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(54) Title: A BOILER AND A SUPERHEATER, AS WELL AS A METHOD

(57) Abstract: A boiler and a method in a boiler (1) producing thermal energy, the method comprising: combustion or fuel and combustion air in the furnace (2) of the boiler, delimited by walls; receiving of thermal energy by a steam superheater (15) placed on the wall of the furnace and comprising at least one heat exchange surface (21), and supplying of gas or a gas mixture to the front of said heat exchange surface to form a barrier layer (18) for protecting the heat exchange surface from flue gases (19) developed in connection with the combustion. At least one supply device (17) is provided in the superheater or in the direct vicinity of the superheater, to supply gas or a gas mixture to the front of said heat exchange surface to form a barrier layer (18) to protect the heat exchange surface from the flue gases (19) in the boiler. In one example, a supply device matrix is provided in the area delimited by the superheater.
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A BOILER AND A SUPERHEATER, AS WELL AS A METHOD

Field of the invention

The invention relates to a boiler for producing thermal energy. The invention also relates to a boiler superheater. Furthermore, the invention relates to a method in a boiler for producing thermal energy.

Background of the invention

In boilers, a lot of compounds are formed which are detrimental to the materials of the heat exchange surfaces of the boiler. Especially when burning biofuel and refuse fuel, corrosion of the heat exchange surfaces of the boiler has been detected, especially corrosion of superheaters and their heat exchange surfaces. In addition, it has been detected that ash produced during combustion deposits on the heat exchange surfaces, which reduces the heat transfer and thereby the recovery of thermal energy.

The above-mentioned biofuels include botanical materials from nature, such as wood chips, bark, agro-biomass, sawdust, black liquor, and the like. Refuse fuels include, for example, sorted household refuse, industrial waste and waste from businesses, as well as demolition wood. These fuels include significant amounts of chlorine. Together with sodium and potassium released from fuel they form gaseous alkaline chlorides in flue gases, which are condensed and deposited on heat exchange surfaces, especially on superheater surfaces. Deposition and condensation takes places especially in places where the surface temperature of the heat exchange surfaces is below 650 °C. When the surface temperature of a heat exchange surface is above 450 °C, the alkaline chlorides cause chlorine corrosion.

Supplying various additional materials to the furnace has been suggested in order to eliminate corrosion problems caused by chlorides. Publication WO 2006/1 34227 A 1 discloses the spraying of a liquid sulphate-containing to the superheater area of a steam boiler, to bind the alkaline chlorides formed in the furnace. According to publication WO 02/059526 A 1, a liquid sulphate compound or sulphuric acid is added to flue gases before the superheaters.
Publication EP 2071 239 A2, in turn, discloses that additional material needed for preventing corrosion is fed to the flue gases of a boiler by means of at least one cooled pipe.

It is also known to decrease the nitrogen oxide emissions of different types of boilers by supplying into their furnace various additional materials which decrease the amount of nitrogen oxides in the flue gases formed during combustion. This kind of a solution is presented, for example, in publication WO 981 3649 A1, in which cooled pipe panel surfaces are installed in the furnace, which include separate additional material channels for the additional material.

According to the prior art, the superheaters of the boiler are placed either in the furnace of the boiler, typically at the top of the furnace, or in the flue gas duct downstream of the furnace, where the flue gases from the furnace are led. The superheaters are placed in the flue gas flow, and the thermal energy of the flue gas is transferred to the superheater by means of both thermal radiation and convection of heat, in which case one can refer to combination superheaters. It is also possible to use special radiant superheaters, whose application is primarily based on utilizing the thermal radiation of the flame, and special convection superheaters, whose application is primarily based on the convection of thermal energy by means of contact between the superheater and flue gases. The radiant superheater is normally placed at the top of the furnace, for example suspended in the furnace, and it is in direct contact with the thermal radiation from the flame. Thus, there is a direct line of sight between the flame and the superheater.

The superheaters are used as heat exchangers which typically comprise a construction of pipes connected to each other, by means of which thermal energy is transferred to a medium, that is steam, flowing inside the pipes.

Significant advantages would be achieved by raising the superheating temperature of the steam, but the required development has been hampered by the restricted corrosion resistance of the material of the superheater.
Brief summary of the invention

The aim of the present invention is thus to provide a system to avoid the above mentioned problems which relate particularly to the corrosion and chemical attacks caused expressly by flue gases. In particular, the aim is to improve the resistance of the superheaters.

A boiler for producing thermal energy according to the invention is presented in claim 1. A boiler superheater according to the invention is presented in claim 7. A method in a boiler for producing thermal energy according to the invention is presented in claim 9.

A principle of the invention is to prevent the detrimental effects of flue gases on the superheater, wherein the aim is not to utilize heat transfer by means of convection of the flue gases.

Another principle of the invention is that the superheater placed on the wall of the boiler is protected from the effects of the flue gases by means of a protective gas curtain.

The principle of an embodiment of the invention is that the superheater placed on the wall of the boiler is protected from the effects of the flue gases by means of a protective gas curtain. The aim is to prevent or strongly restrict the entry of the flue gas as well as the detrimental compounds, corrosive or aggressive substances contained in it, onto the heat exchange surfaces of the superheater.

In one example, the gas or gas mixture of the gas curtain is air. In one example, the gas or gas mixture may be a gas of prior art, known as such, which is used to reduce corrosion problems, or, for example, a gas that is free from corrosive substances. It may also be gas from the boiler.

In one example, inhibitors, such as sulphur dioxide or sulphite, are mixed into the gas or gas mixture, to prevent corrosion problems.
The superheater is placed on the wall of the boiler, for example at the bottom of the furnace. Preferably, the superheater and its heat exchange surfaces also have a direct line of sight to the flame of combustion in the furnace, to recover the thermal energy on the basis of thermal radiation. Convection of heat via the flue gases is to be avoided.

In one example, a large number of supply devices are provided in the area covered by the superheater, to enable the supply of gas to the front of the heat exchange surface of the superheater. Said supply devices may be an orifice extending through the superheater, gas being supplied through said orifice, or a separate pipe or duct, or a nozzle attached to the superheater. In one example, the nozzle is arranged to direct the gas flow in parallel with the heat exchange surface of the superheater, preferably upwards.

The gas supply to the supply device is performed, for example, by means of a separate pipe or duct.

The walls of the furnace of the boiler are made by using pipes to convey a medium, to recover the thermal energy from the furnace by means of radiation and/or convection.

Brief description of the drawings

In the following, the invention will be described in more detail with reference to the appended drawings, in which:

Fig. 1 shows a schematic view of a fluidized bed boiler seen from the side, provided with a superheater,

Fig. 2 shows a schematic view of another example of a superheater placed in a fluidized bed boiler, and

Fig. 3 shows a schematic cross-sectional view of a superheater according to one embodiment.
Detailed description of the invention

Figure 1 shows an example of a steam boiler applying the above-presented superheater configuration. As the steam boiler and the location for the superheater configuration, it is possible to apply a boiler based on fluidized bed combustion, particularly a bubbling fluidized bed boiler (BFB), as shown in Fig. 1, or a circulating fluidized bed boiler (CFB). In bubbling fluidized bed boilers, a fluidized bed is produced by means of a gas flow. As the location, it is also possible to apply a soda recovery boiler which is based on the combustion of black liquor, or a boiler in which the fuel is burnt on top of a grate, or another steam boiler, in which the protection of the superheaters is needed, among other things, because of the high temperatures.

Figure 1 shows the boiler 1 comprising a furnace 2 limited by the walls. The walls of the furnace are formed of water-cooled pipes, which are attached to each other by fins. In the lower part of the furnace, nozzles 3 are provided for supplying fluidizing air and combustion air, i.e. primary air from an air box 4 to the furnace 2. By the effect of the fluidizing air, the fluidized bed 5 in the lower part of the furnace is fluidized, i.e. brought into continuous movement in the furnace 2. Fuel is supplied into the furnace from fuel supply devices 6, and combustion air is supplied from secondary air nozzles 7. In this boiler, combustion air is also supplied into the furnace from tertiary air nozzles 8. The fuel used is, for example, biofuel and/or refuse fuel. The flame 12 produced in connection with the combustion of the fuel is placed above the fluidized bed and extends, for example, above the secondary air nozzles 7 and often also up to the tertiary air nozzles. The combustion of fuel by means of oxygen-containing gas in the lower part of the furnace 2 is the primary source of thermal energy.

The upper part of the furnace comprises superheaters 9 and 13, whose function is to provide superheated steam that is typically used in a turbine (not shown in the figure). The figure also shows the rear wall 2b and the front wall 2a of the furnace, including a nose 10 for guiding the flue gases. In the figure, the superheaters are drawn in a reduced manner to illustrate the circulation of the medium.
The flue gases 19 formed in the furnace are directed further via a flue gas duct 11 in connection with the furnace. The flue gas duct may be provided with heat exchange surfaces or heat exchangers 14.

In Fig. 1, a superheater 15 is fixed or placed on the rear wall 2b, wherein it is a so-called wall superheater. In the figure, the superheater 15 is drawn in a reduced manner by illustrating the circulations of the medium, and configurations known as such can be applied in the superheater. The superheater 15 has a direct line of sight 16 to the frame 12, to utilize the thermal radiation produced in the combustion.

The area covered by the superheater 15 is also provided with several supply devices 17, which make it possible to supply gas to the front of the heat exchange surface of the superheater. The gas forms a barrier layer 18 between the superheater and the rising flue gases, to insulate the superheater 15 from the flue gases as well and as extensively as possible. Simultaneously, the barrier layer 18 guides the flow of flue gases. Gas is supplied continuously from the supply devices 17.

The gas is led to the supply devices 17 from a desired source, for example along a duct or pipe 20 shown in Fig. 3 or 4. The duct or pipe 20 is placed, for example, between the pipes 22 of the superheater, or it is conveyed from between the pipes of the superheater to the front side of the superheater. The pipes are connected to each other by means of, for example, one or two fins. By means of gas supplied from the duct or pipe 20, the barrier layer 18 is formed in front of the heat exchange surface 21 of the superheater.

Figure 5 shows part of the panel structure formed by the superheater 15.

The supply device 17 determines the place or location from where the gas is supplied. The gas supply device 17 is an orifice 24, pipe or duct 20, or a separate nozzle 23, for example, in the heat exchange surface 21 of the superheater. By means of the nozzle, the gas is dispersed or blown in a desired direction, preferably in parallel with the plane defined by the heat exchange surface 21. The nozzle 23 may blow the gas in one or more
directions. Nozzles of prior art, known as such, can be used as the supply device 17.

The superheater 15 can be placed on the front wall 2a or the rear wall 2b of the furnace. Figure 2 shows a superheater 15 and supply devices 17 placed on the side wall of the furnace 2. The supply devices constitute a supply device matrix comprising, for example, two or more rows, each having two or more supply devices. In this way, a larger uniform barrier layer 18 is formed. The supply device matrix is placed in the area limited by the superheater, and if necessary, also in the direct vicinity of the superheater, so that the protective barrier layer that comprises gas or a gas mixture would cover the entire superheater.

The presented superheater configuration can also be applied in a circulating fluidized bed boiler as well as in a soda recovery boiler or in a boiler applying combustion on a grate. In a circulating fluidized bed boiler, the furnace is supplied with fuel, which may be biofuel, refuse fuel or coal, from fuel supply devices, and with combustion air from air nozzles.

In the recovery boiler, the fuel used consists of cooking chemicals produced in pulp manufacture, as well as liquid that contains parts dissolved from wood, i.e. black liquor. The boiler does not have a fluidized bed but a furnace supplied with black liquor from the fuel supply devices and with combustion air from air nozzles at different height levels. During the combustion of the liquor, smelt is produced on the bottom of the furnace, which smelt is discharged from the furnace to be processed further. In boilers equipped with a grate, the fuel burns at the bottom of the furnace, on the grate, and combustion air is also supplied, for example, through the grate.

The invention is not intended to be limited to the embodiments presented as examples above, but the invention is intended to be applied widely within the scope of the features defined in the appended claims.
Claims

1. A boiler for producing thermal energy, the boiler (1) comprising:
   - a furnace (2) limited by walls;
   - at least one steam superheater (15) placed on a wall of the furnace and having at least one heat exchange surface (21) for receiving thermal energy;
   characterized in that the boiler also comprises:
   - at least one supply device (17) for supplying gas or a gas mixture to the front of said heat exchange surface to form a barrier layer (18) to protect the heat exchange surface from the flue gases (19) in the boiler.

2. The boiler according to claim 1, characterized in that the boiler (1) further comprises:
   - devices (6) for supplying fuel to the furnace for combustion;
   - devices (3, 7, 8) for supplying combustion gas to the furnace for combustion;
   - one or more flue gas ducts (11) placed in the upper part of the furnace and discharging the flue gases (19) formed during the combustion from the furnace.

3. The boiler according to claim 1 or 2, characterized in that the boiler is a boiler based on fluidized bed combustion, a soda recovery boiler, or a boiler based on combustion on a grate.

4. The boiler according to any of the claims 1 to 3, characterized in that said supply device comprises an orifice (24), a pipe or a duct (20), or an orifice (23), fitted in the superheater or in the direct vicinity of the superheater.

5. The boiler according to any of the claims 1 to 4, characterized in that the superheater comprises pipes (22) connected to each other, inside which the steam flows.

6. The boiler according to any of the claims 1 to 7, characterized in that the boiler comprises a supply device matrix comprising several said supply
devices provided to supply gas or a gas mixture to the front of said heat exchange surface, to form a uniform barrier layer (18).

7. A boiler superheater provided on the wall of a boiler (1) for producing thermal energy, the wall delimiting the furnace (2) of the boiler, and the superheater (15) comprising at least one heat exchange surface (21) for receiving thermal energy, characterized in that at least one supply device (17) is provided in the superheater or in the direct vicinity of the superheater, for supplying gas or a gas mixture to the front of said heat exchange surface, to form a barrier layer (18) to protect the heat exchange surface from flue gases (19) in the boiler.

8. The superheater according to claim 7, characterized in that a supply device matrix is provided in the area defined by the superheater, the matrix comprising several said supply devices provided to supply gas or a gas mixture to the front of said heat exchange surface, to form a uniform barrier layer (18).

9. A method in a boiler (1) producing thermal energy, the method comprising:
   - combustion of fuel and combustion air in the furnace (2) of the boiler, delimited by walls;
   - receiving of thermal energy by a steam superheater (15) placed on a wall of the furnace and having at least one heat exchange surface (21), characterized in that the method also comprises:
   - supplying of gas or a gas mixture to the front of the heat exchange surface, to form a barrier layer (18) for protecting the heat exchange surface from flue gases (19) developed in connection with the combustion.

10. The method according to claim 9, characterized in that the gas or gas mixture is air or a corrosion inhibitor, particularly sulphur dioxide or sulphide.

11. The method according to claim 9 or 10, characterized in that the method further comprises:
- supplying of gas or gas mixture from several different locations into the area delimited by the superheater, to the front of said heat exchange surface, to form a uniform barrier layer (18).

12. The method according to any of the claims 9 to 11, characterized in that the method further comprises:

- supplying of gas or gas mixture to the barrier layer by using at least one gas supply device (17) placed in the superheater or in the direct vicinity of the superheater, or by using a supply device matrix comprising several said supply devices and placed in the area delimited by the superheater.