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SPECIFICATION

FLUE GAS HEAT RECYCLING SYSTEM

FIELD OF THE INVENTION

[0001] The present disclosure relates to flue gas heat recycling system, and more particularly to a flue gas heat recycling system that is able to heat the condensed water using a boiler flue gas heat.

BACKGROUND

[0002] As we all know, if the flue gas with high temperature of a boiler is directly injected into the atmosphere, it will not only pollute the environment, but also cannot meet the current energy efficiency requirement for boilers. Therefore, how to effectively use the heat energy of the boiler flue gas with high temperature, and provide a type of energy saving boiler has become a concern in this area.

[0003] Currently, the boiler flue gas heat is widely used for heating air and water. For example, the boiler flue gas heat can be used to heat the cold air into an air preheater of a boiler, or can be used to heat the condensed water of other equipment or devices. It is usually to use a low-pressure heater to heat the condensed water of a heat recycling boiler system. However, the low-pressure heaters requires a turbine to exhaust or extract steam in order to heat the condensed water of the heatbacking heater system. The extraction or exhaust of a turbine requires a lot of steam, and this will result in energy waste.

[0004] In addition, during the process of cooling down the flue gas with high temperature and making use of the heat energy, the low-temperature corrosion to the boiler equipment is also a concern.



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[0005] A major factor that causes the low-temperature corrosion of boiler equipment is the low-temperature heating surface condensation problem of the air preheater. Therefore, in order to solve the heating surface condensation problem, it is necessary to increase the temperature of the heating surface. Usually increasing the flue gas temperature or the injected air temperature is used to reduce the low-temperature corrosion problem, exhaust gas temperature or inlet temperature of the boiler equipment. However, this will cause some waste of energy.

[0006] In view of above, it is desirable to provide a new energy-efficient flue gas recycling systems, which can make efficient use of the heat energy of boiler flue gas, and can also effectively improve the low pressure heater acting energy wastage due to extraction problems.

BRIEF DESCRIPTION OF THE INVENTION

[0007] A flue gas heat recycling system is disclosed. The flue gas heat recycling system includes a phase change heat exchanger having a upper phase change section and a lower phase change section. The flue gas heat recycling system further includes an automatic control device arranged on the phase change heat exchanger. The upper phase change section of the phase change heat exchanger is connected to a main condensed water pipe of a low-pressure backheating heater system. The lower phase change section of the phase change heat exchanger is arranged in a flue gas channel. A temperature sensor is arranged on the lower phase change section of the phase change heat exchanger. The automatic control device is able to adjust the condensed water flow from the low-pressure backheating heater system to the upper phase change section of the phase change heat exchanger. The condensed water from the low-pressure backheating heater system enters into the upper phase change section of the phase change heat exchanger is heated, and the heated condensed

water then enters into a main condensed water pipe of the low-pressure backheating heater system.

[0008] In the flue gas heat recycling system, in one aspect, the upper phase change section is connected to the main condensed water pipe of the low-pressure backheating heater system, and the lower phase change section is connected to the flue gas channel. Thus the condensed water entering into the low-pressure backheating heater system of the upper phase change section of the phase change heat exchanger can be heated by the flue gas heat. Therefore, the phase change heat exchanger does not need to get heat from a turbine as a traditional low-pressure heater. This not only save energy, but also make an efficient usage of the boiler flue gas heat.

[0009] In another aspect, the wall temperature of the lower phase change section can be adjusted by adjusting the condensed water flow entering into the upper phase change section using the water flow control value. This ensures that the wall temperature can be always higher than that of the acid dew point of the flue gas, and avoids a low-temperature corrosion to the phase change heat exchanger.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 is an isometric structure of a flue gas heat recycling system in accordance with an exemplary embodiment of the present invention.

[0011] Many aspects of the embodiment can be better understood with reference to the drawings mentioned above. The components in the drawings are not necessarily drawn to scale, the emphasis instead being placed upon clearly illustrating the principles of the present disclosure. Moreover, in the drawings, like reference numerals designate corresponding parts throughout the

several views.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0012] Reference will now be made to describe an exemplary embodiment of the present disclosure in detail.

[0013] Referring to Fig. 1, the present invention is a flue gas heat recycling system which mainly uses the boiler flue gas heat to heat the condensed water of part of a low-pressure backheating heater system, thereby avoiding the energy waste due to the extraction of the low-pressure heater.

[0014] The flue gas recycling system includes a phase change heat exchanger 100 and an automatic control device 200 set on the phase change heat exchanger 100.

[0015] The phase change heat exchanger 100 has a split structure, and includes an upper phase change section 1 and a lower phase change section 9. The lower phase change section 9 is connected to the upper phase change section 1 through a steam rising pipe 30 and a liquid dropping pipe 40. The lower phase change section 9 is arranged on a rear flue gas channel of an output of a boiler air preheater. The upper phase change section 1 is connected to a main condensed water pipe 2 of the low-pressure backheating heater system, therefore, the condensed water in the low-pressure backheating heater system can enter the upper phase change section 1 and change heat with each other.

[0016] The lower phase change section 9 includes a lower phase change box 8, an upper phase change box 5, and a plurality of heat exchange pipes 7 arranged between the lower phase change box 8 and the upper phase change box 5. Each of the heat exchange pipes 7 is filled with phase change media, such as water. In this embodiment, the heat exchange pipe 7 has a spiral finned tube structure. The heat exchange pipes 7 are not limited to this restriction, it can be other structure as long as the phase change media in the heat exchange pipes 7 can

exchange heat with the flue gas out of the heat exchange pipes 7.

[0017] A temperature sensor 6 is arranged on the outmost heat exchange pipes 7 of the lower phase change section 9 of the phase change heat exchanger 100. The temperature sensor 6 is used for sensing the temperature of the outmost heat exchange pipes 7 and then transferring the temperature signal to a signal input terminal of the automatic control device 200. The automatic control device 200 is able to adjust the condensed water flow of the low-pressure backheating heater system, thereby controlling the wall temperature of the lower phase change section 9 through the condensed water flowing through the upper phase change section 1.

[0018] The upper phase change section 1 of the phase change heat exchanger 100 of this embodiment is a parallel tube structured heat exchanger, but is not limited to this restriction.

[0019] In the phase change heat exchanger 100 of the embodiment, a water inlet pipe 50 and a water outlet pipe 52 are arranged between the upper phase change section 1 and the main condensed water pipe 2 of the low-pressure backheating heater system. The main condensed water pipe 2 includes a plurality of heaters connected in series. The water inlet pipe 50 is arranged on a main condensed water pipe 2 behind a heater 4 of the main condensed water pipe 2. The water outlet pipe 52 is arranged on a main condensed water pipe 2 behind a heater 4 with high temperature. It is understood that the water inlet pipe 50 can be partially filled with condensed water to be heated by the heater 4, and the water inlet pipe 50 can also be fully filled with main condensed water which is completely heated by the flue gas heat, without being heated by the heater 4. Moreover, an input port of the water inlet pipe 50 can selectively set as an output port of the first heat 4 or the second heat 4 or the third heat 4, according to the need of a power station. Similarly, the water outlet pipe 52 can be selectively connected to an output port of one of the heater 4 according to the

need of the power station. Thereby, when the temperature of flue gas is relatively high, this arrangement is favorable for heating the condensed water of the upper phase change section 1 of the phase change heat exchanger 100 to a high temperature as much as possible. This can efficiently make use of the flue gas heat. In this invention, according to multiple heating steps, the temperature of the heated condensed water flowing out of the water outlet pipe can reach as high as 140 Degrees Celsius.

[0020] A water flow control valve 3 is arranged on the water inlet pipe 50 of the upper phase change section 1 of the phase change heat exchanger 100, thereby the condensed water flow in the upper phase change section 1 can be adjusted by the water flow control valve 3. A control signal for the water flow control valve 3 is from the signal output terminal of the automatic control device 200.

[0021] A working process of the flue gas heat recycling system is described as below. Firstly, the flue gas with heat energy from the gas channel of the boiler enters into the lower phase change section 9 of the phase change heat exchanger 100. The flue gas exchanges heat with the heat exchange pipes 7 completely, thus the phase change media gets heat and its phase changes from liquid to vapor. Simultaneously, the temperature of the flue gas is reduced and the flue gas enters into a dust collector through the lower phase change section 9. Then the vapor in the lower phase change section 9 rises into the upper phase change section 1 of the phase change heat exchanger 100 through the steam rising pipe 30. Simultaneously, the condensed water in the low-pressure backheating heater system enters into the parallel pipes of the upper phase change section 1 through the water inlet pipe 50 and exchanges heat with the vapor out of the parallel pipes. Thus, the condensed water is heated and the vapor condensed into liquid due to the heat releasing. Then the liquid flows back into the lower phase change section 9 along the liquid dropping pipe 40.

And the heated condensed water in the upper phase change section 1 enters into the main condensed water pipe 2. The above description is the process of the boiler flue gas heat heating the condensed water of the low-pressure backheating heater system.

[0022] The above described heat exchange process between the lower phase change section 9 and the upper phase change section 1 of the phase change heat exchanger 100 is the process of evaporation to condensation of the phase change media. The phase change critical temperature of the phase change media under a certain temperature is constant. Then when the lower phase change section 9 and the upper phase change section 1 of the phase change heat exchanger 100 are in state of changing phase, the temperature of the heat absorbing area of the heat exchange pipes 7 is approximately equal to the phase change critical temperature. Thus the wall temperature of the lower phase change section 9 of the phase change heat exchanger 100 is in an adjustable state.

[0023] Due to the temperature sensor 6 arranged on the lower phase change section 9 of the phase change heat exchanger 100, the automatic control device 200 is able to adjust the wall temperature of the lower phase change section 9. This ensures that the wall temperature of the lower phase change section 9 is always higher than that of the acid dew point of the flue gas. That is, when the wall temperature of the lower phase change section 9 is lower than that of the acid dew point of the flue gas, the wall temperature of the lower phase change section 9 can be adjusted by adjusting the condensed water flow entering into the upper phase change section 1 using the water flow control value 3. This ensures that the wall temperature can be always higher than that of the acid dew point of the flue gas, and avoids a low-temperature corrosion to the phase change heat exchanger 100.

[0024] Compared with the conventional technology, in the present embodiment of the invention, a low-pressure heater is replaced by the phase

change heat exchanger 100, and the condensed water in the low-pressure backheating heater system is heated by the boiler flue gas heat. That is the phase change heat exchanger 100 does not need to get heat from a turbine as a traditional low-pressure heater. This not only save energy, but also make an efficient usage of the boiler flue gas heat.

[0025] It is understood that the structure of the phase change heat exchanger 100 in the embodiment of the present invention is not limited by the embodiment, any heat exchange devices or equipments that can make use the boiler flue gas heat to heat the condensed water of the low-pressure backheating heater system can be used in this invention.

[0026] While the present disclosure has been described with reference to the specific embodiment, the description of the disclosure is illustrative and is not to be construed as limiting the disclosure. Various of modifications to the present disclosure can be made to the exemplary embodiment by those skilled in the art without departing from the true spirit and scope of the disclosure as defined by the appended claims.

What is claimed is:

1. A flue gas heat recycling system, comprising:

a phase change heat exchanger having an upper phase change section and a lower phase change section;

wherein the flue gas heat recycling system further comprises an automatic control device arranged on the phase change heat exchanger, the upper phase change section of the phase change heat exchanger is connected to a main condensed water pipe of a low-pressure backheating heater system, the lower phase change section of the phase change heat exchanger is arranged in a flue gas channel, a temperature sensor is arranged on the lower phase change section of the phase change heat exchanger, the automatic control device is able to adjust the condensed water flow from the low-pressure backheating heater system to the upper phase change section of the phase change heat exchanger according to the signal of the temperature sensor, the condensed water from the low-pressure backheating heater system enters into the upper phase change section of the phase change heat exchanger is heated, and the heated condensed water then enters into a main condensed water pipe of the low-pressure backheating heater system.

2. The flue gas heat recycling system as described in claim 1, wherein a water inlet pipe is arranged between the upper phase change section of the phase change heat exchanger and the main condensed water pipe of the low-pressure backheating heater system, a water flow control valve is arranged on the water inlet pipe, the water flow control valve is connected to the automatic control device, the condensed water flow entering into the upper phase change section of the phase change heat exchanger is adjusted by the automatic control device and the water flow control valve.

3. The flue gas heat recycling system as described in claim 2, wherein a water outlet pipe is arranged between the upper phase change section of the phase change heat exchanger and the main condensed water pipe of the low-pressure backheating heater system, the condensed water of the low-pressure backheating heater system is heated by the upper phase change section of the phase change heat exchanger and then flows back into the main condensed water pipe of the low-pressure backheating heater system through the water outlet pipe.
4. The flue gas heat recycling system as described in claim 3, wherein the main condensed water pipe of the low-pressure backheating heater system comprises a plurality of heaters connected in series, the water inlet pipe is arranged behind different heaters.
5. The flue gas heat recycling system as described in claim 4, wherein the water outlet pipe is arranged behind one of the heaters of the main condensed water pipe of the low-pressure backheating heater system.
6. The flue gas heat recycling system as described in claim 1, wherein the lower phase change section comprises a lower phase change box, an upper phase change box, and a plurality of heat exchange pipes arranged between the lower phase change box and the upper phase change box, the temperature sensor is arranged on the heat exchange pipes.
7. The flue gas heat recycling system as described in claim 6, wherein the temperature sensor is connected to the automatic control device, the automatic control device is able to adjust the main condensed water flow entering into the low-pressure backheating heater system of the upper phase change section of the phase change heat exchanger according to the temperature signal of the temperature sensor.