FLUE GAS WASTE HEAT COUPLED HEATING SYSTEM FOR RECYCLED CONDENSATE WATER

TECHNICAL FIELD

[0001] The present application pertains to the technical field of waste incineration and particularly relates to a flue gas waste heat coupled heating system for recycled condensate water.

BACKGROUND

[0002] The flue gas temperature at the tail of a waste incineration boiler system is generally around 150 °C, and when a Selective Catalytic Reduction (SCR) system is provided, the temperature exceeds 180 °C. Excessively high flue gas temperature results in a considerable amount of energy being discharged directly into the atmosphere without utilization. Therefore, from the perspectives of energy saving, emission reduction, and economic efficiency, further reducing the exhaust temperature has become an inevitable choice in the current development of energy-saving and emission-reduction technologies for power station boilers.

[0003] At present, low-temperature economizer systems can collect waste heat from the flue gas waste heat and improve the economic efficiency of unit operation, offering significant economic benefits. Many existing solutions involve directly drawing a stream of condensate to a low-temperature economizer for heat exchange with flue gas before returning it to the condensate system. In waste incineration plants, fluctuations in waste quantity and calorific value cause variations in turbine load, which in turn lead to changes in extraction steam parameters of low-pressure heaters and consequently large fluctuations in the temperature of heated condensate water. If condensate is directly used to enter the low-temperature economizer for collecting waste heat from flue gas, the temperature of condensate delivered to the low-temperature economizer tends to be excessively low under conditions of low turbine load, readily causing low-temperature

corrosion of the low-temperature economizer, and it is difficult to ensure a stable long-term operation. Moreover, excessively low exhaust gas temperature also causes severe corrosion to the chimney and associated piping. These factors pose challenges to the comprehensive utilization of flue gas waste heat.

[0004] Therefore, overcoming the influence of condensate parameter fluctuations and ensuring that low-temperature economizers do not suffer low-temperature corrosion remain urgent problems to be solved by those skilled in the art.

SUMMARY

[0005] The object of the present application is to provide a flue gas waste heat coupled heating system for recycled condensate water that is capable of effectively overcoming the influence of condensate parameter fluctuations and ensuring that the low-temperature economizer does not undergo low-temperature corrosion.

[0006] To solve the above technical problem, the present application provides a flue gas waste heat coupled heating system for recycled condensate water. The flue gas waste heat coupled heating system for recycled condensate water includes: a boiler, a dust collector, a flue gas-steam heat exchanger, an SCR denitration device, a low-temperature economizer, an induced draft fan, a steam turbine, a condenser, a low-pressure heater, a water-water heat exchanger, a deaerator, a boiler feedwater pump, and a circulating water pump.

[0007] A flue gas outlet of the boiler is sequentially in communication with a flue gas duct of the dust collector, a flue gas duct of the flue gas-steam heat exchanger, a flue gas duct of the SCR denitration device, and a flue gas duct of the induced draft fan. A drum outlet of the boiler is in communication with a steam inlet of the steam turbine. A steam outlet of the steam turbine is sequentially in communication with a condensate passage of the condenser, the low-pressure heater, and the water-water heat exchanger.

[0008] A first inlet of the deaerator is in communication with a condensate outlet of the water-water heat exchanger, and a second inlet of the deaerator is in communication with a circulating water outlet of the low-temperature economizer. A first outlet of the deaerator is in communication with a water inlet of the boiler, and a second outlet of the deaerator is in communication with a circulating water inlet of the low-temperature economizer through a circulating water passage of the water-water heat exchanger.

[0009] Optionally, in the preceding flue gas waste heat coupled heating system for recycled condensate water, the second inlet of the deaerator is connected to one end of a first circulating return water main pipe, the circulating water outlet of the low-temperature economizer is connected to one end of a first branch pipe, a second circulating return water main pipe between the circulating water inlet of the low-temperature economizer and a circulating water outlet of the water-water heat exchanger is connected to one end of a second branch pipe, and the other end of the second branch pipe is separately connected to the other end of the first branch pipe and the other end of the first circulating return water main pipe.

[0010] A circulating return water main pipe electric regulating valve is connected in series on the first circulating return water main pipe, and a low-temperature economizer bypass electric regulating valve is connected in series on the second branch pipe.

[0011] Optionally, the preceding flue gas waste heat coupled heating system for recycled condensate water also includes a first temperature sensor for measuring water temperature of the first circulating return water main pipe and a first pressure sensor for measuring water pressure of the first circulating return water main pipe, and a second temperature sensor for measuring water temperature of the first branch pipe.

[0012] The low-temperature economizer bypass electric regulating valve is configured to control a valve opening based on a value of the first temperature sensor. The circulating return water main pipe electric regulating valve is configured to control a valve opening based on values

of the second temperature sensor and the first pressure sensor.

[0013] Optionally, in the preceding flue gas waste heat coupled heating system for recycled condensate water, a third branch pipe is disposed between a circulating water inlet and a circulating water outlet of the water-water heat exchanger, and a water-water heat exchanger bypass electric regulating valve is connected in series on the third branch pipe.

[0014] Optionally, the preceding flue gas waste heat coupled heating system for recycled condensate water further includes: a third temperature sensor for measuring water temperature of a second circulating return water main pipe between the circulating water inlet of the low-temperature economizer and the circulating water outlet of the water-water heat exchanger, where the water-water heat exchanger bypass electric regulating valve is configured to control an valve opening based on a value of the third temperature sensor.

[0015] Optionally, in the preceding flue gas waste heat coupled heating system for recycled condensate water, a boiler feedwater pump is connected in series between the first outlet of the deaerator and the water inlet of the boiler.

[0016] Optionally, in the preceding flue gas waste heat coupled heating system for recycled condensate water, a circulating water pump is disposed between the second outlet of the deaerator and a circulating water inlet of the water-water heat exchanger.

[0017] Optionally, in the preceding flue gas waste heat coupled heating system for recycled condensate water, a fourth temperature sensor is disposed between a flue gas outlet of the low-temperature economizer and the induced draft fan for monitoring flue gas temperature.

[0018] The circulating water pump is configured to control power of the circulating water pump based on a value of the fourth temperature sensor.

[0019] Optionally, in the preceding flue gas waste heat coupled heating system for recycled condensate water, the water-water heat exchanger is a plate heat exchanger.

[0020] Optionally, in the preceding flue gas waste heat coupled heating system for recycled

condensate water, the low-temperature economizer is a double-H finned tube economizer.

[0021] The present application provides a flue gas waste heat coupled heating system for recycled condensate water, the advantages of which are as follows:

[0022] Depending on the flow of different media, the system may be divided into a waste incineration flue gas discharge system, a condensate heating system, and a closed circulating water system. The waste incineration flue gas discharge system sequentially includes, along the flue gas flow path, the boiler, the dust collector, the flue gas-steam heat exchanger, the SCR denitration device, the low-temperature economizer, and the induced draft fan connected via flue ducts. The condensate heating system sequentially includes, along the water-steam flow path, the steam turbine, the condenser, the low-pressure heater, the water-water heat exchanger, the deaerator, and the boiler feedwater pump. The closed circulating water system sequentially includes, along the water flow path, the deaerator, the circulating water pump, the water-water heat exchanger, and the low-temperature economizer connected via circulating water pipes.

[0023] In the present application, a stream of circulating water is drawn from the low-pressure feedwater of the deaerator to the water-water heat exchanger to heat the condensate exiting the low-pressure heater. The cooled circulating water is then delivered to the low-temperature economizer for heat exchange with flue gas and subsequently returned to the deaerator, thereby forming an independent closed circulating water system. By utilizing the characteristic of constant temperature of outlet water from the deaerator, the influence of condensate parameter fluctuations under different operating conditions can be effectively overcome, ensuring that the low-temperature economizer does not suffer low-temperature corrosion.

BRIEF DESCRIPTION OF DRAWINGS

[0024] To illustrate the solutions in the embodiments of the present application or the solutions in the related art more clearly, drawings used in the description of the embodiments or the related

art will be briefly described below. Apparently, the drawings described below are only embodiments of the present application, and those skilled in the art may obtain other drawings based on provided drawings on the premise that no creative work is done.

[0025] FIG. 1 is a schematic diagram of a flue gas waste heat coupled heating system for recycled condensate water according to an embodiment of the present application.

[0026] Reference list

1 boiler

2 dust collector

3 flue gas-steam heat exchanger

4 SCR denitration device

5 low-temperature economizer

6 induced draft fan

7 steam turbine

8 condenser

9 low-pressure heater

10 water-water heat exchanger

11 deaerator

12 boiler feedwater pump

13 circulating water pump

14 water-water heat exchanger bypass electric regulating valve

15 low-temperature economizer bypass electric regulating valve

16 circulating return water main pipe electric regulating valve

T1 first temperature sensor

T2 second temperature sensor

T3 third temperature sensor

T4 fourth temperature sensor

P1 first pressure sensor

DETAILED DESCRIPTION

[0027] The embodiments of the present application are described in detail below, and examples of the embodiments are illustrated in the drawings, where the same or similar reference numerals indicate the same or similar elements or elements having the same or similar functions. The embodiments described below with reference to the drawings are only exemplary and intended to explain the present application, and are not to be construed as limiting the present application.

[0028] The core of the present application is to provide a flue gas waste heat coupled heating system for recycled condensate water that is capable of effectively overcoming the influence of condensate parameter fluctuations and ensuring that the low-temperature economizer does not undergo low-temperature corrosion.

[0029] For a better understanding of the technical solution provided by the present application by those skilled in the art, the present application will be further described in detail below with reference to the drawing and specific embodiments.

[0030] Specifically, with reference to FIG. 1, an embodiment of the present application provides a flue gas waste heat coupled heating system for recycled condensate water. The flue gas waste heat coupled heating system for recycled condensate water includes a boiler 1, a dust collector 2, a flue gas-steam heat exchanger 3, an SCR denitration device 4, a low-temperature economizer 5, an induced draft fan 6, a steam turbine 7, a condenser 8, a low-pressure heater 9, a water-water heat exchanger 10, a deaerator 11, a boiler feedwater pump 12, and a circulating water pump 13.

[0031] The flue gas outlet of the boiler 1 is sequentially in communication with a flue gas duct of the dust collector 2, a flue gas duct of the flue gas-steam heat exchanger 3, a flue gas duct of

the SCR denitration device 4, and a flue gas duct of the induced draft fan 6. The drum outlet of the boiler 1 is in communication with the steam inlet of the steam turbine 7. The steam outlet of the steam turbine 7 is sequentially in communication with the condensate passage of the condenser 8, the low-pressure heater 9, and the water-water heat exchanger 10.

[0032] A first inlet of the deaerator 11 is in communication with the condensate outlet of the water-water heat exchanger 10, and a second inlet of the deaerator 11 is in communication with the circulating water outlet of the low-temperature economizer 5. A first outlet of the deaerator 11 is in communication with the water inlet of the boiler 1, and a second outlet of the deaerator 11 is in communication with the circulating water inlet of the low-temperature economizer 5 through the circulating water passage of the water-water heat exchanger 10.

[0033] It should be noted that the deaerator 11 adopts the principle of thermal deaeration and employs a medium-pressure rotary-film structure. Extraction steam from the steam turbine 7 is used to heat condensate, providing both condensate temperature and deaeration before delivery to the boiler 1. The outlet water temperature of the deaerator 11 is typically designed to standard parameters (for example, 130 °C/150 °C). In waste incineration plants, the operating pressure of the deaerator 11 remains constant, and the feedwater temperature is also constant and does not fluctuate with load changes. A stream of low-pressure feedwater is drawn from the deaerator 11 as circulating water and delivered to the water-water heat exchanger 10.

[0034] The SCR denitration device 4 is a device that performs denitration using the selective catalytic reduction method.

[0035] In the flue gas waste heat coupled heating system for recycled condensate water provided by this solution, depending on the flow of different media, the system may be divided into a waste incineration flue gas discharge system, a condensate heating system, and a closed circulating water system. The waste incineration flue gas discharge system sequentially includes, along the flue gas flow path, the boiler 1, the dust collector 2, the flue gas-steam heat exchanger

3, the SCR denitration device 4, the low-temperature economizer 5, and the induced draft fan 6 connected via flue ducts. The condensate heating system sequentially includes, along the water-steam flow path, the steam turbine 7, the condenser 8, the low-pressure heater 9, the water-water heat exchanger 10, the deaerator 11, and the boiler feedwater pump 12. The closed circulating water system sequentially includes, along the water flow path, the deaerator 11, the circulating water pump 13, the water-water heat exchanger 10, and the low-temperature economizer 5 connected via circulating water pipes.

[0036] In the present application, a stream of circulating water is drawn from the low-pressure feedwater of the deaerator 11 to the water-water heat exchanger 10 to heat the condensate exiting the low-pressure heater. The cooled circulating water is then delivered to the low-temperature economizer 5 for heat exchange with flue gas and subsequently returned to the deaerator 11, thereby forming an independent closed circulating water system. By utilizing the characteristic of constant temperature of outlet water from the deaerator 11, the influence of condensate parameter fluctuations under different operating conditions can be effectively overcome, ensuring that the low-temperature economizer 5 does not suffer low-temperature corrosion.

[0037] In a specific embodiment, the second inlet of the deaerator 11 is connected to one end of a first circulating return water main pipe, the circulating water outlet of the low-temperature economizer 5 is connected to one end of a first branch pipe, a second circulating return water main pipe between the circulating water inlet of the low-temperature economizer 5 and a circulating water outlet of the water-water heat exchanger 10 is connected to one end of a second branch pipe, and the other end of the second branch pipe is separately connected to the other end of the first branch pipe and the other end of the first circulating return water main pipe.

[0038] A circulating return water main pipe electric regulating valve 16 is connected in series on the first circulating return water main pipe and is configured to control the valve opening of the valve on the first circulating return water main pipe. A low-temperature economizer bypass

electric regulating valve 15 is connected in series on the second branch pipe. The low-temperature economizer bypass electric regulating valve 15 is configured to control the valve opening of the valve on the second branch pipe.

[0039] The present application also includes a first temperature sensor T1 for measuring water temperature of the first circulating return water main pipe and a first pressure sensor P1 for measuring water pressure of the first circulating return water main pipe, as well as a second temperature sensor T2 for measuring water temperature of the first branch pipe.

[0040] The low-temperature economizer bypass electric regulating valve 15 is configured to control the valve opening based on a value of the first temperature sensor T1. The circulating return water main pipe electric regulating valve 16 is configured to control the valve opening based on values of the second temperature sensor T2 and the first pressure sensor P1.

[0041] When the temperature measured by the first temperature sensor T1 exceeds a first preset value, the low-temperature economizer bypass electric regulating valve 15 opens so that the temperature at the first temperature sensor T1 remains below the first preset value. When the temperature measured by the second temperature sensor T2 exceeds a second preset value, the valve opening of the circulating return water main pipe electric regulating valve 16 is reduced so that the pressure measured by the first pressure sensor P1 does not fall below a third preset value.

[0042] In a specific embodiment, a third branch pipe is disposed between the circulating water inlet and the circulating water outlet of the water-water heat exchanger 10, and a water-water heat exchanger bypass electric regulating valve 14 is connected in series on the third branch pipe. The water-water heat exchanger bypass electric regulating valve 14 is configured to control the valve opening of the valve on the third branch pipe.

[0043] The present application also includes a third temperature sensor T3 for measuring water temperature of a second circulating return water main pipe between the circulating water inlet of the low-temperature economizer 5 and the circulating water outlet of the water-water heat

exchanger 10, where the water-water heat exchanger bypass electric regulating valve 14 is configured to control the valve opening based on a value of the third temperature sensor T3.

[0044] When the temperature measured by the third temperature sensor T3 falls below a fourth preset value, the water-water heat exchanger bypass electric regulating valve 14 opens to ensure that the temperature at the third temperature sensor T3 does not fall below the fourth preset value.

[0045] To enhance fluid dynamics, a boiler feedwater pump 12 is connected in series between the first outlet of the deaerator 11 and the water inlet of the boiler 1.

[0046] In a specific embodiment, a circulating water pump 13 is disposed between the second outlet of the deaerator 11 and the circulating water inlet of the water-water heat exchanger 10. The circulating water pump 13 is a variable-frequency water pump.

[0047] A fourth temperature sensor T4 is disposed between the flue gas outlet of the low-temperature economizer 5 and the induced draft fan 6 for monitoring flue gas temperature.

[0048] The circulating water pump 13 is configured to control the power of the circulating water pump 13 based on a value of the fourth temperature sensor T4.

[0049] When the temperature measured by the fourth temperature sensor T4 falls below a fifth preset value, the power of the circulating water pump 13 is increased to increase the flow rate of circulating water, thereby raising the exhaust temperature above the fifth preset value.

[0050] It should be noted that the first, second, third, fourth, and fifth preset values may be adaptively selected as required and are not repeated here.

[0051] The preceding configuration can comprehensively utilize the flue gas waste heat collected by the low-temperature economizer 5, achieves system stability under different operating conditions, overcomes the influence of condensate parameter fluctuations, and allows precise and flexible adjustment of system performance parameters.

[0052] In a specific embodiment, the water-water heat exchanger 10 is a plate heat exchanger with high heat transfer efficiency and compact equipment volume. Low-pressure feedwater from

the deaerator 11 is delivered by the circulating water pump 13 to the water-water heat exchanger 10, serving as the hot send of the water-water heat exchanger 10. The cold end of the water-water heat exchanger 10 is condensate from the outlet of the low-pressure heater 9. The heated condensate is returned to the deaerator 11, thus reducing the amount of extraction steam required for heating in the deaerator 11 and improving power generation efficiency. The cooled circulating water is delivered to the low-temperature economizer 5.

[0053] In another specific embodiment, the low-temperature economizer 5 is a double-H finned tube economizer made of 09CrCuSb steel (also called ND steel) and features low investment cost, a large pitch, and low ash blockage tendency. This equipment is arranged between the SCR denitration device 4 and the induced draft fan 6, with a constant inlet flue gas temperature of 180 °C. The circulating water inlet temperature of the low-temperature economizer 5 is required to be no lower than 100 °C, and the outlet flue gas temperature is required to be no lower than 120 °C. Falling below these values poses a significant risk of low-temperature corrosion to the low-temperature economizer 5, leading to equipment damage and unfavorable long-term operation. The circulating water outlet of the low-temperature economizer 5 is returned to the deaerator 11. The temperature of the circulating return water main pipe must not exceed the saturation temperature under the operating pressure of the deaerator 11 to prevent excessively high temperature from causing self-boiling in the deaerator 11 and affecting equipment operation.

[0054] The design of a 1×500 t/d waste incineration plant is used as an example. The main steam parameters of the waste heat boiler 1 are 6.4 MPa/450 °C. Under design load, the temperature of low-pressure feedwater of the deaerator 11 is 130 °C, the flue gas temperature at the outlet of the SCR denitration device 4 is 180 °C, the flue gas flow rate is 113,000 Nm^3/h, the condensate temperature at the outlet of the low-pressure heater 9 is 82 °C, and the condensate flow rate is 45 t/h.

[0055] The flue gas waste heat recycle system is a closed circulating water system. The low-

temperature economizer bypass electric regulating valve 15 is under interlock control with the first temperature sensor T1 on the first circulating return water main pipe. The circulating return water main pipe electric regulating valve 16 is under interlock control with the second temperature sensor T2 on the first branch pipe at the circulating water outlet of the low-temperature economizer 5 and with the first pressure sensor P1 on the first circulating return water main pipe. The water-water heat exchanger bypass electric regulating valve 14 is under interlock control with the third temperature sensor T3 on the second circulating return water main pipe at the circulating water inlet of the low-temperature economizer 5. The circulating water pump 13 is under interlock control with the fourth temperature sensor T4. Under normal operation of the circulating water pump 13, the water-water heat exchanger bypass electric regulating valve 14 and the low-temperature economizer bypass electric regulating valve 15 are closed, while the circulating return water main pipe electric regulating valve 16 is fully open. First, the temperature at the first temperature sensor T1 is monitored. When the temperature at T1 exceeds 130 °C, the low-temperature economizer bypass electric regulating valve 15 opens to control the temperature at T1 to remain within 130 °C. Subsequently, the temperature at the second temperature sensor T2 is monitored. When the temperature at T2 exceeds 150 °C, the valve opening of the circulating return water main pipe electric regulating valve 16 is reduced so that the pressure at the first pressure sensor P1 remains no lower than 0.6 MPa. Second, the temperature of the circulating water inlet of the low-temperature economizer 5 (that is, the temperature measured by the third temperature sensor T3) is monitored. When the temperature at T3 falls below 100 °C, the water-water heat exchanger bypass electric regulating valve 14 opens to ensure that the temperature at T3 remains no lower than 100 °C. Third, the exhaust temperature measured by the fourth temperature sensor T4 is monitored. When the exhaust temperature falls below 120 °C, the power of the circulating water pump 13 is increased to increase the flow rate of circulating water, thereby raising the exhaust temperature above 120 °C.

[0056] A system where flue gas waste heat is used to heat condensate is used. When the flow rate of the circulating water pump 13 is 64 t/h, the circulating water outlet temperature is 100 °C at the water-water heat exchanger 10, and the condensate outlet temperature reaches 124 °C. The circulating water inlet temperature at the low-temperature economizer 5 is 100 °C and rises to 129 °C after heat exchange with 180 °C flue gas before returning to the deaerator 11. The exhaust temperature is reduced to 130 °C, and the overall plant power generation efficiency is increased by 1%.

[0057] The flue gas waste heat coupled heating system for recycled condensate water provided by the present application possesses at least the following beneficial effects or advantages:

[0058] 1. In the present application, the system is a closed circulating water system with fully enclosed internal circulation of circulating water, which avoids water quality contamination, reduces scaling and corrosion of heat exchange equipment, and improves heat transfer efficiency and service life of heat exchange equipment. Circulating water is used as an intermediate medium, and the flue gas waste heat recovered by the low-temperature economizer 5 directly heats condensate. The system may also be switched with a conventional thermodynamic system. When this system is shut down for maintenance, normal and stable operation of the thermodynamic system is not affected.

[0059] 2. The outlet water temperature of the deaerator 11 is constant. The valve opening of the bypass control valve of water-water heat exchanger 10 is utilized so that the outlet water temperature can be easily controlled under varying operating conditions, thus overcoming the influence of parameter fluctuations under different conditions and ensuring that the low-temperature economizer 5 does not suffer low-temperature corrosion.

[0060] 3. The waste heat recycle system is equipped with a precise exhaust temperature control system. This configuration lowers exhaust temperature, increases overall plant power generation efficiency, and achieves deep energy saving, emission reduction, and carbon reduction. Visual

white plume can also be adjusted by changing the emission temperature at the boiler chimney.

[0061] As indicated in the present application and the claims, unless the context clearly indicates otherwise, the words such as "a", "an", "one", and/or "the" are not specifically singular and may include plural forms. Generally speaking, the terms "comprising" and "including" only indicate the inclusion of explicitly identified steps and elements. These steps and elements do not constitute an exclusive list; a method or apparatus may also include other steps or elements. An element defined by the phrase "comprising an..." does not exclude the presence of other identical elements in the process, method, product, or apparatus that includes the element.

[0062] In the description of the present application, unless otherwise expressly defined, terms such as "setting," "installing," and "connecting" should be interpreted broadly. Those skilled in the art can reasonably determine the specific meaning of the preceding terms in the present application based on the specific content of the technical solution.

[0063] Embodiments in this specification are described in a progressive manner. Each embodiment focuses on differences from other embodiments. The same or similar parts in each embodiment can be referred to by each other.

[0064] Specific examples have been used to illustrate the principles and implementation methods of the present application. The preceding description of the examples is only used to help understand the methods and core concept of the present application. It is to be noted that for those of ordinary skill in the art, a number of improvements and modifications can be made without departing from the principle of the present application, and these improvements and modifications are within the scope of the claims of the present application.

Claims

1. A flue gas waste heat coupled heating system for recycled condensate water, comprising: a boiler, a dust collector, a flue gas-steam heat exchanger, a Selective Catalytic Reduction (SCR) denitration device, a low-temperature economizer, an induced draft fan, a steam turbine, a condenser, a low-pressure heater, a water-water heat exchanger, a deaerator, a boiler feedwater pump, and a circulating water pump;

wherein a flue gas outlet of the boiler is sequentially in communication with a flue gas duct of the dust collector, a flue gas duct of the flue gas-steam heat exchanger, a flue gas duct of the SCR denitration device, and a flue gas duct of the induced draft fan; a drum outlet of the boiler is in communication with a steam inlet of the steam turbine, a steam outlet of the steam turbine is sequentially in communication with a condensate passage of the condenser, the low-pressure heater, and the water-water heat exchanger; and

a first inlet of the deaerator is in communication with a condensate outlet of the water-water heat exchanger, a second inlet of the deaerator is in communication with a circulating water outlet of the low-temperature economizer, a first outlet of the deaerator is in communication with a water inlet of the boiler, and a second outlet of the deaerator is in communication with a circulating water inlet of the low-temperature economizer through a circulating water passage of the water-water heat exchanger.

2. The flue gas waste heat coupled heating system for recycled condensate water according to claim 1, wherein the second inlet of the deaerator is connected to one end of a first circulating return water main pipe, the circulating water outlet of the low-temperature economizer is connected to one end of a first branch pipe, a second circulating return water main pipe between the circulating water inlet of the low-temperature economizer and a circulating water outlet of the water-water heat exchanger is connected to one end of a second branch pipe, and the other end of the second branch pipe is separately connected to the other end of the first branch pipe and the other end of the first circulating return water main pipe; and

a circulating return water main pipe electric regulating valve is connected in series on the first circulating return water main pipe, and a low-temperature economizer bypass electric regulating valve is connected in series on the second branch pipe.

3. The flue gas waste heat coupled heating system for recycled condensate water according to claim 2, further comprising: a first temperature sensor for measuring water temperature of the first circulating return water main pipe and a first pressure sensor for measuring water pressure of the first circulating return water main pipe, and a second temperature sensor for measuring water temperature of the first branch pipe;

wherein the low-temperature economizer bypass electric regulating valve is configured to control a valve opening based on a value of the first temperature sensor, and the circulating return water main pipe electric regulating valve is configured to control a valve opening based on values of the second temperature sensor and the first pressure sensor.

4. The flue gas waste heat coupled heating system for recycled condensate water according to claim 1, wherein a third branch pipe is disposed between a circulating water inlet and a circulating water outlet of the water-water heat exchanger, and a water-water heat exchanger bypass electric regulating valve is connected in series on the third branch pipe.

5. The flue gas waste heat coupled heating system for recycled condensate water according to claim 4, further comprising: a third temperature sensor for measuring water temperature of a second circulating return water main pipe between the circulating water inlet of the low-temperature economizer and the circulating water outlet of the water-water heat exchanger, wherein the water-water heat exchanger bypass electric regulating valve is configured to control a valve opening based on a value of the third temperature sensor.

6. The flue gas waste heat coupled heating system for recycled condensate water according to claim 1, wherein a boiler feedwater pump is connected in series between the first outlet of the deaerator and the water inlet of the boiler.

7. The flue gas waste heat coupled heating system for recycled condensate water according to claim 1, wherein a circulating water pump is disposed between the second outlet of the deaerator and a circulating water inlet of the water-water heat exchanger.

8. The flue gas waste heat coupled heating system for recycled condensate water according to claim 7, wherein a fourth temperature sensor is disposed between a flue gas outlet of the low-temperature economizer and the induced draft fan for monitoring flue gas temperature; and

the circulating water pump is configured to control power of the circulating water pump based on a value of the fourth temperature sensor.

9. The flue gas waste heat coupled heating system for recycled condensate water according to claim 1, wherein the water-water heat exchanger is a plate heat exchanger.

10. The flue gas waste heat coupled heating system for recycled condensate water according to claim 1, wherein the low-temperature economizer is a double-H finned tube economizer.