

DESCRIPTION

Title of Invention

MONITORING METHOD FOR BOILER AND MONITORING DEVICE FOR
BOILER, CONTROLLING METHOD FOR BOILER AND CONTROLLING
DEVICE FOR BOILER, ADJUSTMENT METHOD FOR FUEL OR LIKE AND
ADJUSTMENT DEVICE FOR FUEL OR LIKE, AND BOILER

Technical Field

[0001]

The present invention relates to a monitoring method for a boiler, a monitoring device for a boiler, a controlling method for a boiler, a controlling device for a boiler, an adjustment method for a fuel or the like, an adjustment device for a fuel or the like, and a boiler.

Background Art

[0002]

In the related art, various boiler systems have been proposed in which vapor is generated by the heat of a high-temperature exhaust gas obtained by making a fuel combust in a combustion furnace (furnace). In such boiler systems, due to fuel property fluctuations or an increase or decrease in in-fuel corrosive components, problems, such as a flowing failure in the combustion furnace, deposit (dust)

adhesion to a pipe surface of a boiler, and pipe corrosion caused by adhered deposits, arise in some cases. In order to solve such problems, it is conceivable to perform an operation for measuring a concentration of alkaline metal components contained in an exhaust gas and decreasing the concentration.

[0003]

Thus, in recent years, a technique, in which as alkaline metal components contained in the exhaust gas after passing through a dust collector of the boiler are made to emit light and light in a predetermined wavelength range is dispersed to acquire a relative light emission intensity, a concentration of alkaline metal components that emit light in the wavelength range is measured, has been proposed (for example, see PTL 1). When such a technique is adopted, the concentration of the alkaline metal components in the exhaust gas can be measured with high accuracy.

Citation List

Patent Literature

[0004]

[PTL 1] Japanese Patent No. 3182913

Summary of Invention

Technical Problem

[0005]

However, the measurement method using flame analysis described in PTL 1 has problems in which a concentration of fine salt particles (KCl or the like) contained in the exhaust gas before being collected by the dust collector cannot be appropriately measured since the concentration of the alkaline metal components contained in the exhaust gas after being collected by the dust collector is measured. In addition, in the measurement method using flame analysis described in PTL 1, since it is necessary to form plasma flame in a flue in which a combustion gas flows and to cause some of the combustion gas to emit light in the plasma flame, there are many technical uncertainties, and there is a possibility of measurement becoming difficult.

[0006]

The present invention is devised in view of such circumstances, and an object thereof is to monitor a content of fine salt particles in an exhaust gas of a boiler with a relatively simple method and to appropriately estimate a content of an alkaline metal or chlorine in a fuel.

Solution to Problem

[0007]

According to an aspect of the present invention, in order to achieve the object, there is provided a monitoring method for a boiler that is a method of monitoring an operation state of the boiler, the monitoring method including an exhaust gas collection process of collecting an exhaust gas generated by combustion of a fuel input into a combustion furnace of the boiler and an estimation process of estimating a content of an alkaline metal and/or chlorine in the fuel based on a content of a fine salt particle in the exhaust gas collected in the exhaust gas collection process.

[0008]

In addition, according to another aspect of the present invention, there is provided a monitoring device for a boiler that is a device monitoring an operation state of the boiler, the monitoring device including an exhaust gas collection portion that collects an exhaust gas generated by combustion of a fuel input into a combustion furnace of the boiler and an estimation unit that estimates a content of an alkaline metal and/or chlorine in the fuel based on a content of a fine salt particle in the exhaust gas collected by the exhaust gas collection portion.

[0009]

When such a method and such a configuration are adopted, the exhaust gas generated by combustion of the

fuel input into the combustion furnace of the boiler can be collected, and the content of the alkaline metal or the chlorine in the fuel can be estimated based on the content of the fine salt particle (KCl or the like) in the collected exhaust gas. Then, based on the estimated content of the alkaline metal or the chlorine in the fuel, a load on the boiler (an in-furnace temperature, a vapor temperature, or the like) or the like can be controlled, or an amount, a composition, or the like of the fuel can be changed.

[0010]

In the exhaust gas collection process of the monitoring method for a boiler according to the present invention, the exhaust gas on an upstream side of a dust collector of the boiler may be collected.

[0011]

When such a method is adopted, based on the content of the fine salt particle in the exhaust gas before being collected by the dust collector of the boiler, the content of the alkaline metal or the chlorine in the fuel may be appropriately estimated.

[0012]

In the exhaust gas collection process of the monitoring method for a boiler according to the present

invention, the exhaust gas may be collected at a predetermined frequency.

[0013]

When such a method is adopted, since the exhaust gas can be collected at the predetermined frequency (for example, at least once a day), the content of the fine salt particle in the exhaust gas can be monitored over time.

[0014]

In the exhaust gas collection process of the monitoring method for a boiler according to the present invention, the exhaust gas can be collected when a type of the fuel is changed and/or when an abnormality is found in the operation state of the boiler.

[0015]

When such a method is adopted, correlation information between the type of the fuel and the content of the fine salt particle in the exhaust gas or correlation information between a boiler abnormality and the content of the fine salt particle in the exhaust gas can be obtained.

[0016]

According to still another aspect of the present invention, there is provided a controlling method for a boiler, including the monitoring method for a boiler described already and a control process of controlling a load on the boiler and/or a maintenance operation of the

boiler based on the content estimated in the estimation process of the monitoring method for a boiler.

[0017]

According to still another aspect of the present invention, there is provided a controlling device for a boiler, including the monitoring device for a boiler described already and a control unit that controls a load on the boiler and/or a maintenance operation of the boiler based on a content estimated by the estimation unit of the monitoring device for a boiler.

[0018]

When such a method and such a configuration are adopted, based on the content of the fine salt particle in the exhaust gas generated by combustion of the fuel input into the combustion furnace of the boiler, the content of the alkaline metal or the chlorine in the fuel can be estimated, a load on the boiler (an in-furnace temperature, a vapor temperature, or the like) or a maintenance operation of the boiler (a cleaning operation of a transfer surface of a superheater or a coal economizer by a soot blower or the like, a pulse frequency of a bag filter, or the like) can be controlled based on the estimated content. As described above, as the content of the alkaline metal or the chlorine in the fuel in the boiler is quantitatively identified and the boiler load or the like is controlled

based on the content, it is possible to prolong the life of the existing boiler compared to the related art.

[0019]

According to still another aspect of the present invention, there is provided an adjustment method for a fuel or the like, including the monitoring method for a boiler described already and an adjustment process of changing, based on a content estimated in the estimation process of the monitoring method for a boiler, at least any one of an amount, a composition, a type, and a mixed firing ratio of the fuel input into the combustion furnace, a supply amount of an additive input into the combustion furnace, a supply amount of a fluid medium input into the combustion furnace, and/or an extraction amount of the fluid medium from the combustion furnace.

[0020]

According to still another aspect of the present invention, there is provided an adjustment device for a fuel or the like, including the monitoring device for a boiler described already and an adjusting unit that changes, based on a content estimated by the estimation unit of the monitoring device for a boiler, at least any one of an amount, a composition, a type, and a mixed firing ratio of the fuel input into the combustion furnace, a supply amount of an additive input into the combustion

furnace, a supply amount of a fluid medium input into the combustion furnace, and/or an extraction amount of the fluid medium from the combustion furnace.

[0021]

When such a method and such a configuration are adopted, based on the content of the fine salt particle in the exhaust gas generated by combustion of the fuel input into the combustion furnace of the boiler, the content of the alkaline metal or the chlorine in the fuel can be estimated, and based on the estimated content, at least any one of the amount, the composition, the type, and the mixed firing ratio of the fuel input into the combustion furnace, the supply amount of the additive input into the combustion furnace, the supply amount of the fluid medium input into the combustion furnace, and/or the extraction amount of the fluid medium from the combustion furnace can be changed. As described above, as the content of the alkaline metal or the chlorine in the fuel in the boiler is quantitatively identified and the amount of the fuel or the amount of combustion furnace contents (the additive and the fluid medium) is adjusted based on the content, it is possible to prolong the life of the existing boiler compared to the related art and to manage changes in fuel properties of an input fuel (wood chips, tires, Refuse Paper & Plastic Fuel

(RPF), or the like), an increase or decrease of corrosive components, or the like during a boiler operation.

[0022]

According to still another aspect of the present invention, there is provided a boiler including a heat recovery portion that recovers heat of a combustion gas generated by a combustion furnace and a dust collector that filters and collects dust contained in a gas which has passed through the heat recovery portion, in which in order to monitor a content of a fine salt particle in the gas which has passed through the heat recovery portion, a connecting part, to which a recovery pipe capable of recovering a gas in a pipe communicating and connecting the heat recovery portion and the dust collector to each other is connected, is provided.

[0023]

When such a configuration is adopted, the exhaust gas before being collected by the dust collector of the boiler can be recovered via the pipe that communicates and connects the heat recovery portion and the dust collector to each other and the recovery pipe. For this reason, it is possible to appropriately monitor the content of the fine salt particle (KCl or the like) in the exhaust gas before being collected by the dust collector.

Advantageous Effects of Invention

[0024]

With the present invention, it is possible to monitor the content of fine salt particle in the exhaust gas of the boiler with a relatively simple method and to appropriately estimate the content of the alkaline metal or the chlorine in the fuel.

Brief Description of Drawings

[0025]

Fig. 1 is a schematic diagram showing an overall configuration of a boiler according to an embodiment of the present invention.

Fig. 2 is a graph showing an example of correlation information used in content estimation in the embodiment of the present invention (a graph showing correlation between a measured value from an alkaline metal ion monitor and a content of an alkaline metal in a fuel).

Fig. 3 is a graph showing an example of correlation information used in content estimation in the embodiment of the present invention (a graph showing correlation between a measured value from a chlorine detector pipe and a content of chlorine in the fuel).

Fig. 4 is a flowchart for describing a monitoring method for a boiler, a controlling method for a boiler, and

an adjustment method for a fuel or the like according to the embodiment of the present invention.

Description of Embodiments

[0026]

Hereinafter, each of embodiments of the present invention will be described with reference to the drawings. Each of the following embodiments is merely suitable application examples, and the scope of application of the present invention is not limited thereto.

[0027]

First, a fluidized bed type (circulating fluidized bed (CFB) boiler (hereinafter, referred to as a "CFB boiler") 1 in each of the embodiments of the present invention will be described with reference to Fig. 1.

[0028]

The CFB boiler 1 includes a combustion furnace 2 that makes a fuel combust and that generates vapor by heating water in a closed container, a cyclone separator 4 that separates a solid matter out from a combustion gas (hereinafter, referred to as an "exhaust gas") G generated by the combustion furnace 2, a heat recovery portion 6 that recovers heat of the exhaust gas G, a return line 8 through which flying ash separated out from the exhaust gas G by the cyclone separator 4, that is, some of a fluid medium

separated out from the exhaust gas G returns to a lower portion of a combustion furnace 3, a bag filter 10 that filters and collects dust contained in the exhaust gas G which has passed through the heat recovery portion 6, a central processing device 100 that comprehensively controls various types of configurations of the CFB boiler 1, and the like.

[0029]

The combustion furnace 2 is an external circulation type fluidized layer combustion furnace. Various types of fuels (for example, biomass fuels such as rice hulls and empty fruit bunches (EFB), wood chips, tires, RPF, and the like) are input into the combustion furnace 2 via a fuel charging port (not shown). Among these, biomass fuels such as rice hulls and EFBs are low-grade fuels containing a large amount of alkaline components such as potassium (K) and sodium (Na). In addition, a fluid medium of which a main component is quartz particles is input into the combustion furnace 2 via the fuel charging port, air is supplied into the fluid medium from a lower portion, and the fluid medium flows to form a fluidized bed (hereinafter, referred to as a "bed") F. The formation of the bed F promotes combustion of the fuel. The fluid medium contains bottom ash BA formed as particles as components in the biomass fuel adhere by being condensed, melted, and

aggregated using sand as a source or chemically react on a sand surface.

[0030]

The exhaust gas G generated as a result of combustion rises in the combustion furnace 2 while accompanying some of the fluid medium. A gas outlet 2A through which the exhaust gas is exhausted is provided in an upper portion of the combustion furnace 2. An exhaust port (not shown) for exhausting the bottom ash BA is provided in the lower portion of the combustion furnace 2. A supply adjustment mechanism that can change each of an amount, a composition, a type, and a mixed firing ratio of a fuel, a supply amount of an additive, a supply amount of a fluid medium is provided at the fuel charging port of the combustion furnace 2. An exhaust adjustment mechanism that can change an extraction amount of the fluid medium is provided at the exhaust port of the combustion furnace 2. As the supply adjustment mechanism and the exhaust adjustment mechanism are controlled by an adjusting unit 40 (to be described later) of the central processing device 100, the amount of the fuel input into the combustion furnace 2 and the amount of the fluid medium extracted from the combustion furnace 2 are adjusted.

[0031]

The cyclone separator 4 is disposed adjacent to the combustion furnace 2 and is connected to the combustion furnace 2 via the gas outlet 2A. The cyclone separator 4 functions as a solid-gas separator, receives the exhaust gas G and a fluid medium accompanying the exhaust gas G that are exhausted from the combustion furnace 2, separates the exhaust gas G and the fluid medium from each other with a centrifugal separation action, returns the fluid medium to the combustion furnace 2, and sends the exhaust gas G to the heat recovery portion 6. The return line 8 is connected to the cyclone separator 4.

[0032]

Various types of heat exchange tubes (for example, a superheater that generates superheated vapor, a coal economizer that preheats boiler water supply, and the like) for recovering heat of an exhaust gas are disposed at the heat recovery portion 6. The superheater generates the superheated vapor by superheating the vapor using the heat of the exhaust gas. The superheated vapor is supplied to a turbine (not shown) outside the CFB boiler 1 through a pipe (not shown) and is used in power generation. The coal economizer preheats the boiler water supply by transferring the heat of the exhaust gas to the boiler water supply.

[0033]

The return line 8 is formed of a pipeline connected to the lower portion of the combustion furnace 2 and is provided with a loop seal 8A on the middle thereof. The loop seal 8A is a facility that prevents backflow of the exhaust gas G from the combustion furnace 2. A fluid medium sent from the cyclone separator 4 is accumulated in the loop seal 8A. In addition, the fluid medium in the loop seal 8A is input from a return chute portion 8B at an outlet of the loop seal 8A into the combustion furnace 2.

[0034]

The bag filter 10 is for filtering and collecting fine particles (containing fly ash FA) such as dust contained in the exhaust gas G which has passed through the heat recovery portion 6 and is an example of a dust collector in the present invention. The fly ash FA means particles formed by condensing, melting, and aggregating components in a biomass fuel among fluid media (also includes those in which some of the bottom ash BA formed as particles has become finer). A pipe 16 that communicates and connects the heat recovery portion 6 and the bag filter 10 to each other is provided with a connecting part 16A to which a recovery pipe 22 (to be described later) is connected in order to recover an exhaust gas flowing in the pipe 16.

[0035]

The bag filter 10 includes a dust collecting chamber in which a plurality of cylindrical filter cylinders formed of filter cloth are hung and a hopper that is disposed at a lower portion of the dust collecting chamber in order to collect dust brushed off the filter cylinders. In addition, the bag filter 10 is provided with a compressed air pipe for brushing off dust accumulated on an outer surface of each filter cylinder by momentarily jetting compressed air from an upper portion of each filter cylinder and generating a pulse jet airflow. A compressed air jetting timing is controlled by a control unit 30 (to be described later) of the central processing device 100.

[0036]

The exhaust gas G that has passed through the bag filter 10 and that has been filtered is sucked by a suction pump 12 and is exhausted from a chimney 14 to the outside of the CFB boiler 1. Dust (containing the fly ash FA) collected by the bag filter 10 is recovered from the exhaust port (not shown) provided below the hopper.

[0037]

The central processing device 100 is configured by a memory that stores various types of control programs and the like and various types of control data, a processor that executes the various types of control programs, and the like and includes a plurality of functional units (an

estimation unit 28, the control unit 30, the adjusting unit 40, and the like). Each functional unit will be described in detail later.

[0038]

<First Embodiment>

Next, a monitoring device for a boiler 20 according to a first embodiment of the present invention will be described with reference to Figs. 1 to 3.

[0039]

The monitoring device for a boiler 20 according to the present embodiment is a device that monitors an operation state of the CFB boiler 1 and includes an exhaust gas collection portion (the recovery pipe 22, a water tank 24, and a suction pump 26) and the estimation unit 28.

[0040]

The exhaust gas collection portion functions to collect an exhaust gas generated by combustion of a fuel input into the combustion furnace 2 of the CFB boiler 1 and includes the recovery pipe 22 that is connected to the pipe 16, which communicates and connects the heat recovery portion 6 and the bag filter 10 to each other, the water tank 24 that stores water therein, and the suction pump 26. An upper end of the recovery pipe 22 is connected to the pipe 16, and a lower end of the recovery pipe 22 is immersed in water in the water tank 24. Then, as air in the

water tank 24 is sucked by the suction pump 26 and a pressure in the water tank 24 is made lower than the atmospheric pressure, an exhaust gas in the pipe 16 (that is, an upstream side of the bag filter 10) can be sucked via the recovery pipe 22 and be collected into the water tank 24. The exhaust gas collected in such a manner also contains dust before being filtered and collected by the bag filter 10. An operation of the suction pump 26 is operated by an observer of the CFB boiler 1.

[0041]

The estimation unit 28 functions to estimate contents of an alkaline metal and chlorine in a fuel based on a content of fine salt particles in an exhaust gas collected by the exhaust gas collection portion and is one functional unit of the central processing device 100. In the present embodiment, a weight per unit volume (mg/L) of fine salt particles (KCl or the like) contained in the exhaust gas collected in the water tank 24 via the recovery pipe 22 is measured by an alkaline metal ion monitor (not shown) and a chlorine detector pipe (not shown), the measured value is input into the central processing device 100, and a weight per unit weight (mg/kg) of the alkaline metal and the chlorine in the fuel is estimated by the estimation unit 28 based on the input measured value.

[0042]

The estimation unit 28 estimates a content (mg/kg) of an alkaline metal in a fuel of the CFB boiler 1 based on a measured value (a content (mg/L) of alkaline metal ions (for example, potassium ions and sodium ions) in a collected exhaust gas) from the alkaline metal ion monitor. In the present embodiment, correlation information between the measured value from the alkaline metal ion monitor and the content of the alkaline metal in the fuel is acquired in advance through experiments, and estimation is made using the correlation information. An example of the correlation information includes a linear graph L1 shown in Fig. 2.

[0043]

In addition, the estimation unit 28 estimates a content (mg/kg) of chlorine in a fuel of the CFB boiler 1 based on a measured value from the chlorine detector pipe (a content (mg/L) of chlorine ions in a collected exhaust gas). In the present embodiment, correlation information between the measured value from the chlorine detector pipe and the content of the chlorine in the fuel is acquired in advance through experiments, and estimation is made using the correlation information. An example of the correlation information includes a linear graph L2 shown in Fig. 3.

[0044]

In the present embodiment, in a case where an upper limit value U1 (Fig. 2) is set for a content of an alkaline metal in a fuel, an upper limit value U2 (Fig. 3) is set for a content of chlorine in the fuel, and at least any one of the contents of the alkaline metal and the chlorine in the fuel that are estimated by the estimation unit 28 exceeds each of the upper limit values U1 and U2, boiler control or adjustment of the fuel or the like that are to be described later are performed.

[0045]

In the present embodiment, instead of estimating the contents using the estimation unit 28 of the monitoring device for a boiler 20, the observer of the CFB boiler 1 manually estimates the contents. That is, the observer takes water in the water tank 24 in which an exhaust gas in the pipe 16 is dissolved, measures a content (mg/L) of fine salt particles (alkaline metal ions and chlorine ions) contained in the taken water with the alkaline metal ion monitor and the chlorine detector pipe, and estimates contents (mg/kg) of an alkaline metal and chlorine in a fuel with reference to the graphs L1 and L2 shown in Figs. 2 and 3. In a case where each of the upper limit values U1 and U2 is exceeded, it is also possible for the observer to perform boiler control or adjustment of the fuel or the like to be described later.

[0046]

Next, the control unit 30 of the central processing device 100 according to the present embodiment will be described.

[0047]

The control unit 30 is one functional unit of the central processing device 100 and controls a load and/or a maintenance operation of the CFB boiler 1 based on contents of an alkaline metal and chlorine in a fuel that are estimated by the estimation unit 28 or the observer of the CFB boiler 1. A controlling device for a boiler in the present invention is configured by the monitoring device for a boiler 20 and the control unit 30 in the present embodiment.

[0048]

In a case where at least any one of contents of an alkaline metal and chlorine in a fuel that are estimated by the estimation unit 28 exceeds each of the upper limit values U1 and U2, the control unit 30 can continue a boiler operation by controlling a load (output) on the CFB boiler 1 such that a temperature in the combustion furnace 2 of the CFB boiler 1, a temperature of vapor generated by the heat recovery portion 6, and the like decrease.

[0049]

In addition, in a case where at least any one of contents of an alkaline metal and chlorine in a fuel that are estimated by the estimation unit 28 or the observer of the CFB boiler 1 exceeds each of the upper limit values U1 and U2, the control unit 30 can suppress deposit adhesion on the surface by controlling an operation of a soot blower such that a transfer surface of the superheater or the coal economizer in the heat recovery portion 6 of the CFB boiler 1 is more frequently cleaned than usual and can restore a dust collection function of the bag filter 10 by performing control such that a jetting frequency of compressed air jetted from the compressed air pipe of the bag filter 10 of the CFB boiler 1 is higher than usual. Operation control of the soot blower or control of the jetting frequency of compressed air correspond to a maintenance operation of the CFB boiler 1.

[0050]

In the present embodiment, instead of the control unit 30 controlling various types of components of the CFB boiler 1, it is also possible to control a load and a maintenance operation of the CFB boiler 1 by the observer of the CFB boiler 1 manually operating the various types of components of the CFB boiler 1.

[0051]

Next, the adjusting unit 40 of the central processing device 100 according to the present embodiment will be described.

[0052]

The adjusting unit 40 is one functional unit of the central processing device 100 and, based on a content estimated by the estimation unit 28, changes at least any one of an amount, a composition, a type, and a mixed firing ratio of a fuel input into the combustion furnace 2 of the CFB boiler 1 and changes at least any one of a supply amount of an additive input into the combustion furnace 2, a supply amount of a fluid medium input into the combustion furnace 2, and an extraction amount of the fluid medium from the combustion furnace 2. Herein, "changing" the supply amount or the extraction amount means changing the supply amount or the extraction amount from a first amount to a second amount and also includes not only making any one of the first amount and the second amount zero (transitioning from a state of not performing supply or extraction to a state of performing supply or extraction and transitioning from a state of performing supply or extraction to a state of not performing supply or extraction), but also making the first amount and the second amount the same (making a change amount of the supply amount or the extraction amount zero (that is, not

changing the supply amount or the extraction amount)). An adjustment device for a fuel or the like in the present invention is configured by the monitoring device for a boiler 20 and the adjusting unit 40 in the present embodiment.

[0053]

In a case where at least any one of contents of an alkaline metal and chlorine in a fuel that are estimated by the estimation unit 28 exceeds each of the upper limit values U1 and U2, the adjusting unit 40 can continue a boiler operation by controlling the supply adjustment mechanism provided at the fuel charging port of the combustion furnace 2 such that the amount of the fuel input into the combustion furnace 2 of the CFB boiler 1 is decreased, a composition or a type of the fuel is changed to a type with a small amount of alkali or chlorine, and a mixed firing ratio of the fuel is changed to an appropriate value.

[0054]

In addition, in a case where at least any one of contents of an alkaline metal and chlorine that are estimated by the estimation unit 28 exceeds each of the upper limit values U1 and U2, the adjusting unit 40 can continue a boiler operation by increasing a supply amount of an additive input into the combustion furnace 2 of the

CFB boiler 1, controlling the supply adjustment mechanism provided at the fuel charging port of the combustion furnace 2 such that a supply amount of a fluid medium input into the combustion furnace 2 is increased, or controlling the exhaust adjustment mechanism provided at the exhaust port of the combustion furnace 2 such that an extraction amount of the fluid medium from the combustion furnace 2 is increased.

[0055]

In the present embodiment, instead of the adjusting unit 40 controlling devices, it is also possible for the observer of the CFB boiler 1 to manually adjust a fuel input amount or the like and to continue a boiler operation by controlling a load on the CFB boiler 1.

[0056]

Next, a monitoring method for a boiler or the like according to the present embodiment will be described with reference to a flowchart of Fig. 4.

[0057]

First, an exhaust gas generated by combustion of a fuel input into the combustion furnace 2 of the CFB boiler 1 is collected using the exhaust gas collection portion (the recovery pipe 22, the water tank 24, and the suction pump 26) (an exhaust gas collection process: S1). In the exhaust gas collection process S1 in the present

embodiment, the exhaust gas on the upstream side of the bag filter 10 of the CFB boiler 1 is collected as described already. A time or a frequency of collecting the exhaust gas can be set as appropriate according to specifications of the CFB boiler 1 or the like. For example, the exhaust gas can be collected at a predetermined time at least once a day, the exhaust gas can be collected when a type of fuel is changed, or the exhaust gas can be collected when an abnormality is found in the operation state of the CFB boiler 1. In such a manner, it is possible to monitor a content of fine salt particles in the exhaust gas over time, and correlation information between the type of fuel and the content of the fine salt particles in the exhaust gas or correlation information between a boiler abnormality and the content of the fine salt particles in the exhaust gas can be obtained.

[0058]

Next, contents of an alkaline metal and chlorine in the fuel are estimated based on the content of the fine salt particles in the exhaust gas collected in the exhaust gas collection process S1 (an estimation process: S2). As described already, the observer of the CFB boiler 1 estimates the content of the alkaline metal in the fuel using correlation (for example, the linear graph L1 shown in Fig. 2) between a measured value (a content (mg/L) of

alkaline metal ions in the collected exhaust gas) from the alkaline metal ion monitor and the content (mg/kg) of the alkaline metal in the fuel of the CFB boiler 1 and estimates the content of the chlorine in the fuel using correlation (for example, the linear graph L2 shown in Fig. 3) between a measured value from the chlorine detector pipe (a content (mg/L) of chlorine ions in the collected exhaust gas) and the content (mg/kg) of the chlorine in the fuel of the CFB boiler 1.

[0059]

Next, the observer of the CFB boiler 1 determines whether or not at least any one of the contents of the alkaline metal and the chlorine in the fuel that are estimated in the estimation process S2 exceeds the predetermined upper limit values U1 and U2 (a determination process: S3). In the determination process S3, in a case where it is determined that the estimated contents of the alkaline metal and the chlorine in the fuel are equal to or smaller than the upper limit values U1 and U2, processing returns to the exhaust gas collection process S1, and subsequent processes are repeatedly executed.

[0060]

On the other hand, in the determination process S3, in a case where it is determined that the estimated contents of the alkaline metal and the chlorine in the fuel exceed

the upper limit values U1 and U2, the observer of the CFB boiler 1 controls a load and/or a maintenance operation of the CFB boiler 1 (a boiler control process: S4) and changes at least any one of an amount, a composition, a type, and a mixed firing ratio of the fuel input into the combustion furnace 2 of the CFB boiler 1 and at least any one of a supply amount of an additive input into the combustion furnace 2, a supply amount of a fluid medium input into the combustion furnace 2, and/or an extraction amount of the fluid medium from the combustion furnace 2 (a fuel or the like adjustment process: S5). As described already, "changing" the supply amount or the extraction amount means changing the supply amount or the extraction amount from the first amount to the second amount and also includes not only making any one of the first amount and the second amount zero, but also making the first amount and the second amount the same.

[0061]

In the boiler control process S4, the observer of the CFB boiler 1 can continue a boiler operation by controlling a load (output) on the CFB boiler 1 such that a temperature in the combustion furnace 2 of the CFB boiler 1, a temperature of vapor generated by the heat recovery portion 6, and the like decrease. In addition, in the boiler control process S4, the observer of the CFB boiler 1 can

suppress deposit adhesion on the surface by controlling an operation of the soot blower such that the transfer surface of the superheater or the coal economizer in the heat recovery portion 6 of the CFB boiler 1 is more frequently cleaned than usual and can restore a dust collection function of the bag filter 10 by performing control such that a jetting frequency of compressed air jetted from the compressed air pipe of the bag filter 10 of the CFB boiler 1 is higher than usual.

[0062]

In the fuel or the like adjustment process S5, the observer of the CFB boiler 1 can continue the boiler operation through control of a load on the CFB boiler 1 by controlling the supply adjustment mechanism provided at the fuel charging port of the combustion furnace 2 such that the amount of a fuel input into the combustion furnace 2 of the CFB boiler 1 is decreased, a composition or a type of the fuel is changed to a type with a small amount of alkali or chlorine, and a mixed firing ratio of the fuel is changed to an appropriate value. In addition, in the fuel or the like adjustment process S5, the observer of the CFB boiler 1 can continue the boiler operation through control of a load on the CFB boiler 1 by increasing a supply amount of an additive input into the combustion furnace 2 of the CFB boiler 1, controlling the supply adjustment mechanism

provided at the fuel charging port of the combustion furnace 2 such that a supply amount of a fluid medium input into the combustion furnace 2 is increased, or controlling the exhaust adjustment mechanism provided at the exhaust port of the combustion furnace 2 such that an extraction amount of the fluid medium from the combustion furnace 2 is increased.

[0063]

The exhaust gas collection process S1 and the estimation process S2 in the present embodiment configure an example of the monitoring method for a boiler in the present invention. The exhaust gas collection process S1, the estimation process S2, the determination process S3, and the boiler control process S4 in the present embodiment configure an example of a controlling method for a boiler in the present invention (herein, the determination process S3 and the boiler control process S4 configure an example of a control process in the present invention). The exhaust gas collection process S1, the estimation process S2, the determination process S3, and the fuel or the like adjustment process S5 in the present embodiment configure an example of an adjustment method for a fuel or the like in the present invention (herein, the determination process S3 and the fuel or the like adjustment process S5 configure

an example of an adjustment process in the present invention).

[0064]

In the monitoring method for a boiler according to the embodiment described hereinbefore, an exhaust gas generated by combustion of a fuel input into the combustion furnace 2 of the CFB boiler 1 can be collected, and contents of an alkaline metal and chlorine in the fuel can be estimated based on a content of fine salt particles in the collected exhaust gas. Then, based on the estimated contents of the alkaline metal and the chlorine in the fuel, a load on the CFB boiler 1 (an in-furnace temperature, a vapor temperature, or the like) or the like can be controlled, or an amount, a composition, or the like of the fuel can be changed. In particular, in the exhaust gas collection process S1 in the present embodiment, since the exhaust gas on the upstream side of the bag filter 10 of the CDB boiler 1 is collected, the content of the fine salt particles (KCl or the like) in the exhaust gas before being collected by the bag filter 10 can be monitored, and the contents of the alkaline metal and the chlorine in the fuel can be appropriately estimated.

[0065]

In addition, in the controlling method for a boiler according to the embodiment described hereinbefore, based

on contents of an alkaline metal and chlorine in a fuel, which are estimated from a content of fine salt particles in an exhaust gas generated by combustion of the fuel input into the combustion furnace of the CFB boiler 1, a load on the CFB boiler 1 (an in-furnace temperature, a vapor temperature, or the like) or a maintenance operation of the CFB boiler 1 (cleaning of the transfer surface of the superheater or the coal economizer by the soot blower or the like, a pulse frequency of the bag filter, or the like) can be controlled. As described above, as the contents of the alkaline metal and the chlorine in the fuel in the CFB boiler 1 are quantitatively identified and the boiler load or the like is controlled based on the contents, it is possible to prolong the life of the existing boiler compared to the related art.

[0066]

In addition, in the adjustment method for a fuel or the like according to the embodiment described hereinbefore, based on contents of an alkaline metal and chlorine in a fuel which are estimated from a content of fine salt particles in an exhaust gas generated by combustion of the fuel input into the combustion furnace 2 of the CFB boiler 1, at least any one of an amount, a composition, a type, and a mixed firing ratio of the fuel input into the combustion furnace 2, a supply amount of an

additive input into the combustion furnace 2, a supply amount of the fluid medium input into the combustion furnace, and/or an extraction amount of the fluid medium from the combustion furnace 2 can be changed. As described above, as the contents of the alkaline metal and the chlorine in the fuel in the CFB boiler 1 are quantitatively identified and the amount of the fuel or the amount of combustion furnace contents (the additive and the fluid medium) is adjusted based on the contents, it is possible to prolong the life of the existing boiler compared to the related art and to manage changes in fuel properties of an input fuel (wood chips, tires, Refuse Paper & Plastic Fuel (RPF), or the like), an increase or decrease of corrosive components, or the like during a boiler operation.

[0067]

<Second Embodiment>

Next, a monitoring method for a boiler or the like according to a second embodiment of the present invention will be described.

[0068]

In the present embodiment, instead of the observer of the CFB boiler 1 manually performing content estimation, control, and adjustment, contents of an alkaline metal and chlorine in a fuel are estimated using the estimation unit 28 of the monitoring device for a boiler 20, a load and a

maintenance operation of the CFB boiler 1 is controlled by the control unit 30, and a fuel input amount or the like is adjusted by the adjusting unit 40. Since configurations of the monitoring device for a boiler 20 (the estimation unit 28), the control unit 30, and the adjusting unit 40 are the same as those in the first embodiment, detailed description will be omitted. Since the content of each process of the monitoring method for a boiler or the like according to the present embodiment is common to the first embodiment (although a principal is changed), the content will be described as appropriate with reference to the flowchart of Fig. 4.

[0069]

First, an exhaust gas generated by combustion of a fuel input into the combustion furnace 2 of the CFB boiler 1 is collected using the exhaust gas collection portion (the recovery pipe 22, the water tank 24, and the suction pump 26) (the exhaust gas collection process: S1). Also in the exhaust gas collection process S1 of the present embodiment, the exhaust gas on the upstream side of the bag filter 10 of the CFB boiler 1 is collected. In the present embodiment, the exhaust gas is collected at a predetermined time or frequency by controlling the suction pump 26 with the control unit 30 of the central processing device 100. A time or a frequency of collecting the exhaust gas can be

set as appropriate according to specifications of the CFB boiler 1 or the like. For example, the exhaust gas can be collected at a predetermined time at least once a day, the exhaust gas can be collected when a type of fuel is changed, or the exhaust gas can be collected when an abnormality is found in the operation state of the CFB boiler 1.

[0070]

Next, contents of an alkaline metal and chlorine in the fuel are estimated by the estimation unit 28 of the central processing device 100 based on a content of fine salt particles in the exhaust gas collected in the exhaust gas collection process S1 (the estimation process: S2). As described already, the estimation unit 28 estimates the content of the alkaline metal in the fuel using correlation (for example, the linear graph L1 shown in Fig. 2) between a measured value from the alkaline metal ion monitor (a content (mg/L) of alkaline metal ions in the collected exhaust gas) and the content (mg/kg) of the alkaline metal in the fuel of the CFB boiler 1 and estimates the content of the chlorine in the fuel using correlation (for example, the linear graph L2 shown in Fig. 3) between a measured value from the chlorine detector pipe (a content (mg/L) of chlorine ions in the collected exhaust gas) and a content (mg/kg) of the chlorine in the fuel of the CFB boiler 1.

[0071]

Next, the central processing device 100 determines whether or not at least any one of the contents of the alkaline metal and the chlorine in the fuel that are estimated in the estimation process S2 exceeds the predetermined upper limit values U1 and U2 (the determination process: S3). In the determination process S3, in a case where it is determined that the estimated contents of the alkaline metal and the chlorine in the fuel are equal to or smaller than the upper limit values U1 and U2, processing returns to the exhaust gas collection process S1, and subsequent processes are repeatedly executed.

[0072]

On the other hand, in the determination process S3, in a case where it is determined that the estimated contents of the alkaline metal and the chlorine in the fuel exceed the upper limit values U1 and U2, the control unit 30 of the central processing device 100 controls a load and/or a maintenance operation of the CFB boiler 1 (the boiler control process: S4), and the adjusting unit 40 of the central processing device 100 changes at least any one of an amount, a composition, a type, and a mixed firing ratio of the fuel input into the combustion furnace 2 of the CFB boiler 1 and at least any one of a supply amount of an

additive input into the combustion furnace 2, a supply amount of a fluid medium input into the combustion furnace 2, and/or an extraction amount of the fluid medium from the combustion furnace 2 (the fuel or the like adjustment process: S5).

[0073]

In the boiler control process S4, the control unit 30 can continue a boiler operation by controlling a load (output) on the CFB boiler 1 such that a temperature in the combustion furnace 2 of the CFB boiler 1, a temperature of vapor generated by the heat recovery portion 6, and the like decrease. In addition, in the boiler control process S4, the control unit 30 can suppress deposit adhesion on the surface by controlling an operation of the soot blower such that the transfer surface of the superheater or the coal economizer in the heat recovery portion 6 of the CFB boiler 1 is more frequently cleaned than usual and can quickly restore a dust collection function of the bag filter 10 by performing control such that a jetting frequency of compressed air jetted from the compressed air pipe of the bag filter 10 of the CFB boiler 1 is higher than usual.

[0074]

In the fuel or the like adjustment process S5, the adjusting unit 40 can continue the boiler operation through

control of a load on the CFB boiler 1 by controlling the supply adjustment mechanism provided at the fuel charging port of the combustion furnace 2 such that the amount of a fuel input into the combustion furnace 2 of the CFB boiler 1 is decreased, a composition or a type of the fuel is changed to a type with a small amount of an alkaline metal or chlorine, and a mixed firing ratio of the fuel is changed to an appropriate value. In addition, in the fuel or the like adjustment process S5, the adjusting unit 40 can continue the boiler operation through control of a load on the CFB boiler 1 by increasing a supply amount of an additive input into the combustion furnace 2 of the CFB boiler 1, controlling the supply adjustment mechanism provided at the fuel charging port of the combustion furnace 2 such that a supply amount of a fluid medium input into the combustion furnace 2 is increased, or controlling the exhaust adjustment mechanism provided at the exhaust port of the combustion furnace 2 such that an extraction amount of the fluid medium from the combustion furnace 2 is increased.

[0075]

In the monitoring device for a boiler 20 according to the embodiment described hereinbefore, an exhaust gas generated by combustion of a fuel input into the combustion furnace 2 of the CFB boiler 1 can be collected, and

contents of an alkaline metal and chlorine in the fuel can be estimated based on a content of fine salt particles in the collected exhaust gas. Then, based on the estimated contents of the alkaline metal and the chlorine in the fuel, a load on the CFB boiler 1 (an in-furnace temperature, a vapor temperature, or the like) or the like can be controlled, or an amount, a composition, or the like of the fuel can be changed. In particular, in the exhaust gas collection process S1 in the present embodiment, since the exhaust gas on the upstream side of the bag filter 10 of the CDB boiler 1 is collected, the content of the fine salt particles (KCl or the like) in the exhaust gas before being collected by the bag filter 10 can be monitored, and the contents of the alkaline metal and the chlorine in the fuel can be appropriately estimated.

[0076]

In addition, in the controlling device for a boiler (the monitoring device for a boiler 20 and the control unit 30) according to the embodiment described hereinbefore, based on contents of an alkaline metal and chlorine in a fuel, which are estimated from a content of fine salt particles in an exhaust gas generated by combustion of the fuel input into the combustion furnace of the CFB boiler 1, a load on the CFB boiler 1 (an in-furnace temperature, a vapor temperature, or the like) or a maintenance operation

of the CFB boiler 1 (cleaning of the transfer surface of the superheater or the coal economizer by the soot blower or the like, a pulse frequency of the bag filter, or the like) can be controlled. As described above, as the contents of the alkaline metal and the chlorine in the fuel in the CFB boiler 1 are quantitatively identified and the boiler load or the like is controlled based on the contents, it is possible to prolong the life of the existing boiler compared to the related art.

[0077]

In addition, in the adjustment device for a fuel or the like (the monitoring device for a boiler 20 and the adjusting unit 40) according to the embodiment described hereinbefore, based on contents of an alkaline metal and chlorine in a fuel, which are estimated from a content of fine salt particles in an exhaust gas generated by combustion of the fuel input into the combustion furnace 2 of the CFB boiler 1, at least any one of an amount, a composition, a type, and a mixed firing ratio of the fuel input into the combustion furnace 2, a supply amount of an additive input into the combustion furnace 2, a supply amount of a fluid medium input into the combustion furnace, and/or an extraction amount of the fluid medium from the combustion furnace 2 can be changed. As described above, as the contents of the alkaline metal and the chlorine in the

fuel in the CFB boiler 1 are quantitatively identified and the amount of the fuel or the amount of combustion furnace contents (the additive and the fluid medium) is adjusted based on the contents, it is possible to prolong the life of the existing boiler compared to the related art and to manage changes in fuel properties of an input fuel (wood chips, tires, Refuse Paper & Plastic Fuel (RPF), or the like), an increase or decrease of corrosive components, or the like during a boiler operation.

[0078]

The present invention is not limited to each of the above embodiments, and appropriate design changes to the embodiments are implemented by a person skilled in the art, which are also included in the scope of the present invention as long as the features of the present invention are included. That is, each element included in each of the embodiments, disposition thereof, a material, a condition, a shape, a size, and the like are not limited to those exemplified and can be changed as appropriate. In addition, the elements included in each of the embodiments can be combined as much as technically possible, and the combination is also included in the scope of the present invention as long as the features of the present invention are included.

[0079]

In addition, all the documents, patent applications, and technical standards described in the specification are incorporated herein by reference to the same extent as in a case where it is specifically and individually stated that the individual documents, patent applications, and technical standards are incorporated by reference.

Industrial Applicability

[0080]

The present invention is useful when monitoring a content of fine salt particles in an exhaust gas of a boiler with a relatively simple method and appropriately estimating a content of an alkaline metal or chlorine in a fuel.

Reference Signs List

[0081]

- 1 CFB boiler
- 2 combustion furnace
- 6 heat recovery portion
- 10 bag filter (dust collector)
- 16 pipe
- 16A connecting part
- 20 monitoring device for a boiler
- 22 recovery pipe (exhaust gas collection portion)

- 24 water tank (exhaust gas collection portion)
- 26 suction pump (exhaust gas collection portion)
- 28 estimation unit
- 30 control unit
- 40 adjusting unit
- S1 exhaust gas collection process
- S2 estimation process
- S3 determination process (control process, adjustment
process)
- S4 boiler control process (control process)
- S5 fuel or the like adjustment process (adjustment
process)

CLAIMS

1. A monitoring method for a boiler that is a method of monitoring an operation state of the boiler, the monitoring method comprising:

an exhaust gas collection process of collecting an exhaust gas generated by combustion of a fuel input into a combustion furnace of the boiler; and

an estimation process of estimating a content of an alkaline metal and/or chlorine in the fuel based on a content of a fine salt particle in the exhaust gas collected in the exhaust gas collection process.

2. The monitoring method for a boiler according to claim 1,

wherein in the exhaust gas collection process, the exhaust gas on an upstream side of a dust collector of the boiler is collected.

3. The monitoring method for a boiler according to claim 1 or 2,

wherein in the exhaust gas collection process, the exhaust gas is collected at a predetermined frequency.

4. The monitoring method for a boiler according to claim 1 or 2,

wherein in the exhaust gas collection process, the exhaust gas is collected when a type of the fuel is changed and/or when an abnormality is found in the operation state of the boiler.

5. A controlling method for a boiler, comprising:

the monitoring method for a boiler according to any one of claims 1 to 4; and

a control process of controlling a load on the boiler and/or a maintenance operation of the boiler based on the content estimated in the estimation process of the monitoring method for a boiler.

6. An adjustment method for a fuel or the like, comprising:

the monitoring method for a boiler according to any one of claims 1 to 4; and

an adjustment process of changing, based on a content estimated in the estimation process of the monitoring method for a boiler, at least any one of an amount, a composition, a type, and a mixed firing ratio of the fuel input into the combustion furnace, a supply amount of an additive input into the combustion furnace, a supply amount

of a fluid medium input into the combustion furnace, and/or an extraction amount of the fluid medium from the combustion furnace.

7. A monitoring device for a boiler that is a device monitoring an operation state of the boiler, the monitoring device comprising:

an exhaust gas collection portion that collects an exhaust gas generated by combustion of a fuel input into a combustion furnace of the boiler; and

an estimation unit that estimates a content of an alkaline metal and/or chlorine in the fuel based on a component contained in the exhaust gas collected by the exhaust gas collection portion.

8. A controlling device for a boiler, comprising:

the monitoring device for a boiler according to claim 7; and

a control unit that controls a load on the boiler and/or a maintenance operation of the boiler based on a content estimated by the estimation unit of the monitoring device for a boiler.

9. An adjustment device for a fuel or the like, comprising:

the monitoring device for a boiler according to claim 7; and

an adjusting unit that changes, based on a content estimated by the estimation unit of the monitoring device for a boiler, at least any one of an amount, a composition, a type, and a mixed firing ratio of the fuel input into the combustion furnace, a supply amount of an additive input into the combustion furnace, a supply amount of a fluid medium input into the combustion furnace, and/or an extraction amount of the fluid medium from the combustion furnace.

10. A boiler comprising:

a heat recovery portion that recovers heat of a combustion gas generated by a combustion furnace; and

a dust collector that filters and collects dust contained in a gas which has passed through the heat recovery portion,

wherein in order to monitor a content of a fine salt particle in the gas which has passed through the heat recovery portion, a connecting part, to which a recovery pipe capable of recovering a gas in a pipe communicating and connecting the heat recovery portion and the dust collector to each other is connected, is provided.