[54] SINGLE-DUCT TUBULAR BOILER FOR USE IN CONNECTION WITH A REFUSE INCINERATOR AND AN AIR PREHEATER
11 Claims, 2 Drawing Figs.

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[50] Field of Search ................................................................ 122/10, 7, 235 T, 480, 110/10

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ABSTRACT: A tubular boiler for the generation of steam or hot water, and a ducting arrangement for use more particularly in connection with a refuse incinerator and an air preheater, including a horizontally disposed duct, heating surfaces comprising vertically arranged boiler tubes therein, a bypass duct in parallel flow relation with said first duct so as to bypass the heating surfaces and means for controlling the volume of flue gas flowing through said bypass duct.
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SINGLE-DUCT TUBULAR BOILER FOR USE IN CONNECTION WITH A REFUSE INCINERATOR AND AN AIR PREHEATER

BACKGROUND OF THE INVENTION

The present invention relates to a horizontally disposed single-duct steam or hot water boiler, with the heating surfaces thereof consisting of vertically arranged boiler tubes arranged in banks in said horizontally disposed single duct, with such duct in communication with hot flue gas that flows across said heating surfaces and including a gas passage in such single duct serving to bypass the heating surfaces and means for controlling the volume of flue gas flowing through said bypass.

The invention furthermore relates to the method of operating said boiler, more particularly in connection with a refuse incinerator and an air preheater arranged ahead of and behind the boiler, respectively, as regards the direction of flow of the flue gas, said method of operation essentially referring to the controlling of the temperature of the flue gas at its inlet let into the air preheater.

It is a well-known fact in connection with steam or hot water boilers operated at constant steam or hot water parameters and at constant or practically constant combustion chamber and exhaust flue-gas temperatures, that when such a boiler is fired with a fuel of variable calorific value, then pronounced changes occur in the variation of the flue-gas temperature along the heating surfaces of the boiler. With fuels of lower calorific value, for instance, the available efficient temperature drop for the secondary heating surfaces, such as those of an air preheater, will be reduced, with the result that less preheated combustion supporting air will be supplied into the furnace, particularly in situations when hotter combustion supporting air is needed for burning low-grade fuel.

Circumstances as outlined above, are particularly apparent in refuse incinerators having heat recovery boilers and air preheaters associated therewith. Due to hygienic requirements, total burnout of the refuse and odorless operation has to be ensured, and to accomplish this, practical experience has demonstrated that the furnace temperature has to be kept in the range of 900°-1,000°C, in any case not below 800°C. In addition, both practical experience and theory teach, that to obtain efficient dedusting of the exhaust flue gas and to avoid dew-point corrosion of the secondary heating surfaces and condensation at the outlet of the chimney or flue during the cold season, the temperature of the exhaust flue gas has to be kept at about 250°C at least.

On the other hand, refuse, whether household, municipal or industrial refuse, is a low-grade fuel of very variable calorific value. This is due to its heterogeneous composition and to its variable humidity, the variations being not only local or seasonal, but occurring even during the same day. Rain, dampness, the presence of garden foliage and of green vegetables during summer and the presence of ash from coal fired heating stoves or furnaces during winter, are only a few of the factors influencing the calorific value of the refuse.

Under such circumstances, for operating a refuse incinerator under optimum conditions and within the optimum range of temperatures, as mentioned above, it obviously is of great advantage to be able to reverse the trend of the dropping or falling of the preheat temperature of the combustion supporting air, when refuse of lower calorific value is being burnt, as explained at the beginning, in other words, to be able to supply hotter combustion supporting air when burning refuse of low calorific value.

SUMMARY OF THE INVENTION

Accordingly, the present invention seeks to attain this aim by providing means, by which a part of the steam of hot flue gas, issuing from the furnace or combustion chamber of the refuse incinerator, is diverted to bypass the heating surfaces of the boiler, and to thereafter mix that diverted stream of still hot gas with the flue gas, which has flown across the heating surfaces and thereby has been cooled down to a lower temperature. This mixing or comingling is effected in advance of the inlet into the air preheater, thereby increasing the inlet temperature, for obtaining hotter air, while maintaining at the outlet of said air preheater the temperature of the exhaust flue gas at the prescribed minimum level. Furthermore, according to the invention, means are provided for controlling the volume of flue gas diverted, to suit the actual requirements of the incinerating process, said control being effected either manually or automatically in ways known in the art.

BRIEF DESCRIPTION OF THE DRAWING

The invention will be better understood and its objects set forth above, and others will become apparent in detail, when consideration is given to the following description. This description makes reference to the accompanying drawing in which:

FIG. 1 is a simplified, longitudinal sectional view showing, by way of example, a possible arrangement of a refuse incinerator, a boiler according to the invention and an air preheater mounted in succession as regards the direction of flue-gas flow, and

FIG. 2 is a fragmentary view partly in transverse cross section, illustrating the boiler tubes and bypass duct.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In this drawing numerals have been used for convenience, to designate the various elements of the arrangement. Numerals 1 designates the brickwork of the incinerating furnace and the incinerating grates, namely the predrying, the combustion and the burnout grates are indicated at 2a, 2b and 2c, respectively. The uncooled combustion chamber 3 extends above the grates and the discharge chute 3a is provided for the noncombustible residues, or so-called cinder. The boiler includes an upper drum 4, the descending vertically arranged tubes 5, and lower and upper headers 6 and 7, respectively. The heating surface of the boiler is indicated at 8 and said heating surfaces being constituted by vertically arranged boiler tubes, arranged in a plurality of single row banks, transversal and orthogonal to the horizontal direction of flow of the flue gas. In each of the tube banks, a gap is provided by a wider spacing between two adjacent boiler tubes, said gaps being in alignment and thus defining a longitudinal channel 10, which is provided with a gastight overall enclosure, defined by the upper and lower sidewalk means 9a and 9b and lateral sidewalks 8a-8b. The lateral sidewalks 8a and 8b may be achieved by means known to the art, such as by using finned tubes for the marginal tubes 8a and 8b with the fins extending in the direction of the flow of the flue gas and by welding these fins together, or in any suitable manner. The details of construction of such sidewalks are irrelevant as regards the basic idea of the invention, namely, the provision of a gastight bypass flue duct 10 extending parallel to the direction of flow of the flue gas across the heating surface. The location of the parallel flue duct 10, within the transverse cross section of the boiler is optional, the axial position represented in the drawing being only one possibility. Furthermore, the gastight enclosure as defined above, may be provided with welded studs on its inner sides lined with refractory and heat insulating material, to reduce to a minimum the heat transmission in the parallel duct 10.

At the outlet end of bypass duct or passage 10 is a system of hinged or otherwise articulated dampers 11, arranged as in a venetian blind arrangement. These dampers are simultaneously actuated from the outside, for closing or opening the parallel duct 10 to the through-flow of flue gas, or for controlling said through-flow, with the dampers disposed in some intermediate position, as will be explained hereafter.

The stream of hot flue gas issuing from the combustion chamber 3, flows as indicated by the arrows 12 into the setting chamber 13 ahead of the boiler, where most of the entrained fly ash and dust is separated and discharged through outlet 14. Thereupon, the stream of hot flue gas enters into the boiler proper, i.e., flows across and over its heating surfaces 8,
as indicated by the arrows 16. A part of the stream of flue gas is diverted to flow into the parallel bypass duct 10, the ratio of diversion being controlled by the position of the dampers 11. As a result of this, there will enter into the chamber 17, on one hand a main stream of flue gas, which has passed across the heating surfaces 8 and has transmitted heat therein and therefore is cooled down, and, on the other hand, a partial stream of flue gas, which by flowing through the parallel duct 10, with very little or practically no heat transmission therein, particularly when said duct has a lining of refractory and heat insulating material, and therefore has practically the same temperature as existed in the chamber 13. These two streams mix or comingle in the chamber 17, the actual temperature of the mixture lying obviously between that of the cooled main flue gas stream and that of the hot bypassed stream and being determined by the ratio of the volumes of these two streams, i.e., by the position of the dampers 11.

The stream of flue gas having a temperature resulting from the mixture or comingle of the two flue-gas streams of different temperatures then enters into the air preheater 19, its flow path being marked with the arrows 18a and 18b. By the transmission of further sensible heat for the preheating of air, the temperature of the exhaust flue gas, at the outlet 20, is lowered to its minimum level of 250°C as explained before. The ingress of the cold air into and the exit of the preheated air from the preheater 19 are diagrammatically indicated at 21 and 22. Within the air preheater 19, the airstream may be led in parallel with, opposed to or crosswise of the path of the direction of flow of the flue gas.

From the outlet denoted diagrammatically at 22, the preheated air is directed by ducts, not shown, to chambers 23a, 23b and 23c and serves as an underblast or air feed for the respective grates 2a, 2b and 2c.

There is no need to emphasize that an increase or rise in the temperature of the flue-gas mixture at its inlet into the air preheater at 18b will entail a corresponding increase or rise in the temperature of the preheated air leaving the preheater through outlet 22.

From the foregoing, it is clear that in an easy way, by simply modifying the position of the dampers 11, the invention enables one to adapt the temperature of the preheated combustion air to the burning conditions on the grates 2a, 2b and 2c and in the combustion chamber 3, thereby compensating for variations in calorific value of the refuse and most particularly a drop in such value, thus obviating the previously mentioned inconveniences and ensuring satisfactory incineration of even very moist and low-grade refuse.

Various methods of operation are possible:

In a first mode of operation, the arrangement as described above and depicted in the drawing, may be run with the preheat temperature of the preheated combustion supporting air at 22 being kept constant or under control.

In an alternative mode of operation, the temperature of the preheated combustion supporting air may be controlled as a function of the temperature existing in the combustion chamber 3 or in the settling chamber 13.

In a further alternative, the temperature of the flue gas at the inlet 18b into the air preheater may be kept constant or under control.

Moreover and independently of the above, it is possible to maintain the temperature of the exhaust flue gas existing at 20 at or above its minimum level.

In the aforesaid alternative methods of operation, temperature sensing or detecting means such as thermostats are mounted in the locations or points where the temperature is to be maintained constant or under a definite control. Thus such sensing or detecting means are located at 22' in the preheated air outlet, at 13' in the separating zone in the main flue-gas passage, at 18' at the inlet of the flue gas into the air preheater, at 20' at the outlet of the flue gas from the air preheater, and at 3' in the combustion zone of the incinerator. If desired, additional temperature sensing means can be mounted in the undergrate zones 23a, 23b, 23c. All of the temperature sensing or detecting means are connected with a control unit indicated diagrammatically at CU which actuates the damper operating means shown schematically at DA. The control can be electrical, hydraulic, pneumatic or mechanical.

The damper supporting shafts or pivots can be actuated by rack and pinion means, link and lever systems, cable devices or by any other expedient known in the art. Thus, the thermostats can govern the actuation of solenoid operated valves in a fluid circuit for a hydraulically operated piston and cylinder unit that is connected with a rack that has teeth meshing with pins on the ends of the shafts that support the damper plates. Thus, the amount and direction of reciprocation of the rack will determine the direction and degree of pivoting movement of the damper plates 11.

If desired, the dampers 11 can be adjusted by hand by an operator after he has observed temperature conditions existing in the various locations within the system. In such instances, there will be a temperature detecting means at each location and means to observe such detected temperature, i.e., a thermostatic device.

The selection of the optimum method of operation will depend upon the nature of the local refuse to be incinerated and particularly upon its susceptibility to changes in calorific value, thus making use of the possibilities offered by the invention and providing the most convenient equipment for control.

What we claim is:

1. A ducting arrangement for a tubular boiler for generating steam or hot water by heat recovery from flue gas issuing from an incinerator for low-grade refuse of variable calorific value, comprising a horizontal flue-gas duct, said boiler including vertical boiler tubes arranged in a plurality of one row banks transversal and orthogonal to the axis of said horizontal duct, with a gap in each of the tube banks, defined by wider spacing between two adjacent boiler tubes, said gaps being in alignment and thus defining a longitudinal through channel, said channel being provided with an all-side gastight enclosure, to serve as parallel duct for diverting at least a part of the stream of flue gas, to bypass the heating surface of the boiler.

2. A ducting arrangement for a tubular boiler as claimed in claim 1, and further including movable damper means at the outlet of said parallel duct, and means externally of said horizontal duct for actuating said damper means for controlling the volume of flue gas flowing through said parallel duct.

3. In a system including means defining an incinerator for low-grade refuse of variable calorific value, said means including a combustion chamber, an undergrate combustion supporting air chamber means, a flue-gas duct including a horizontal portion, an air preheating means arranged within said flue-gas duct downstream of said horizontal portion for preheating air and including an outlet for delivering said preheated air to said undergrate combustion supporting air chamber means, a boiler including boiler tube bank means disposed within said horizontal portion of said flue-gas duct, said boiler tube bank means being vertically disposed and so arranged as to include at least two rows of longitudinally spaced tubes spaced transversely of the longitudinal axis of said horizontal portion of said flue-gas duct and means operably associated with said at least two rows of tubes defining a gastight passage extending longitudinally of said horizontal portion of said flue-gas duct to constitute a bypass duct having an inlet and an outlet in parallel flow relation with said flue-gas duct.

4. A system as claimed in claim 3 and movable damper means operably associated with the outlet of said bypass duct for controlling the volume of flue gas flowing through said bypass duct.

5. A system as claimed in claim 4 and means for varying the position of said damper means in dependence upon temperature conditions existing in one of either combustion chamber, said outlet of said air preheating means, said flue-gas duct downstream of said air preheating means, or said flue-gas duct at a location between said bypass duct and said air preheating means.
6. In the operation of a system including an incinerator having a combustion chamber for burning low-grade refuse of variable calorific value, a flue-gas duct communicating with said incinerator and including a horizontal portion, a boiler including tubes arranged within said flue-gas duct to extract heat from flue gas flowing through said duct, an air preheater arranged within said flue-gas duct downstream of said tubes for also extracting heat from such flue gas and for delivering preheated combustion supporting air to said incinerator, a method of controlling such operation including constraining at least a portion of such flue gas to flow through such horizontal portion of said flue-gas duct in a to bypass at least the majority of such tubes and in a parallel flow relationship with the main flue gas flow stream and controlling the volume of such bypassed portion of flue gas by variably positioning dampers controlling such bypassed flow.

7. In the operation of a system as claimed in claim 6 and positioning such dampers in accordance with the temperature of the preheated combustion supporting air.

8. In the operation of a system as claimed in claim 6 and positioning such dampers in accordance with temperature conditions within the combustion chamber.

9. In the operation of a system as claimed in claim 6 and positioning such dampers in accordance with the temperature of the flue gas at its entry into the air preheater.

10. In the operation of a system as claimed in claim 6 and positioning such dampers in accordance with the temperature of the flue gas downstream of the air preheater.

11. A ducting arrangement for a tubular boiler for generating steam or hot water by heat recovery from flue gas issuing from an incinerator for low-grade refuse of variable calorific value, comprising a substantially horizontal flue-gas duct, said boiler including vertical boiler tubes arranged in a plurality of one row banks substantially transversal and substantially orthogonal to the axis of said horizontal duct, with a gap in each of the tube banks, defined by wider spacing between two adjacent boiler tubes, said gaps being in substantial alignment and thus defining a longitudinal through-channel, said channel being provided with an all-side gastight enclosure, to serve as parallel duct for diverting at least a part of the stream of flue gas, to bypass the heating surface of the boiler, movable damper means at the outlet of said parallel duct, and means for actuating said damper means for controlling the volume of flue gas flowing through said parallel duct.