly limited, a so-called boiler that superheats vapor by the heat exchange between the combustion gas produced in the combustion furnace 20 and the superheater 40 and uses it for power generation can be given as an example. Further, as the combustion facility 10, although not particularly limited, in addition to a once-through boiler, a circulation boiler, and an exhaust heat recovery boiler, which are mainly used for a thermal power generation business, a circulating fluidized bed boiler (CFB), fluidized bed boiler (BFB), or the like, which is used for industrial purposes, may be used.

[0014]

As shown in Fig. 1, the combustion furnace 20 is configured in a vertically long tubular shape, for example, and burns the combustion object that is supplied from the combustion object feeder 22 in the furnace. As the combustion object, it is not particularly limited as long as it is a combustible material, and for example, biomass fuel containing an alkali salt such as Na or K, or waste fuel containing heavy metal such as lead or zinc can be used.

[0015]

When the combustion object supplied from the combustion object feeder 22 to the combustion furnace 20 is burned, a combustion gas is produced in the furnace. Further, although not shown in the drawings, a water pipe can be installed on a furnace wall of the combustion furnace 20, and saturated vapor can be produced by exposing the water pipe to the combustion gas in the combustion furnace 20. The combustion gas contains a first measurement target and a second measurement target produced by the combustion of the combustion object. The first measurement target and the second measurement target are different substances, and the second measurement target has an absorption spectrum in a wavelength band similar to that of the first measurement target and has a unique absorption spectrum in a wavelength band different from that of the first measurement target. For example, as the first measurement target, a molten salt having a low melting point, such as KCl or NaCl which is produced by the combustion of the biomass fuel or ZnCl_2 which is produced by the combustion of the waste fuel, can be given as an example. As the second measurement target, a solid particle such as charcoal combustion ash (fly ash) or bottom ash (furnace bottom ash), which is produced by the combustion, can be given as an example. The combustion gas produced in the combustion furnace 20 is sent to the measurement unit 30 while containing the first measurement target and the second measurement target.

[0016]

The measurement unit 30 is a device for measuring the concentration of the first measurement target in the combustion gas. In the measurement unit 30, transmitted light intensities I_1 and I_2 corresponding to the first and second measurement targets in the combustion gas are measured. An absorptiometry is used for the measurement of the concentration of the measurement target in the measurement unit 30, and for example, an ultraviolet absorptiometry is used. The measurement unit 30 in the present embodiment will be described with reference to Fig. 2. Fig. 2 is a schematic diagram for explaining the configuration of the measurement unit in the first embodiment. In Fig. 2, a thin arrow indicates the trajectory of light which is emitted from a light emitting diode, and a thick arrow indicates a flow direction of the combustion gas.

[0017]

As shown in Fig. 2, the measurement unit 30 is provided with a light emitter 32 and a spectrometer 34. Further, the measurement unit 30 is provided with a flow path 39 of the combustion gas sent from the combustion furnace 20, and is configured to be able to measure the concentrations of the first and second measurement targets in the combustion gas flowing through the flow path 39. In Fig. 1, it is shown that the combustion gas is sent to the measurement unit 30 from the left side toward the right side on the paper surface of the drawing.

However, in Fig. 2, for the sake of description, the measurement unit 30 is shown such that the flow direction of the combustion gas is from the lower side to the upper side on the paper surface of the drawing.

5 [0018]

The light emitter 32 includes a light source unit 32A provided with a light emitting diode that emits irradiation light in an absorption wavelength band that includes the absorption spectrum of the first measurement target, and a light source unit 32B provided with a light emitting diode that emits irradiation light in an absorption wavelength band that includes an absorption spectrum which is the absorption spectrum of the second measurement target and is different from the absorption spectrum of the first measurement target. The measurement unit 30 emits irradiation light in a different absorption wavelength band from each light source unit toward the combustion gas flowing through the flow path 39.

[0019]

As described above, each of the light source units 32A and 32B is provided with a light emitting diode. In the present embodiment, in the measurement of the first and second measurement targets in the combustion gas, the light emitting diode is used instead of a high-voltage lamp such as a xenon lamp or a mercury lamp that has been used in the related art, and therefore, the light source life is longer than in a case

where the high-voltage lamp is used. Further, since the stability of light source intensity is excellent, the concentration of the measurement target can be measured more accurately. As the light emitting diode that is used in the present embodiment, a light emitting diode having a wavelength corresponding to the absorption spectrum of the measurement target can be appropriately selected. For example, in a case where other substances other than the first and second measurement targets are contained in the combustion gas, it is preferable that the absorption wavelength band of light 36B that is emitted from the light source unit 32B is set so as to avoid the absorption spectrum of the other substances.

[0020]

The spectrometer 34 includes a light receiving unit 34A that receives the irradiation light emitted from the light source unit 32A, and a light receiving unit 34B that receives the irradiation light emitted from the light source unit 32B. The spectrometer 34 is a device provided with a photodiode that receives the light emitted from the light emitter 32 and penetrated the combustion gas, and functions as a transmitted light intensity monitor. As shown in Fig. 2, the light 36A and the light 36B emitted from the light source units penetrate the combustion gas in the flow path 39 and are received by the light receiving unit 34A and the light receiving unit 34B corresponding to the light 36A and the light 36B, respectively. Therefore,

in the spectrometer 34, it is possible to measure the transmitted light intensity of light in the absorption wavelength range corresponding to each light source unit.

[0021]

5 As shown in Fig. 2, the measurement unit 30 is provided with a beam splitter 37, and is configured such that a part of the light 36A and the light 36B that are emitted from the light emitter 32 is reflected downward on the paper surface of the drawing. The light 37A and the light 37B reflected by the beam
10 splitter 37 are received by a photodiode 38 for light source intensity monitoring. The photodiode 38 includes a plurality of light receiving units (not shown) so as to be able to receive the light emitted from each light source unit. In the measurement unit 30, the beam splitter 37 is installed such that
15 the light which is emitted from the light emitter 32 is reflected before it reaches the combustion gas, and a configuration is made such that the light source intensity of each light source unit provided in the light emitter 32 can be monitored by the photodiode 38. The monitoring of the light source intensity of
20 the light emitter 32 may be configured to measure a fluctuation of the light source intensity or a decrease in intensity due to deterioration of each light source unit, based on the intensity of the light received by the photodiode 38, and correct the light source intensity corresponding to each light emitting
25 diode set in advance based on the measured values.

[0022]

As shown in Fig. 2, the light emitter 32, the spectrometer 34, and the photodiode 38 are electrically connected to the control unit 50. When the light emitted from the light emitter 32 is received by the spectrometer 34, an electric signal is transmitted to the control unit 50, and in the control unit 50, the transmitted light intensity I_1 of the irradiation light received by the light receiving unit 34A and the transmitted light intensity I_2 of the irradiation light received by the light receiving unit 34B are measured. Further, the light emitted from the light emitter 32 is received by the photodiode 38, so that an electric signal is transmitted to the control unit 50 and the light source intensity I_{01} and the light source intensity I_{02} of the light source unit 32A and the light source unit 32B are measured.

[0023]

Next, as shown in Fig. 1, the control unit 50 is a device such as a CPU provided with a calculation unit 52 and a supply amount control unit 54. The calculation unit 52 calculates the absorbance and transmittance of the first measurement target and the second measurement target, based on the transmitted light intensity or the light source intensity measured by the measurement unit 30, that is, the transmitted light intensity I_1 of the irradiation light received by the light receiving unit 34A and the transmitted light intensity I_2 of the irradiation

light received by the light receiving unit 34B. In the present embodiment, the concentration of the first measurement target is calculated based on the values. In Fig. 1 and the like, the calculation unit 52 and the supply amount control unit 54 are shown within the control unit 50. However, they do not need to be independent devices and a configuration can be made so as to play each role in one CPU.

[0024]

A method of calculating the concentration of the first measurement target in the calculation unit 52 will be specifically described. First, the calculation unit 52 calculates concentration X_1 of a substance having an absorption spectrum of the light emitted by the light source unit 32A in the combustion gas by using the Lambert-Beer's law ($A = -\log_{10}(I_x/I_{0x}) = ECl = \varepsilon cl$ [A: absorbance, I_{0x} : light source intensity of the xth light source unit, I_x : transmitted light intensity received by the xth light receiving unit, E: specific absorbance, C: mass-to-volume percentage concentration of the substance having the absorption spectrum of the light emitted by the xth light source unit, ε : molar absorption coefficient, x: molar concentration of a substance having the absorption spectrum of the light emitted by the xth light source unit, and l: light penetration length (optical path length))] or the like. Here, not only the first measurement target but also the second measurement target such as fly ash has an absorption spectrum

in the absorption wavelength band of the light emitted from the light source unit 32A. Therefore, the concentration of the second measurement target affects the concentration X_1 , and the concentration X_1 is the total concentration of the first measurement target and the second measurement target in the combustion gas. Next, concentration X_2 of a substance having the absorption spectrum of the light emitted by the light source unit 32B in the combustion gas is calculated. Here, since the substance having the absorption spectrum of the light emitted by the light source unit 32B in the combustion gas is the second measurement target such as fly ash, the concentration X_2 is the concentration of the second measurement target in the combustion gas. Therefore, by excluding the concentration X_2 from the concentration X_1 , it is possible to calculate the concentration of the first measurement target with the influence of the second measurement target eliminated. As described above, as I_{0x} , the light source intensity I_{01} and the light source intensity I_{02} monitored by the photodiode 38 are used, and as I_x , the transmitted light intensity I_1 and the transmitted light intensity I_2 monitored by the spectrometer 24 are used. However, the concentration calculation method in the calculation unit 52 is not limited to the example described above.

[0025]

Next, as shown in Fig. 1, the measurement unit 30 is provided with the corrosion inhibitor supply device 31 that

supplies a corrosion inhibitor to the combustion gas. The corrosion inhibitor is a substance that reduces the concentration of the first measurement target by reacting with the first measurement target. As the corrosion inhibitor, a substance having a function of chemically reacting with the first measurement target and making the first measurement target another compound by a redox reaction or the like can be used. As such a corrosion inhibitor, for example, in a case where the combustion object is biomass fuel containing KCl or the like, a sulfur component such as ammonium sulfate ($(\text{NH}_4)\text{SO}_4$), aluminum sulfate ($\text{Al}_4(\text{SO}_4)_3$), or sulfur (Elemental Sulphur) can be given as an example. Further, as the corrosion inhibitor, fine particles or the like that can be physically adsorbed to the first measurement target to reduce the concentration of the first measurement target itself may be used.

[0026]

The corrosion inhibitor supply device 31 is electrically coupled to the supply amount control unit 54 in the control unit 50. The corrosion inhibitor supply device 31 is controlled by the control unit 50, and the supply timing or the supply amount of the corrosion inhibitor is controlled by the supply amount control unit 54 in the control unit 50. In the present embodiment, in the control unit 50, the supply amount of the corrosion inhibitor that is supplied from the corrosion inhibitor supply device 31 is controlled by the supply amount control unit 54

so as to become appropriate with respect to the abundance of the first measurement target, based on the concentration of the first measurement target in the combustion gas calculated by the calculation unit 52. Although not particularly limited, the control unit 50 can control the supply amount of the corrosion inhibitor in the combustion gas such that the abundance of the corrosion inhibitor is not excessive or insufficient with respect to the abundance of the first measurement target.

[0027]

When the corrosion inhibitor is supplied to the combustion gas in the measurement unit 30, the concentration of the first measurement target in the combustion gas is lowered. In the present embodiment, a configuration is made such that the combustion gas having a lowered concentration of the first measurement target is sent from the measurement unit 30 to the superheater 40. A vapor pipe (not shown) is installed in the superheater 40. Saturated vapor produced by the heat of the combustion furnace 20 flows in the vapor pipe, and the saturated vapor is superheated by the heat exchange between the combustion gas and the superheater 40. The combustion gas discharged from the superheater 40 is sent to each facility (downstream-side device) installed in the lower stage of the superheater 40. Further, the saturated vapor superheated by the superheater 40 can be used, for example, for driving of a power generation turbine, or the like.

[0028]

As described above, in the present embodiment, the combustion object is burned in the combustion furnace 20, the irradiation light in the absorption wavelength band that includes the absorption spectrum of the first measurement target produced by the combustion of the combustion object, and the irradiation light in the absorption wavelength band that includes an absorption spectrum which is the absorption spectrum of the second measurement target produced by the combustion of the combustion object and is different from the absorption spectrum of the first measurement target are emitted from the light source unit 32A and the light source unit 32B each provided with a light emitting diode toward the combustion gas generated by the combustion of the combustion object, the irradiation light emitted from each light source unit is received by each of the light receiving unit 34A or the light receiving unit 34B, the absorbance and/or the transmittance of the first measurement target and the second measurement target can be calculated by the calculation unit, based on the transmitted light intensity I_1 and the transmitted light intensity I_2 of the irradiation light received by the light receiving units, and the concentration of the first measurement target can be calculated based on the value. In this manner, in the present embodiment, it is possible to provide a corrosion prevention device and a corrosion prevention method in which a light source life is long by using

light emitting diodes in a plurality of light source units and it is possible to measure the absorbance, transmittance, or concentration of a substance in a mixture containing two or more substances having similar absorption wavelengths. Further, since the light emitting diode is excellent in the stability of the light source intensity, it is possible to more accurately calculate the absorbance, transmittance, or concentration of the first measurement target.

[0029]

Further, in the present embodiment, the supply amount of the corrosion inhibitor is controlled based on the concentration of the first measurement target calculated by the calculation unit 52, and the corrosion inhibitor is supplied to the combustion gas. Therefore, since an appropriate amount of the corrosion inhibitor with respect to the abundance of the first measurement target in the combustion gas can be supplied, the concentration of the first measurement target can be effectively reduced and corrosion in each device in the combustion facility due to the first measurement target can be effectively suppressed.

[0030]

In the present embodiment, the aspect has been described in which the absorbance and/or the transmittance of the first measurement target and the second measurement target is calculated and the concentration of the first measurement target

is calculated from the value. However, the present invention is not limited to the aspect, and an aspect may be adopted in which only the absorbance and/or the transmittance of the first measurement target is calculated in the calculation unit 52 without calculating the concentration of the first measurement target and a subsequent process is performed based on the value.

[0031]

(Second Embodiment)

A combustion facility provided with a corrosion prevention device in a second embodiment will be described with reference to Fig. 3. Fig. 3 is a schematic diagram showing the second embodiment of the present invention. In the present embodiment, a combustion facility, in which biomass fuel containing KCl as the first measurement target is used as the combustion object, a sulfur component is used as the corrosion inhibitor, and it is provided with a circulating fluidized bed boiler (CFB) as the combustion furnace, will be described as an example.

[0032]

As shown in Fig. 3, a combustion facility 100 includes a combustion furnace 120 to which the biomass fuel is supplied and in which the biomass fuel is burned in the furnace, a cyclone 130 that separates solid contents from the combustion gas generated by the combustion of the biomass fuel, a measurement unit 140 that measures each component in the combustion gas, and a superheater 150 that is superheated by the heat exchange

with the combustion gas. Further, the combustion furnace 120 is provided with a fuel feeder 122 that supplies the biomass fuel into the furnace. The measurement unit 140 is provided with a corrosion inhibitor supply device 148 that supplies a sulfur component to the combustion gas, and the combustion facility 100 is further provided with the control unit 50 electrically connected to each of the measurement unit 140 and the corrosion inhibitor supply device 148. In the present embodiment, the measurement unit 140 and the control unit 50 serve as the corrosion prevention device.

[0033]

The combustion furnace 120 is configured in a vertically long tubular shape, and burns the biomass fuel that is supplied from the fuel feeder 122 in the furnace. The combustion furnace 120 is a fluidized bed furnace that burns the biomass fuel while making it flow in a fluidized bed. Further, the combustion furnace 120 is a circulating fluidized bed furnace in which the solid contents each having a particle size equal to or larger than a predetermined particle size is returned by the cyclone 130, as will be described later. The temperature inside the combustion furnace 120 is not particularly limited. However, the temperature can be set such that the temperature of the combustion gas becomes a temperature in a range of about 800 to 1000°C.

[0034]

When the biomass fuel supplied from the fuel feeder 122 to the combustion furnace 120 is burned, a combustion gas is produced. Further, although not shown in the drawings, a water pipe can be installed on the furnace wall of the combustion furnace 120, and saturated vapor can be produced by exposing the water pipe to the combustion gas in the combustion furnace 120. Further, due to the combustion of the biomass fuel, KCl, which is the first measurement target, is contained in the combustion gas, and fly ash produced by the combustion is contained in the combustion gas. In the present embodiment, the fly ash is the second measurement target. Further, in the present embodiment, in addition to KCl and the flash ash, NaCl or SO₂ that is contained in the sulfur component (described later) is contained in the combustion gas. The combustion gas produced in the combustion furnace 120 is sent to the cyclone 130 while containing the component such as KCl or the fly ash.

[0035]

The cyclone 130 is a solid-gas separation device that separates the solid contents each having a particle size equal to or larger than a predetermined particle size, which are discharged from the combustion furnace 120, from the combustion gas, and returns them to the combustion furnace 120. The cyclone 130 separates the solid contents each having a particle size equal to or larger than a predetermined particle size from the combustion gas, returns them to the combustion furnace 120, and

sends the combustion gas separated from which the solid contents are separated to the measurement unit 140 in the subsequent stage. The sorting particle size of the solid content by the cyclone 130 is not particularly limited. However, it can be set to, for example, about 20 μm .

[0036]

The measurement unit 140 is a device for calculating the absorbance and transmittance of KCl in the combustion gas and measuring the concentration of KCl, based on the values. In the measurement unit 140, the transmitted light intensities I_1 and I_2 corresponding to KCl (the first measurement target) and the fly ash (the second measurement target) in the combustion gas are measured. In the present embodiment, an ultraviolet absorptiometry method is used for the measurement of the concentration of the measurement target in the measurement unit 140. The measurement unit 140 in the present embodiment will be described with reference to Fig. 4. Fig. 4 is a schematic diagram showing an aspect of the measurement unit in the second embodiment.

[0037]

As shown in Fig. 4, the measurement unit 140 is provided with a main pipe 141 through which the combustion gas supplied from the cyclone 130 flows, and an external measurement unit 142, and is configured such that a part of the combustion gas flowing in the main pipe 141 flows to the external measurement

unit 142 through a gas pipe 141A. A light emitter 144 and a spectrometer 146 are provided in the external measurement unit 142, and the combustion gas flows from the left side to the right side on the paper surface of the drawing between the light emitter 144 and the spectrometer 146. The combustion gas discharged from the external measurement unit 142 is returned to the main pipe 141 through a gas pipe 141B.

[0038]

The light emitter 144 is installed on the upper side of the external measurement unit 142 on the paper surface of the drawing. Although not shown in the drawings, the light emitter 144 includes a first light source unit provided with a light emitting diode that emits irradiation light in an absorption wavelength band that includes the absorption spectrum of KCl, and a second light source unit provided with a light emitting diode that emits irradiation light in an absorption wavelength band that includes an absorption spectrum which is the absorption spectrum of the fly ash is different from the absorption spectrum of KCl. Here, the peak of the absorption spectrum of each component contained in the combustion gas is in the vicinity of 250 nm in the case of KCl, is in the vicinity of 240 nm in the case of NaCl, and is in the vicinity of 220 nm and the vicinity of 290 nm in the case of SO₂. On the other hand, the fly ash has a wide wavelength band of an absorption spectrum, and has absorption even in the wavelength band of the absorption spectrum

of KCl or the like. Therefore, in the present embodiment, the first light source unit uses a light emitting diode having a wavelength of about 250 nm corresponding to the absorption spectrum of KCl, and the second light source unit uses a light emitting diode having a wavelength of about 400 nm. In this manner, the wavelength of the light emitting diode of the second light source unit is set to around 400 nm, which is not easily affected by components other than the fly ash which is the second measurement target, so that it is possible to more accurately calculate the absorbance, transmittance, and concentration of the flash ash in the combustion gas.

[0039]

The spectrometer 146 is installed on the lower side of the external measurement unit 142 on the paper surface of the drawing. Although not shown in the drawings, the spectrometer 146 includes a first light receiving unit that receives irradiation light having a wavelength of 250 nm, which is emitted from the first light source unit, and a receiving unit that receives irradiation light having a wavelength of 400 nm, which is emitted from the second light source unit. Similar to the first embodiment, the irradiation light emitted from each light source unit penetrates the combustion gas and is received by the corresponding light receiving unit.

[0040]

Further, although not shown in the drawings, the external measurement unit 142 is provided with a beam splitter such that light which is emitted from the light emitter 144 is reflected before it reaches the combustion gas, and is configured such that a part of the irradiation light emitted from the light emitter 144 is reflected and received by a photodiode for light source intensity monitoring. In the present embodiment, similar to the first embodiment, the light source intensity of the light emitter 144 is detected by the photodiode.

10 [0041]

As shown in Fig. 3, the external measurement unit 142 is electrically connected to the control unit 50. When the light emitted from the light emitter 144 is received by the spectrometer 146, an electric signal is transmitted to the control unit 50, and in the control unit 50, the transmitted light intensity I_1 of the irradiation light having a wavelength of 250 nm received by the first light receiving unit and the transmitted light intensity I_2 of the irradiation light having a wavelength of 400 nm received by the second light receiving unit are detected. Further, the light emitted from the light emitter 144 is received by the photodiode, so that an electric signal is transmitted to the control unit 50 and the light source intensity I_{01} and the light source intensity I_{02} of the first and second light source units are detected.

25 [0042]

In the present embodiment, the type is adopted in which the external measurement unit 142 is installed in the main pipe 141 located in the front stage of the superheater 150 to measure the concentration of the components in the combustion gas.

5 However, the installation location of the external measurement unit 142 is not limited to this, and for example, the combustion furnace 120 or the like can be appropriately selected according to a desire. As shown by Lambert-Beer's law, if the optical path length is long, the transmittance is lowered accordingly.

10 Therefore, when the external measurement unit 142 is used as in the present embodiment, the optical path length (the distance between the light emitter 144 and the spectrometer 146) can be made constant according to the size of the external measurement unit 142, and therefore, the transmitted light intensity I_1 and
15 the transmitted light intensity I_2 can be detected under the same condition without being affected by the size of a furnace or a pipe in which the measurement unit is installed.

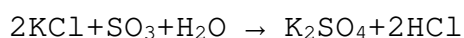
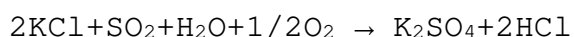
[0043]

In the present embodiment, the control unit 50 includes
20 the calculation unit 52 and the supply amount control unit 54, and similar to the first embodiment, the control unit 50 calculates the absorbance and transmittance of KCl, which is the first measurement target, based on the transmitted light intensity I_1 and the transmitted light intensity I_2 measured by

the measurement unit 140, and calculates the concentration of KCl, based on the values.

[0044]

The measurement unit 140 is provided with the corrosion
5 inhibitor supply device 148 that supplies a sulfur component
to the combustion gas. The sulfur component includes at least
one selected from, for example, ammonium sulfate ((NH₄)SO₄),
aluminum sulfate (Al₄(SO₄)₃), sulfur (Elemental Sulphur), and
the like. As shown in the expression below, the sulfur component
10 can react with KCl to produce harmless K₂SO₄ and reduce the
concentration of KCl.



[0045]

15 As shown in Fig. 3, the corrosion inhibitor supply device
148 is electrically coupled to the supply amount control unit
54 in the control unit 50. The corrosion inhibitor supply device
148 is controlled by the control unit 50, and the supply amount
of the sulfur component that is supplied from the corrosion
20 inhibitor supply device 148 is controlled by the supply amount
control unit 54. In the control unit 50, the supply amount of
the sulfur component that is supplied from the corrosion
inhibitor supply device 148 is controlled by the supply amount
control unit 54 so as to become appropriate with respect to the
25 abundance of KCl, based on the concentration of KCl in the

combustion gas calculated by the calculation unit 52. Although not particularly limited, the control unit 50 can control the supply amount of the sulfur component in the combustion gas such that the abundance of the sulfur component is not excessive or
5 insufficient with respect to the abundance of KCl.

[0046]

If the sulfur component is supplied into the combustion gas by the corrosion inhibitor supply device 148, the concentration of KCl in the combustion gas can be lowered. In
10 the present embodiment, a configuration is made such that the combustion gas having a lowered concentration of KCl is sent from the measurement unit 140 to the superheater 150. Similar to the first embodiment, a pipe (not shown) is installed in the superheater 150, and the saturated vapor produced by the heat
15 of the combustion furnace 120 flows in the pipe and is superheated by the heat exchange between the combustion gas and the superheater 150. The combustion gas discharged from the superheater 150 is sent to each facility (a downstream-side device) installed downstream of the superheater 150. Further,
20 the saturated vapor superheated by the superheater 150 can be used, for example, for driving of a power generation turbine, or the like.

[0047]

Here, since KCl has a melting point of about 780°C, KCl
25 itself adheres to the inner wall or the like of the superheater

150 at the time the heat exchange between the superheater 150 and the combustion gas, thereby causing corrosion of these devices. Further, the adhesion of the KCl gas promotes the adhesion of the fly ash. The adhesion of the fly ash causes a decrease in heat exchange efficiency in the superheater 150. The combustion facility 100 reduces the concentration of KCl in the combustion gas by the supply of the sulfur component in order to reduce the influence of the components contained in such low-grade biomass fuel. In this way, it is possible to suppress a decrease in heat exchange efficiency due to corrosion of the superheater 150 or the like, which is located in a subsequent stage of the corrosion inhibitor supply device 148, by KCl, or adhesion of the fly ash to the inside of the superheater 150 due to the presence of KCl. In particular, in the superheater 150, the temperature of the combustion gas is lowered by heat exchange, so that KCl easily aggregate, and therefore, it is preferable to supply the corrosion inhibitor at the stage between the cyclone 130 and the superheater 150.

[0048]

As described above, in the present embodiment, the biomass fuel containing KCl is burned in the combustion furnace 120, the irradiation light in the absorption wavelength band that includes the absorption spectrum of KCl, and the irradiation light in the absorption wavelength band that includes an absorption spectrum which is the absorption spectrum of the fly

ash produced by the combustion of the biomass fuel and is different from the absorption spectrum of KCl are emitted from the light source units each provided with a light emitting diode toward the combustion gas generated by the combustion of the biomass fuel, the irradiation light emitted from each light source unit is received by each light receiving unit, the absorbance and transmittance of KCl is calculated based on the transmitted light intensity I_1 and the transmitted light intensity I_2 of the irradiation light received by the light receiving units, and the concentration of KCl can be calculated by the calculation unit, based on the values. In this manner, in the present embodiment, it is possible to provide a corrosion prevention device and a corrosion prevention method in which a light source life is long due to using the light emitting diodes in a plurality of light source units and it is possible to measure the concentration of a substance in a mixture containing two or more substances having similar absorption wavelengths. Further, since the light emitting diode is excellent in the stability of the light source intensity, the absorbance, transmittance, and concentration of KCl can be calculated more accurately.

[0049]

Further, in the present embodiment, the supply amount of the sulfur component is controlled based on the concentration of KCl calculated by the calculation unit 52, and the sulfur

component is supplied to the combustion gas. Therefore, since an appropriate amount of sulfur component with respect to the abundance of KCl in the combustion gas can be supplied, the concentration of KCl can be effectively reduced and the corrosion of the inside of each device in the combustion facility 100 by KCl can be effectively suppressed.

[0050]

Also in the present embodiment, the aspect has been described in which the absorbance and/or the transmittance of KCl and the fly ash is calculated and the concentration of KCl is calculated from the value. However, the present invention is not limited to the aspect, and an aspect may be adopted in which only the absorbance and/or the transmittance of KCl is calculated in the calculation unit 52 without calculating the concentration of KCl and a subsequent process is performed based on the value.

[0051]

(Other Aspects)

In the second embodiment, the aspect has been described in which the measurement unit 140 provided with the external measurement unit 142 is used. However, as the measurement unit, a measurement unit 160 having a structure as shown in Fig. 5 may be used. Fig. 5 is a schematic diagram showing another aspect of the measurement unit in the second embodiment.

25 [0052]

As shown in Fig. 5, the measurement unit 160 is provided with the main pipe 141 through which the combustion gas supplied from the cyclone 130 flows, and a light emitter 162 and a spectrometer 164 are installed in the main pipe 141. In the main pipe 141, the combustion gas flows from the left side toward the right side on the paper surface of the drawing. Further, the flow path of the combustion gas is narrowed by the light emitter 162 and the spectrometer 164 within the main pipe 141. The space between the light emitter 162 and the spectrometer 164 is narrowed in this manner, so that the optical path length (the distance between the light emitter 144 and the spectrometer 146) in the measurement unit 160 can be shortened with a simple configuration. In this manner, the measurement accuracy of the concentration of each component in the combustion gas can be enhanced by appropriately adjusting the optical path length in the measurement unit 160 to a length suitable for the type or concentration of a gas in a boiler to be measured.

[0053]

Further, in each of the embodiments described above, the configuration has been adopted in which the first and second light source units are used and the corrosion inhibitor is supplied based on the concentration of the first measurement target calculated by the calculation unit. However, the present invention is not limited to this aspect, and for example, it is also possible to use three types of light source units. For

example, in addition to the first and second light source units, a third light source unit provided with a light emitting diode that emits irradiation light in an absorption wavelength band that includes an absorption spectrum which is the absorption spectrum of a third measurement target produced from the corrosion inhibitor and is different from the absorption spectra of the first and second measurement targets, and a third light receiving unit that receives the irradiation light emitted from the third light source unit can be installed. In such an aspect, a configuration is made such that the calculation unit calculates the absorbance and transmittance of the third measurement target in the combustion gas, based on transmitted light intensity I_3 of the irradiation light received by the third light receiving unit and the transmitted light intensity I_2 of the irradiation light received by the second light receiving unit, and calculates the concentration of the third measurement target, based on the values, and the supply amount control unit controls the supply amount of the corrosion inhibitor, based on the absorbance or transmittance of the first and third measurement targets calculated by the calculation unit, or the concentration calculated based on the value.

[0054]

As such an example, for example, an aspect can be given in which biomass fuel is used as the combustion object, the first measurement target is KCl, the second measurement target is fly

ash, the third measurement target is SO₂ that is produced from a sulfur component, a light emitting diode having a wavelength of about 250 nm corresponding to the absorption spectrum of KCl is used in the first light source unit, a light emitting diode
5 having a wavelength of about 400 nm is used in the second light source unit, and a light emitting diode having a wavelength of about 290 nm corresponding to the absorption spectrum of SO₂ is used in the third light source unit. According to this aspect, the absorbance and transmittance of SO₂ that is produced from
10 the sulfur component that is supplied as a corrosion inhibitor can be calculated, and the concentration of SO₂ can be calculated based on the values. Therefore, in a case where the supply amount control unit determines that the sulfur component is excessively supplied, based on the concentration of SO₂, the supply amount
15 of the sulfur component is lowered, and thus a more appropriate amount of the corrosion inhibitor can be provided.

[0055]

The embodiments described above through the embodiments of the invention described above can be used in appropriate
20 combination according to the intended use, or used with modifications or improvements made thereto. Further, the present invention is not limited to the description of the embodiments described above.

25 Reference Signs List

[0056]

- 10, 100 combustion facility
- 20, 120 combustion furnace
- 22 combustion object feeder
- 5 30, 140 measurement unit
- 31, 148 corrosion inhibitor supply device
- 32, 144, 162 light emitter
- 32A, 32B light source unit
- 34, 146, 164 spectrometer
- 10 34A, 34B light receiving unit
- 37 beam splitter
- 38 photodiode
- 40, 150 superheater
- 50 control unit
- 15 52 calculation unit
- 54 supply amount control unit
- 122 fuel feeder
- 130 cyclone
- 141 main pipe
- 20 142 external measurement unit

CLAIMS

1. A corrosion prevention device comprising:

5 a first light source unit provided with a light emitting diode that emits irradiation light in an absorption wavelength band that includes an absorption spectrum of a first measurement target produced by combustion of a combustion object;

10 a second light source unit provided with a light emitting diode that emits irradiation light in an absorption wavelength band that includes an absorption spectrum which is an absorption spectrum of a second measurement target produced by combustion of the combustion object and is different from the absorption spectrum of the first measurement target;

15 a first light receiving unit that receives the irradiation light emitted from the first light source unit;

a second light receiving unit that receives the irradiation light emitted from the second light source unit; and

20 a calculation unit that calculates absorbance and/or transmittance of the first measurement target in a combustion gas generated by combustion of the combustion object, based on transmitted light intensity I_1 of the irradiation light received by the first light receiving unit and transmitted light intensity I_2 of the irradiation light received by the second light receiving
25 unit.

2. The corrosion prevention device according to claim 1,
further comprising:

a corrosion inhibitor supply unit that supplies a
5 corrosion inhibitor that reacts with the first measurement
target to the combustion gas; and

a supply amount control unit that controls a supply amount
of the corrosion inhibitor that is supplied from the corrosion
inhibitor supply unit.

10

3. The corrosion prevention device according to claim 2,
wherein the supply amount control unit controls the supply amount
of the corrosion inhibitor, based on the absorbance and/or the
transmittance of the first measurement target calculated by the
15 calculation unit.

4. The corrosion prevention device according to claim 2,
further comprising:

a third light source unit provided with a light emitting
20 diode that emits irradiation light in an absorption wavelength
band that includes an absorption spectrum which is an absorption
spectrum of a third measurement target produced from the
corrosion inhibitor and is different from the absorption spectra
of the first and second measurement targets; and

a third light receiving unit that receives the irradiation light emitted from the third light source unit,

wherein the calculation unit calculates absorbance and/or transmittance of the third measurement target in the combustion gas, based on transmitted light intensity I_3 of the irradiation light received by the third light receiving unit and the transmitted light intensity I_2 of the irradiation light received by the second light receiving unit, and

the supply amount control unit controls the supply amount of the corrosion inhibitor, based on the absorbance and/or the transmittance of the first and third measurement targets calculated by the calculation unit.

5. A corrosion prevention method comprising:

emitting irradiation light in an absorption wavelength band that includes an absorption spectrum of a first measurement target produced by combustion of a combustion object, and irradiation light in an absorption wavelength band that includes an absorption spectrum which is an absorption spectrum of a second measurement target produced by combustion of the combustion object and is different from the absorption spectrum of the first measurement target, from a first light source unit or a second light source unit each provided with a light emitting diode toward a combustion gas generated by combustion of the combustion object;

receiving the irradiation light emitted from the first light source unit and the irradiation light emitted from the second light source unit by a first light receiving unit or a second light receiving unit; and

5 calculating absorbance and/or transmittance of the first measurement target by a calculation unit, based on transmitted light intensity I_1 of the irradiation light received by the first light receiving unit and transmitted light intensity I_2 of the irradiation light received by the second light receiving unit.

10

6. The corrosion prevention method according to claim 5, further comprising:

controlling a supply amount of a corrosion inhibitor that reacts with the first measurement target, based on the absorbance
15 and/or the transmittance of the first measurement target calculated by the calculation unit; and

supplying the corrosion inhibitor to the combustion gas.

7. The corrosion prevention method according to claim 6,
20 further comprising:

emitting irradiation light in an absorption wavelength band that includes an absorption spectrum which is an absorption spectrum of a third measurement target produced from the corrosion inhibitor and is different from the absorption spectra
25 of the first and second measurement targets, from a third light

source unit provided with a light emitting diode toward the combustion gas;

receiving the irradiation light emitted from the third light source unit by a third light receiving unit;

5 calculating absorbance and/or transmittance of the third measurement target by the calculation unit, based on transmitted light intensity I_3 of the irradiation light received by the third light receiving unit and the transmitted light intensity I_2 of the irradiation light received by the second light receiving
10 unit;

controlling the supply amount of the corrosion inhibitor that reacts with the first measurement target, based on the absorbance and/or the transmittance of the first and third measurement targets calculated by the calculation unit; and

15 supplying the corrosion inhibitor to the combustion gas.