

[DESCRIPTION]

[TITLE OF INVENTION]

WASTE HEAT POWER GENERATION SYSTEM

[Technical Field]

5 [0001]

The present invention relates to a waste heat power generation system which generates electric power using waste heat from an incinerator.

Priority is claimed on Japanese Patent Application No. 2015-251539, filed December 24, 2015, the content of which is incorporated herein by reference.

10 [Background Art]

[0002]

In a sludge incineration plant which processes sludge such as sewage sludge, combustion air supplied to an incinerator is preheated using waste heat from the incinerator, or electric power is generated using steam generated by a boiler which recovers waste heat.

15 Accordingly, in the sludge incineration plant, a thermal effective utilization rate of the entire plant is improved (refer to, for example, Patent Literature 1).

[0003]

In such a sludge incineration plant, it is common to provide a dust collection device for performing a dust collection treatment of exhaust gas discharged from the incinerator.

20 In the sludge incineration plant, a temperature of the exhaust gas flowing into the dust collection device is adjusted on the basis of a heat-resistant temperature of the dust collection device. Conventionally, water was sprayed in an exhaust gas-cooling tower on the exhaust gas introduced into the dust collection device, and the temperature was adjusted to, for example, about 200°C.

25 [Citation List]

[Patent Literature]

[0004]

[Patent Literature 1]

Japanese Unexamined Patent Application, First Publication No. 2013-155974

5 [Summary of Invention]

[Technical Problem]

[0005]

However, the adjusting of the temperature by spraying water on the exhaust gas is not preferable because it results in the heat being discarded. Further, it is also possible to
10 control the temperature by mixing the exhaust gas introduced into the dust collection device with air or the like. However, even in this method, as the same as in the exhaust gas-cooling tower, the heat is eventually discarded, which is not preferable. Further, a large amount of air is required, and it is necessary to increase a capacity of an apparatus to cope with a large increase in a gas amount.

15 [0006]

There is also a method in which a gas type air preheater is installed to control the temperature, but there is a problem in that a heat transfer tube of the gas type air preheater tends to become a low-temperature corrosion zone.

[0007]

20 The object of the present invention is to provide a waste heat power generation system which has a higher thermal effective utilization rate in a waste heat power generation system that generates electric power using waste heat from an incinerator.

[Solution to Problem]

[0008]

25 A first aspect of the present invention provides a waste heat power generation system that

includes an incinerator, an exhaust gas line through which exhaust gas discharged from the incinerator flows, a power generation device configured to generate electric power using heat transfer oil as a heat source, a first heat exchanger configured to exchange heat between the exhaust gas and the heat transfer oil supplied to the power generation device, 5 an air preheater disposed in the exhaust gas line in parallel with the first heat exchanger and configured to exchange heat between the exhaust gas and air supplied to the incinerator, a dust collection device configured to remove solid components from the exhaust gas having exchanged heat in the first heat exchanger and the air preheater, and a second heat exchanger provided in the exhaust gas line on an upstream side of the dust 10 collection device and configured to exchange heat between the exhaust gas, that has exchanged heat in the first heat exchanger and the air preheater, and the heat transfer oil that is supplied to the first heat exchanger.

[0009]

According to such a constitution, since the temperature of the exhaust gas introduced into 15 the dust collection device is reduced using the second heat exchanger, the heat can be more effectively utilized as compared with, for example, a case in which the temperature of the exhaust gas is reduced using an exhaust gas-cooling tower.

[0010]

The waste heat power generation system may include a control device configured to 20 adjust a flow rate of the heat transfer oil which exchanges heat in the second heat exchanger on the basis of a temperature of the exhaust gas discharged from the second heat exchanger.

[0011]

According to such a constitution, since the flow rate of the heat transfer oil is adjusted 25 and thus the temperature of the exhaust gas is adjusted, it is possible that the temperature

of the exhaust gas becomes a temperature corresponding to a heat-resistant temperature of the dust collection device.

[0012]

The waste heat power generation system may include a heat transfer oil-circulation path through which the heat transfer oil circulates, and a bypass path configured to connect an upstream side of the second heat exchanger with a downstream side of the second heat exchanger in the heat transfer oil-circulation path while bypassing the second heat exchanger, and the control device may adjust the flow rate of the heat transfer oil flowing through the bypass path.

10 [0013]

Since the temperature of the exhaust gas flowing into the dust collection device is adjusted according to the flow rate of the heat transfer oil introduced into the second heat exchanger disposed on the upstream side of the dust collection device, it is possible to adjust the temperature of the exhaust gas more quickly.

15 [0014]

The waste heat power generation system may adjust a flow speed of the heat transfer oil supplied to the power generation device on the basis of the temperature of the heat transfer oil having exchanged heat in the first heat exchanger.

[0015]

20 According to such a constitution, it is possible to adjust the temperature of the heat transfer oil to a temperature suitable for the power generation device. Also, it is possible to cope with a temperature rise of the exhaust gas in the case in which the temperature (heat capacity) of the exhaust gas discharged from the incinerator increases greatly. Furthermore, it is possible to cope with a temperature drop of the exhaust gas
25 in the case in which the temperature (heat capacity) of the exhaust gas discharged from

the incinerator decreases greatly.

[0016]

The waste heat power generation system may include a white smoke prevention device configured to heat external air with the exhaust gas discharged from the second heat

5 exchanger and having passed through the dust collection device and configured to supply the heated external air to a chimney.

[0017]

According to such a constitution, as compared with the case, for example, the white smoke prevention device is installed on the upstream side of the second heat exchanger,

10 heat is recovered from the exhaust gas having a low temperature and therefore a heat recovery rate of the entire system can be improved.

[Advantageous Effects of Invention]

[0018]

According to the present invention, it is possible to utilize the heat more effectively by

15 reducing the temperature of the exhaust gas introduced into the dust collection device using the second heat exchanger as compared with a case, for example, the temperature of the exhaust gas is reduced using an exhaust gas-cooling tower.

[Brief Description of Drawings]

[0019]

20 FIG. 1 is a system diagram of a sludge incineration plant according to an embodiment of the present invention.

FIG. 2 is a flowchart illustrating a first control method of the sludge incineration plant according to the embodiment of the present invention.

FIG. 3 is a flowchart illustrating a second control method of the sludge incineration plant
25 according to the embodiment of the present invention.

[Description of Embodiments]

[0020]

Hereinafter, a sludge incineration plant 1 as a waste heat power generation system according to an embodiment of the present invention will be described in detail with reference to the drawings.

As illustrated in FIG. 1, the sludge incineration plant 1 of the present embodiment includes an incinerator 2 which incinerates sludge S such as sewage sludge, a power generation device 3 which generates electric power using waste heat (incineration heat) of exhaust gas EG discharged from incinerator 2, and a control device 4. The sludge incineration plant 1 of the present embodiment is a waste heat power generation system which generates electric power by incinerating the sludge S and recovering heat generated by incineration. The power generation device 3 uses a heat transfer oil HO as a heat medium circulating in the plant.

[0021]

The sludge incineration plant 1 includes an exhaust gas line 5 into which the exhaust gas EG discharged from the incinerator 2 is introduced, a first heat exchanger 6 provided on the exhaust gas line 5, an air preheater 7 provided in parallel with the first heat exchanger 6 in the exhaust gas line 5, a second heat exchanger 8 provided on a downstream side of the first heat exchanger 6 and the air preheater 7, and an exhaust gas treatment device 9 provided on a downstream side of the second heat exchanger 8.

[0022]

A sludge dryer which dries dewatered sludge as sludge containing moisture may be provided on an upstream side of the incinerator 2. The sludge dryer is a device which dries dewatered sludge (dehydrated cake having, for example, a water content of 72%) introduced through a volume reduction process of condensation/dehydration and

produces dried sludge (having, for example, a water content of 50%).

[0023]

The first heat exchanger 6 and the second heat exchanger 8 are heat exchangers for heat exchange between the exhaust gas EG discharged from the incinerator 2 and the heat transfer oil HO supplied to the power generation device 3 (i.e. heating the heat transfer oil HO). The air preheater 7 is a heat exchanger for heat exchange between the exhaust gas EG discharged from the incinerator 2 and combustion air A1 supplied to the incinerator 2 (i.e. preheating the combustion air A1).

[0024]

The exhaust gas treatment device 9 includes a dust collection device 14 (e.g. bag filter) for removing solid components (e.g. ash or the like) from the exhaust gas EG and performing a dust collection treatment, a white smoke prevention device 15, a scrubber 16 (i.e. an exhaust gas-scrubbing device) which brings a washing liquid into contact with the exhaust gas EG and detoxifies it, and a chimney 17 which discharges the treated exhaust gas EG to the atmosphere.

[0025]

The power generation device 3 includes a power generation device body 11, and a heat transfer oil-circulation path 12 (indicated by a two-dot chain line in FIG. 1) which is an annular heat source system for introducing the heat transfer oil HO into the power generation device body 11. The heat transfer oil-circulation path 12 is a path through which the heat transfer oil HO circulates among the power generation device body 11, the first heat exchanger 6 and the second heat exchanger 8. In the heat transfer oil-circulation path 12, the heat transfer oil HO flows in one direction.

[0026]

The incinerator 2 is a facility which incinerates the sludge S by stirring and mixing in a

high-temperature fluidized bed. The incinerator 2 may be an incineration facility which incinerates waste and discharges high-temperature exhaust gas EG. An incineration facility such as a bubble type fluidized bed furnace and a circulation type fluidized bed furnace may be adopted as the incinerator 2.

5 The combustion air A1 (i.e. “flowing air”) is introduced into the incinerator 2 via a combustion air line 13 (indicated by a one-dot chain line in FIG. 1). The exhaust gas EG is discharged from the incinerator 2 through a first exhaust gas line 5a. A temperature of the exhaust gas EG discharged from the incinerator 2 is, for example, 850°C.

10 [0027]

The first exhaust gas line 5a branches into two second exhaust gas lines 5b (5b1 and 5b2) provided in parallel on a downstream side. One second exhaust gas line 5b1 is connected to the first heat exchanger 6. The first heat exchanger 6 is provided on the second exhaust gas line 5b1 which is on the heat transfer oil-circulation path 12. The first heat exchanger 6 functions as a heating device in which the heat transfer oil HO is heated by recovering the heat of the high-temperature exhaust gas EG flowing through the second exhaust gas line 5b1.

The other second exhaust gas line 5b2 is connected to the air preheater 7. The air preheater 7 is a heat exchanger in which the combustion air A1 flowing through the combustion air line 13 is heated (preheated) by recovering the heat of the high-temperature exhaust gas EG flowing through the second exhaust gas line 5b2.

20 The first heat exchanger 6 and the air preheater 7 are provided in parallel on the exhaust gas line 5.

[0028]

25 The two second exhaust gas lines 5b are combined on a downstream side of the first heat

exchanger 6 and the air preheater 7. The two second exhaust gas lines 5b are connected to the third exhaust gas line 5c. The second heat exchanger 8 is provided on the downstream side of the first heat exchanger 6 and the air preheater 7, that is, on the third exhaust gas line 5c. The second heat exchanger 8 functions as a heating device in which the heat transfer oil HO is heated by recovering the heat of the exhaust gas EG which exchanges heat with the first heat exchanger 6 and the air preheater 7.

[0029]

Next, the exhaust gas treatment device 9 which removes dust, SO₂, HCl and so on contained in the exhaust gas EG discharged from the incinerator 2 to form clean exhaust gas will be described.

The dust collection device 14 provided on a downstream side of the second heat exchanger 8 is a device which filters and collects solid components such as dust and ash in the exhaust gas EG using a heat-resistant filter cloth or the like. That is, the dust and so on are removed from the exhaust gas EG discharged from the second heat exchanger 8 and introduced into the dust collection device 14 via a fourth exhaust gas line 5d.

In the dust collection device 14, a heat-resistant temperature is set with respect to the temperature of the exhaust gas EG to be introduced. The heat-resistant temperature of the dust collection device 14 is, for example, 220°C.

[0030]

The white smoke prevention device 15 provided on a downstream side of the dust collection device 14 in the exhaust gas line 5 is a device which prevents white smoke of the exhaust gas EG. The white smoke prevention device 15 includes an air supply fan 19 which suctions and feeds air A2, an air heater 20 which exchanges heat between the exhaust gas EG introduced from the dust collection device 14 through a fifth exhaust gas line 5e and the air A2 and heats the air A2 to make it into mixing air A3, and a mixing air

line 21 which guides the mixing air A3 to the chimney 17.

[0031]

As the air heater 20 of the white smoke prevention device 15, for example, a shell and tube type heat exchanger can be adopted. A heat transfer tube of the air heater 20 is covered with, for example, a corrosion-resistant material of “Teflon” (registered trademark). In other words, a corrosion-resistant layer made of Teflon is formed on an exhaust gas contact surface of the air heater 20. That is, the air heater 20 of the present embodiment has a low-temperature corrosion-preventing type heat transfer tube.

Therefore, corrosion of a metal surface of the heat transfer tube is minimized and

low-temperature corrosion is prevented. A treatment for making the white smoke prevention device 15 into a low-temperature corrosion-preventing type is not limited to the above-described Teflon, and it is also possible to employ a nonmetallic material such as, for example, a resin. Further, the heat transfer tube itself may be formed of a corrosion-resistant material such as a ceramic.

[0032]

The scrubber 16 is an exhaust gas-scrubbing device which brings the exhaust gas EG discharged from the white smoke prevention device 15 and introduced through a sixth exhaust gas line 5f into contact with a cleaning liquid such as water, a caustic soda aqueous solution or the like and detoxifies it.

The exhaust gas EG in the exhaust gas line 5 is suctioned by an induction blower (not illustrated) and is discharged through the chimney 17.

[0033]

In the exhaust gas line 5, an exhaust gas temperature-measuring device 18 which measures the temperature of the exhaust gas EG flowing through a fourth exhaust gas line 5d is provided on the fourth exhaust gas line 5d which connects the second heat

exchanger 8 and the dust collection device 14. The exhaust gas temperature-measuring device 18 measures the temperature of the exhaust gas EG flowing into the dust collection device 14. The temperature of the exhaust gas EG measured by the exhaust gas temperature-measuring device 18 is transmitted to the control device 4.

5 [0034]

Next, the power generation device 3 of the present embodiment will be described in detail.

The power generation device body 11 adopts a so-called binary waste heat power generation system (organic Rankine cycle waste heat power generation system) in which
10 an organic working medium M is heated and evaporated using waste heat from the incinerator 2 as a heat source and a steam turbine 23 is rotated by the steam evaporated from the organic working medium M to generate electric power.

[0035]

The power generation device body 11 of the present embodiment includes an evaporator
15 22 which heats and evaporates the organic working medium M using the heat of the heat transfer oil HO supplied to the power generation device body 11 via the heat transfer oil-circulation path 12, the steam turbine 23 rotated by the steam of the organic working medium M, a generator 24 directly connected to the steam turbine 23, and a condenser 25 which condenses the organic working medium M guided from the steam turbine 23.

20 [0036]

The heat transfer oil-circulation path 12 is a path which recovers the heat of the exhaust gas EG flowing through the third exhaust gas line 5c and also recovers the heat of the exhaust gas EG flowing through the second exhaust gas line 5b1.

The heat transfer oil-circulation path 12 includes a first circulation path 12a which
25 connects the power generation device body 11 and the second heat exchanger 8, a second

circulation path 12b which connects the second heat exchanger 8 and the first heat exchanger 6, and a third circulation path 12c which connects the first heat exchanger 6 and the power generation device body 11.

[0037]

5 The heat transfer oil HO which has heated the organic working medium M in the power generation device body 11 circulates in order of the second heat exchanger 8 and the first heat exchanger 6. The first heat exchanger 6 is provided on a downstream side of the second heat exchanger 8 in the heat transfer oil-circulation path 12.

The heat transfer oil HO, introduced into the second heat exchanger 8 via the first
10 circulation path 12a, is heated by the exhaust gas EG flowing through the third exhaust gas line 5c. The heat transfer oil HO, introduced into the first heat exchanger 6 via the second circulation path 12b, is heated by the exhaust gas EG flowing through the second exhaust gas line 5b1. The heat transfer oil HO, heated in the second heat exchanger 8 and the first heat exchanger 6, is introduced into the evaporator 22 of the power
15 generation device body 11 via the third circulation path 12c.

[0038]

The first circulation path 12a, located on an upstream side of the second heat exchanger 8, and the second circulation path 12b, located on a downstream side of the second heat exchanger 8, are connected directly by bypassing the second heat exchanger 8 using a
20 bypass path 27b. That is, part of the heat transfer oil HO flowing through the first circulation path 12a is introduced into the bypass path 27b without being introduced into the second heat exchanger 8.

A first flow rate control valve 29 which adjusts a flow rate of the heat transfer oil HO is provided between a branch point 28 of the bypass path 27b provided in the first
25 circulation path 12a and the second heat exchanger 8. A second flow rate control valve

30 which adjusts the flow rate of the heat transfer oil HO is provided in the bypass path 27b.

[0039]

A heat transfer oil pump 31 which adjusts the flow rate of the heat transfer oil HO flowing through the heat transfer oil-circulation path 12 is provided on the first circulation path 12a located on an upstream side of the branch point 28. The heat transfer oil pump 31 is a pump which supplies the heat transfer oil HO to the heat transfer oil-circulation path 12. The heat transfer oil pump 31 controls the flow rate of the heat transfer oil HO which is discharged by a discharge damper or an inverter.

10 [0040]

The first flow rate control valve 29, the second flow rate control valve 30, and the heat transfer oil pump 31 are controlled by the control device 4.

When it is assumed that the flow rate of the heat transfer oil HO flowing through a main path 27a on a downstream side of the branch point 28 of the first circulation path 12a is O1 and the flow rate of the heat transfer oil HO flowing through the bypass path 27b is O2, the control device 4 normally controls the first flow rate control valve 29 and the second flow rate control valve 30 such that $O1:O2 = \text{approximately } 4:1$. That is, the control device 4 normally controls the first flow rate control valve 29 and the second flow rate control valve 30, so that the flow rate of the heat transfer oil HO flowing through the main path 27a, which is a main flow, becomes sufficiently larger than the flow rate of the heat transfer oil HO flowing through the bypass path 27b.

[0041]

In the heat transfer oil-circulation path 12, a heat transfer oil temperature-measuring device 32, which measures the temperature of the heat transfer oil HO flowing through the third circulation path 12c, is provided in the third circulation path 12c which connects

the first heat exchanger 6 and the power generation device body 11. The heat transfer oil temperature-measuring device 32 measures the temperature of the heat transfer oil HO introduced into the power generation device body 11. The temperature of the heat transfer oil HO measured by the heat transfer oil temperature-measuring device 32 is transmitted to the control device 4.

[0042]

The control device 4 of the present embodiment has a function of adjusting the flow rate of the heat transfer oil HO introduced into the second heat exchanger 8 on the basis of the temperature of the exhaust gas EG measured by the exhaust gas temperature-measuring device 18.

When the temperature of the exhaust gas EG becomes higher than a first threshold value set to, for example, 220°C, the control device 4 controls the first flow rate control valve 29 and the second flow rate control valve 30, so that the flow rate of the heat transfer oil HO flowing through the main path 27a (downstream side of the branch point 28) of the first circulation path 12a increases. Specifically, the control device 4 operates the second flow rate control valve 30, so that the flow rate of the heat transfer oil HO flowing through the bypass path 27b decreases, and operates the first flow rate control valve 29, so that the flow rate of the heat transfer oil HO flowing through the main path 27a increases.

[0043]

At this time, the flow rate of the heat transfer oil HO in the entire heat transfer oil-circulation path 12 does not change. That is, it is possible to increase the flow rate of the heat transfer oil HO supplied to the second heat exchanger 8 without changing the flow rate of the heat transfer oil HO flowing through the entire heat transfer oil-circulation path 12. Therefore, a heat exchange amount due to the second heat

exchanger 8 is increased, and the temperature of the exhaust gas EG is lowered.

[0044]

Further, the control device 4 has a function of adjusting a flow speed of the heat transfer oil HO flowing through the entire heat transfer oil-circulation path 12 on the basis of the temperature of the heat transfer oil HO measured by the heat transfer oil temperature-measuring device 32.

When the temperature of the heat transfer oil HO becomes higher than a second threshold value set to, for example, 280°C, the control device 4 controls the heat transfer oil pump 31 so that the flow speed of the heat transfer oil HO flowing through the entire heat transfer oil-circulation path 12 increases.

As the flow speed of the heat transfer oil HO in the entire heat transfer oil-circulation path 12 increases, the temperature of the heat transfer oil HO decreases.

[0045]

Next, an operation of the sludge incineration plant 1 of the present embodiment will be described.

The sludge S is put into the incinerator 2 and incinerated. The exhaust gas EG (for example, 850°C) generated as a result of incineration is used as a heating source of the heat transfer oil HO in the first heat exchanger 6. Further, the exhaust gas EG is used as a heating source of the combustion air A1 in the air preheater 7.

The temperature of the exhaust gas EG which has passed through the first heat exchanger 6 and the air preheater 7 drops to, for example, 300°C. That is, the exhaust gas EG is rapidly cooled from 850°C to 300°C.

[0046]

Then, the exhaust gas EG is used as a heating source of the heat medium in the second heat exchanger 8. The temperature of the exhaust gas EG, which has passed through the

second heat exchanger 8, drops to 220°C. That is, the temperature of the exhaust gas EG drops to the heat-resistant temperature of the dust collection device 14 due to heat exchange in the second heat exchanger 8. The exhaust gas EG which has passed through the second heat exchanger 8 is introduced into the dust collection device 14.

- 5 The exhaust gas EG which has passed through the second heat exchanger 8 is introduced into the dust collection device 14, and a dust-collecting treatment is performed.

[0047]

The exhaust gas EG, discharged from the dust collection device 14, exchanges heat with the air A2 supplied by the air supply fan 19 in the air heater 20 of the white smoke
10 prevention device 15, and increases the temperature of the air A2. The temperature of the air A2 increases to, for example, 150°C. The mixing air A3, which has passed through the air heater 20, is introduced into the chimney 17 via the mixing air line 21.

[0048]

- The exhaust gas EG which has passed through the white smoke prevention device 15 is
15 introduced into the scrubber 16 and is detoxified. The temperature of the exhaust gas EG drops to, for example, 40°C in the scrubber 16. The exhaust gas EG which has passed through the scrubber 16 is introduced into the chimney 17 and mixed with the high-temperature mixing air A3 introduced through the mixing air line 21. Generation of white smoke from the chimney 17 is prevented by mixing the exhaust gas EG with the
20 mixing air A3 for preventing white smoke.

[0049]

Next, an operation of the power generation device 3 will be described.

- The heat transfer oil HO circulating in the heat transfer oil-circulation path 12 is heated to, for example, 280°C by exchanging heat with the exhaust gas EG in the second heat
25 exchanger 8 and the first heat exchanger 6. The heat transfer oil HO, of which the

temperature has increased, is used for heating the organic working medium M in the evaporator 22 of the power generation device body 11. The organic working medium M becomes steam in the evaporator 22, is introduced into the steam turbine 23 and drives the generator 24. The steam discharged from the steam turbine 23 is cooled and condensed in the condenser 25. The condensed organic working medium M is returned to the evaporator 22.

[0050]

Next, a control method of the sludge incineration plant 1 of the present embodiment will be described. The control method of the sludge incineration plant 1 of the present embodiment includes a first control method of adjusting the temperature of the exhaust gas EG introduced into the dust collection device 14, and a second control method of adjusting the temperature of the heat transfer oil HO introduced into the power generation device body 11.

[0051]

The first control method is a control method in which the flow rate of the heat transfer oil HO introduced into the second heat exchanger 8 is controlled and the temperature of the exhaust gas EG introduced into the dust collection device 14 is adjusted.

The first control method includes an exhaust gas temperature-determining process P11 for determining whether or not the temperature of the exhaust gas EG discharged from the second heat exchanger 8 is higher than the first threshold value, and a main path flow rate-increasing process P12 for increasing the flow rate of the heat transfer oil HO flowing through the main path 27a of the first circulation path 12a when the temperature of the exhaust gas EG introduced into the second heat exchanger 8 is higher than the first threshold value.

[0052]

In the exhaust gas temperature-determining process P11, the control device 4 refers to the temperature of the exhaust gas EG transmitted from the exhaust gas

temperature-measuring device 18. The control device 4 determines whether or not the temperature of the exhaust gas EG is higher than the first threshold value (for example, 220°C). When the temperature of the exhaust gas EG is equal to or lower than 220°C, the control device 4 does not change an opening degree of the valves 29 and 30.

When the temperature of the exhaust gas EG is higher than 220°C, the control device 4 performs the main path flow rate-increasing process P12. In the main path flow rate-increasing process P12, the control device 4 adjusts the opening degree of the valves

29 and 30 and increases the flow rate of the heat transfer oil HO flowing through the main path 27a. Therefore, the heat exchange amount between the exhaust gas EG and the heat transfer oil HO increases, and the temperature of the exhaust gas EG decreases.

On the other hand, when the temperature of the exhaust gas EG is low, the control device 4 may control the opening degree of the first flow rate control valve 29 and the second flow rate control valve 30 to decrease the flow rate of the heat transfer oil HO flowing through the main path 27a.

[0053]

The second control method is a control method, in which the flow rate of the heat transfer oil HO flowing through the entire heat transfer oil-circulation path 12 is controlled, and in which the flow speed of the heat transfer oil HO introduced into the power generation device body 11 is adjusted.

The second control method includes a heat transfer oil temperature-determining process P21 for determining whether or not the temperature of the heat transfer oil HO

discharged from the first heat exchanger 6 is higher than the second threshold value, and

a heat transfer oil flow rate-increasing process P22 for increasing the flow speed of the

heat transfer oil HO flowing through the entire heat transfer oil-circulation path 12 when the temperature of the heat transfer oil HO is higher than the second threshold value.

[0054]

In the heat transfer oil temperature-determining process P21, the control device 4 refers
5 to the temperature of the heat transfer oil HO transmitted from the heat transfer oil temperature-measuring device 32. The control device 4 determines whether or not the temperature of the heat transfer oil HO is higher than the second threshold value (for example, 280°C). When the temperature of the heat transfer oil HO is equal to or lower than 280°C, the control device 4 does not change a discharge flow rate of the heat
10 transfer oil pump 31.

[0055]

When the temperature of the heat transfer oil HO discharged from the first heat exchanger 6 is higher than 280°C, the control device 4 performs the heat transfer oil flow rate-increasing process P22. In the heat transfer oil flow rate-increasing process P22,
15 the control device 4 adjusts the discharge flow rate of the heat transfer oil pump 31 and increases the flow speed of the heat transfer oil HO flowing through the entire heat transfer oil-circulation path 12. As a result, the temperature of the heat transfer oil HO introduced into the power generation device body 11 decreases.

On the other hand, when the temperature of the heat transfer oil HO is low, the control
20 device 4 may adjust the discharge flow rate of the heat transfer oil pump 31 to decrease the flow speed of the heat transfer oil HO.

[0056]

According to the above embodiment, since the temperature of the exhaust gas EG introduced into the dust collection device 14 is reduced using the second heat exchanger
25 8, the heat can be more effectively utilized as compared with, for example, a case in

which the temperature of the exhaust gas is reduced using the exhaust gas-cooling tower.

[0057]

Further, since the flow rate of the heat transfer oil HO introduced into the second heat exchanger 8 is adjusted on the basis of the temperature of the exhaust gas EG measured

5 by the exhaust gas temperature-measuring device 18, it is possible that the temperature of the exhaust gas EG becomes a temperature corresponding to the heat-resistant temperature of the dust collection device 14.

[0058]

Further, since the temperature of the exhaust gas EG flowing into the dust collection

10 device 14 is adjusted, according to the flow rate of the heat transfer oil HO introduced into the second heat exchanger 8 disposed on the upstream side of the dust collection device 14, it is possible to adjust the temperature of the exhaust gas EG more quickly.

[0059]

Further, since the flow speed of the heat transfer oil HO supplied to the power generation

15 device body 11 is adjusted on the basis of the temperature of the heat transfer oil HO which has exchanged heat in the first heat exchanger 6, it is possible to adjust the temperature of the heat transfer oil HO to a temperature suitable for the power generation device 3. Also, it is possible to cope with a temperature rise of the exhaust gas EG in the case in which the temperature (heat capacity) of the exhaust gas EG discharged from
20 the incinerator 2 increases greatly. Furthermore, it is possible to cope with a temperature drop of the exhaust gas in the case in which the temperature (heat capacity) of the exhaust gas discharged from the incinerator decreases greatly.

[0060]

Also, since the white smoke prevention device 15, which heats external air with the

25 exhaust gas EG having passed through the dust collection device 14 and supplies it to the

chimney 17, is provided, heat is recovered from the lower temperature exhaust gas EG as compared with, for example, the case in which the white smoke prevention device is installed on the upstream side of the second heat exchanger 8, and thus a heat recovery rate of the entire system can be improved.

5 [0061]

Further, since a low-temperature corrosion-preventing type is adopted for the white smoke prevention device 15a, even when the white smoke prevention device 15 recovers the temperature of the exhaust gas EG having a temperature of 200°C or lower, it is possible to prevent the low-temperature corrosion of metals caused by sulfur (S) and
10 chlorine (Cl) in the sludge.

[0062]

Further, since the heat transfer oil HO is used as a heat medium used for heat recovery from the exhaust gas EG which is a waste heat source, simplification and miniaturization of the facility and apparatus can be achieved, as compared with using steam or the like in
15 heat recovery.

In addition, since a binary waste heat power generation system is adopted as the power generation device 3, even when a scale of the plant is small (for example, a sludge-processing amount is 100t/day), power generation can be performed efficiently.

[0063]

20 Although the embodiment of the present invention has been described in detail, various modifications can be made without departing from the technical idea of the present invention.

For example, the white smoke prevention device 15 may be omitted in a case where the smoke discharged from the chimney 17 is allowed to be white smoke.

25 Further, the control device 4 may simultaneously perform the first control method and the

second control method. By simultaneously controlling the temperature of the exhaust gas and the temperature of the heat transfer oil, it is possible to accelerate mutual responsiveness by a synergistic effect, and as a result, a speed of convergence can be increased.

5 [Reference Signs List]

[0064]

- 1 Sludge incineration plant
- 2 Incinerator
- 3 Power generation device
- 10 4 Control device
- 5 Exhaust gas line
- 6 First heat exchanger
- 7 Air preheater
- 8 Second heat exchanger
- 15 9 Exhaust gas treatment device
- 11 Power generation device body
- 12 Heat transfer oil-circulation path
- 12a First circulation path
- 12b Second circulation path
- 20 12c Third circulation path
- 13 Combustion air line
- 14 Dust collection device
- 15 White smoke prevention device
- 16 Scrubber
- 25 17 Chimney

- 18 Exhaust gas temperature-measuring device
- 19 Air supply fan
- 20 Air heater
- 21 Mixing air line
- 5 22 Evaporator
- 23 Steam turbine
- 24 Generator
- 25 Condenser
- 27a Main path
- 10 27b Bypass path
- 28 Branch point
- 29 First flow rate control valve
- 30 Second flow rate control valve
- 31 Heat transfer oil pump
- 15 32 Heat transfer oil temperature-measuring device
- A1 Combustion air
- A2 Air
- EG Exhaust gas
- HO Heat transfer oil
- 20 M Organic working medium
- S Sludge

[CLAIMS]

[Claim 1]

A waste heat power generation system, comprising:

an incinerator,

5 an exhaust gas line through which exhaust gas discharged from the incinerator flows,

a power generation device configured to generate electric power using heat transfer oil as a heat source,

10 a first heat exchanger configured to exchange heat between the exhaust gas and the heat transfer oil supplied to the power generation device,

an air preheater disposed in the exhaust gas line in parallel with the first heat exchanger and configured to exchange heat between the exhaust gas and air supplied to the incinerator,

15 a dust collection device configured to remove solid components from the exhaust gas having exchanged heat in the first heat exchanger and the air preheater, and

a second heat exchanger provided in the exhaust gas line on an upstream side of the dust collection device and configured to exchange heat between the exhaust gas, that has exchanged heat in the first heat exchanger and the air preheater, and the heat transfer oil that is supplied to the first heat exchanger.

20

[Claim 2]

The waste heat power generation system according to Claim 1, comprising

a control device configured to adjust a flow rate of the heat transfer oil which exchanges heat in the second heat exchanger on the basis of a temperature of the exhaust
25 gas discharged from the second heat exchanger.

[Claim 3]

The waste heat power generation system according to Claim 2, comprising
a heat transfer oil-circulation path through which the heat transfer oil circulates,
5 and
a bypass path configured to connect an upstream side of the second heat
exchanger with a downstream side of the second heat exchanger in the heat transfer
oil-circulation path while bypassing the second heat exchanger,
wherein the control device adjusts the flow rate of the heat transfer oil flowing
10 through the bypass path.

[Claim 4]

The waste heat power generation system according to any one of Claims 1 to 3,
wherein
15 a flow speed of the heat transfer oil supplied to the power generation device is
adjusted on the basis of the temperature of the heat transfer oil having exchanged heat in
the first heat exchanger.

[Claim 5]

20 The waste heat power generation system according to any one of Claims 1 to 4,
comprising
a white smoke prevention device configured to heat external air with the exhaust
gas discharged from the second heat exchanger and having passed through the dust
collection device and to supply the heated external air to a chimney.