HEAT EXCHANGE SYSTEM FOR HEATING MILL AIR AND FOR REHEATING STACK GAS SUBSEQUENT TO WET SCRUBBING

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ABSTRACT OF THE DISCLOSURE

The combination of a steam generator and a wet scrubber positioned downstream thereof. Heat is extracted from the rear pass of the steam generator and used for heating the air going to the fuel pulverizing mill and also to heat the cleaned, cooled, moisture-laden gases leaving the wet scrubber and being exhausted to the atmosphere.

Background of the invention

In view of recent concern about air pollution, gas cleaning equipment is being installed to remove impurities from combustion gases being discharged from fossil fuel fired steam generators. One common form of cleaning equipment is a wet scrubber. One problem encountered in using a wet scrubber is that the discharge from the scrubber may be in the form of a visible plume, caused by the moisture carried by the gases, which appears immediately upon contact with the atmosphere, if the atmospheric temperature is sufficiently low.

Summary of the invention

The invention comprises a fossil fuel fired steam generator having a wet scrubber positioned downstream thereof for removing sulphur compounds and other impurities theretofrom prior to being exhausted to the atmosphere. Heat absorbed by a heat exchanger positioned upstream of the economizer in the rear gas pass of the steam generator is used to heat both mill air and the cleaned, cooled, moisture-laden gases exiting from the wet scrubber. The mill pulverizes the coal burned in the furnace of the steam generator, and also pulverizes any additive, for example dolomite, which may also be introduced into the furnace for the purpose of combining with the sulphur so as to form compounds which can be readily removed from the combustion gases by the wet scrubber.

Brief description of the drawing

The figure is a schematic illustration of a steam generator and wet scrubber combination constructed in accordance with our invention.

Description of the preferred embodiment

Looking now to the figure, numeral 10 denotes a steam generator having a furnace 12, all four walls of which are lined with steam generating tubes 13. Fuel is supplied to the furnace through burners 14.

Positioned in the upper horizontal pass 15 of the steam generator are finishing superheater 16, reheater 18, and primary superheater 20. In the rear gas pass 21, the combustion gases pass over heat exchanger surface 22 and economizer 24. Air to support combustion of the fuel in the furnace is heated in air preheater 26.

The combustion gases, after passing through air preheater 26, are subjected to water sprays 28 where the sulphur compounds and other impurities are removed from the gas stream. The temperature of the gases leaving the scrubber 28 is substantially reduced. The cleaned, cooled, moisture-laden gases leaving the wet scrubber pass through heat exchanger 30 before being exhausted to the atmosphere through stack 32. Induced draft fan 34 helps maintain a good velocity to these exiting gases.

Coal to be burned in the furnace is fed to a pulverizing mill 36 by inlet line 38. The coal is ground to a flour-like texture before being carried in an air stream through duct 44 to the furnace. An additive, for example dolomite, is fed into the mill 36 through inlet line 40. The dolomite will react with the sulphur compounds under the heat of the furnace to form compounds which are more readily removed from the gas stream by the wet scrubber 28. Air is supplied to the mill through duct 42.

In order to insure that all of the moisture is evaporated from the coal, it is desirable to have the air stream carrying the coal to the furnace at an elevated temperature, for example 200° F. For this reason, heat exchanger 46 is positioned in air duct 42. Heat exchanger 46 will heat the air to a temperature of approximately 600° F., which will result in a 200° F. temperature of the coal and air mixture leaving the mill outlet.

Heated liquid flows to heat exchanger 46 from the heat exchanger 22 located in the rear gas pass of the steam generator through line 48. A constant speed pump 49 maintains flow through this line. After the water flows through heat exchanger 46, it passes through line 50 to heat exchanger 30 which is located downstream of the wet scrubber 28. The gases, which leave the scrubber saturated with water, and at a very low temperature, for example 120° F., then absorb heat in passing through the heat exchanger 30. Thus, by raising the temperature of these gases, not only is all of the moisture contained therein evaporated, but the increased temperature of the gases enables them to exit from the stack at an increased velocity. Both of these factors help prevent a visible plume of the gases exiting from the top of stack 32. Relatively cool liquid is returned to the heat exchanger 22 from heat exchanger 30 through line 52.

Since both the humidity and temperature conditions of the atmosphere can vary considerably during the year, the temperature to which the gases exiting from the wet scrubber must be raised in order to prevent a visible plume from being seen will also vary. This temperature may vary for example, between 125-360° F., depending on conditions. For this reason, line 58 containing valve 60 connects the outlet of heat exchanger 22 with the inlet of heat exchanger 30. An electric eye 62, or other suitable device for detecting steam plumes, is positioned at the top of stack 32. When a visible plume is detected, a signal is sent to valve 60, moving it in an opening direction. When the visible plume is no longer present, the electric eye 62 moves the valve 60 in a closing direction. During normal operations, when sufficient heat is supplied to heat exchanger 30 from the heat exchanger 46, valve 60 remains in a closed position.

For the same reason of changing atmospheric conditions, the air being supplied to the pulverizing mill 36 may vary considerably in humidity and temperature. Also, the moisture contained in the coal being fed to the mill can vary. Thus, the amount of heat supplied to heat exchanger 46 in order to maintain the coal-air stream leaving the mill at 200° F. is controlled by valve 54. Valve 54 is operated by temperature sensing device 56, which is positioned in the outlet of the pulverizing mill. When a temperature exceeding 200° F. is detected by sensor 56, valve 54 is moved in a closing direction. When a temperature below 200° F. is detected, valve 54 is moved in an opening direction.

In a large utility steam generator, a large number of coal pulverizing mills are required. Each mill would have
its own air supply duct corresponding to duct 42, and its own heat exchanger corresponding to 46. These heat exchangers would be in parallel flow relationship to each other and would each have their own temperature sensors 56 and control valves 54.

Although the invention has been illustrated in conjunction with a coal fired steam generator, it would also have application on oil fired units, when the oil contains a large percentage of sulphur. Although there would be no coal to be pulverized, the dolomite would still have to be dried and ground in order to be air-fired to the furnace, and the gases leaving the wet scrubber would still have to be raised in temperature to eliminate the visible plume. A heat exchange arrangement such as 22, 46, and 30 could be used to accomplish this on an oil fired unit also.

From the above, it can be seen that a simple and efficient heat exchange system has been provided for maintaining the fuel-air stream exiting from the pulverizing mill at a temperature of 200°F, and for also maintaining the gases exiting from the stack at a temperature where no visible steam plume can be seen. No more heat than is necessary to accomplish the above is extracted from the rear gas pass of the steam generator by heat exchanger 22. Thus the temperature of the combustion gases flowing through the air preheater 26 is maintained as high as possible during all operating conditions.

While the preferred embodiment of the invention has been illustrated and described, it is to be understood that the invention should not be limited thereto.

What we claim is:

1. In combination, a furnace for burning coal, a pulverizing mill for the coal, means for introducing air and coal to the pulverizing mill, duct means for conveying the pulverized coal to the furnace in an air stream, a rear gas pass connected to the furnace through which the combustion gases flow, a wet scrubber connected to the rear gas pass, where the combustion gases are cleaned and cooled, a stack connected to the wet scrubber, through which the cleaned, cooled gases are exhausted to atmosphere, a first heat exchanger positioned in the rear gas pass, for absorbing heat from the hot combustion gases, a second heat exchanger positioned upstream of the pulverizing mill for drying and heating the coal and air, the outlet of said first heat exchanger being connected to the inlet of said second heat exchanger, means for causing liquid to flow from said first heat exchanger to said second heat exchanger, a third heat exchanger positioned in the stack, for heating the cleaned, cooled gases, the inlet of said third heat exchanger being connected to the outlet of said second heat exchanger, and the outlet of the third heat exchanger being connected to the inlet of the first heat exchanger.

2. The combination set forth in claim 1, including temperature sensing means positioned in the outlet of the pulverizing mill, first valve means for controlling the flow of liquid from the first heat exchanger to the second heat exchanger, said temperature sensing means being interconnected with the first valve means such that when the sensing means detects a temperature below a predetermined value, it causes the valve means to move in an opening direction, and when it detects a temperature above the predetermined value, it causes the valve means to move in a closing direction.

3. The combination set forth in claim 2, including sensing means for detecting a steam plume issuing from the stack, means connecting the outlet of the first heat exchanger to the inlet of the third heat exchanger, second valve means for controlling flow from the first heat exchanger to the third heat exchanger, said sensing means being interconnected to the second valve means such that when the sensing means detects a steam plume, it moves the second valve means in an opening direction.

4. The combination set forth in claim 1, including means connecting the outlet of the first heat exchanger to the inlet of the third heat exchanger, and valve means for controlling flow from the first heat exchanger to the third heat exchanger.

5. The combination set forth in claim 4, including economizer means positioned in the rear gas pass, said first heat exchanger positioned upstream of the economizer means.

6. In combination, a furnace for burning sulphur containing fuel, means for introducing fuel to the furnace, duct means for introducing an additive to the furnace which will react with the sulphur under furnace conditions, a pulverizing mill for pulverizing the additive, the outlet of said pulverizing mill being connected to the duct means, means for introducing air and additive to the pulverizing mill, a rear gas pass connected to the furnace through which the combustion gases flow, a wet scrubber connected to the rear gas pass, where the gases are sprayed to remove the additive, sulphur, and other impurities from the gases, a stack connected to the wet scrubber, through which the cleaned gases are exhausted to atmosphere, a first heat exchanger positioned in the rear gas pass, for absorbing heat from the hot combustion gases, a second heat exchanger positioned upstream of the pulverizing mill for drying and heating the additive and air, the outlet of said first heat exchanger being connected to the inlet of said heat exchanger, a third heat exchanger positioned in the stack, for heating the cleaned, cooled gases, the inlet of said third heat exchanger being connected to the outlet of said second heat exchanger, and the outlet of the third heat exchanger being connected to the inlet of the first heat exchanger.

7. The combination set forth in claim 6, including means connecting the outlet of the first heat exchanger to the inlet of the third heat exchanger, and valve means for controlling flow from the first heat exchanger to the third heat exchanger.

References Cited

UNITED STATES PATENTS


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