METHOD OF AND ARRANGEMENT FOR FEEDING FUEL INTO A CIRCULATING FLUIDIZED BED BOILER

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13/503,957

PCT Filed: Oct. 29, 2010

PCT No.: PCT/FI10/50862

§371(c)(1), (2), (4) Date: May 31, 2012

Foreign Application Priority Data

Nov. 10, 2009 (FI) ............................... 20096169

Publication Classification

Int. Cl. F23C 10/22 (2006.01)
F23K 3/00 (2006.01)
F28D 13/00 (2006.01)
F23C 10/04 (2006.01)

U.S. Cl. .......... 431/7; 122/4 D; 110/101 R; 110/265; 165/104.16

ABSTRACT

A method of feeding at least one of light, fine, volatile and moist fuel into a furnace of a circulating fluidized bed boiler. Fuel is introduced into the furnace and is combusted in the presence of a fluidized bed material to form flue gases. The fluidized bed material is circulated both inside the furnace in an internal circulation in which bed material returns along walls of the furnace down to the bottom of the furnace, and outside the furnace in an external circulation that includes at least a solids separator arranged in flow communication with the furnace. Bed material is separated from the flue gases in the separator. The flue gases are removed from the separator for further treatment. The separated bed material is returned to the furnace. Circulating bed material from at least the internal circulation flowing down along the furnace walls to a return flow is collected, and the return flow is introduced in a consolidated form into communication with the fuel being introduced in the furnace, so that the bed material return flow and the fuel flow are mixed together and flow downwards in the furnace. This increases the residence time of the fuel in the furnace.
METHOD OF AND ARRANGEMENT FOR FEEDING FUEL INTO A CIRCULATING FLUIDIZED BED BOILER


FIELD OF THE INVENTION

[0002] The present invention relates to a method and an arrangement for feeding fuel into a circulating fluidized bed boiler (CFB). The invention is specifically concerned with feeding fine, light, volatile and/or moist fuel into the boiler.

BACKGROUND OF THE INVENTION

[0003] A CFB generally includes a furnace having a bottom, side walls, and a roof, and at least one particle separator connected in flow communication with the upper portion of the furnace. At least some of the walls of the bottom portion of the furnace may be inclined such that the cross section of the furnace increases upwardly, i.e., the portion of the furnace having the inclined walls may be called a converging bottom part. In practice, all of the walls and the roof of the boiler and the separator comprise water tubes to collect heat from the furnace. The bottom of the furnace is provided with a grid for introducing combustion or suspending or fluidizing gas into the furnace, and for removing ash and other debris from the furnace. The side walls of the furnace are provided with means for introducing fuel into the furnace, as well as means for introducing secondary air into the furnace. The furnace is also equipped with means for feeding inert bed material that is normally sand.

[0004] The particle separator separates solid particles from a fluid gas-solid particles suspension entering the separator from the upper portion of the furnace. Separated solids are recycled back to the lower portion of the furnace via a recirculation conduit that includes a sealing device, such as a loop seal, the purpose of which is to prevent gas flow from the furnace to the separator via the recirculation conduit. Thus, at least a further opening in the furnace wall is needed for the solids introduction. This solids circulation is called an external circulation. In addition to vertical upflow of fluid gas-solid particles suspension in the furnace entering finally into the separator inlet, there is a vertical downflow of particles near the furnace walls. This solids circulation is called an internal circulation.

[0005] Very often, in connection with the internal or the external circulation of solids material or both, a fluidized bed heat exchange chamber has been arranged to transfer heat from the bed of fluidized particulate solids to a heat transfer medium. The heat exchange chamber may be located inside the furnace of the circulating fluidized bed boiler adjacent to at least one of the furnace walls. A preferred location for the heat exchange chamber (or chambers) is adjacent to the bottom portion of the furnace where the chamber is integrated with the inclined wall (or walls). The fluidized bed heat exchanger may also be arranged in the external circulation, so that the solids leaving the solids separator are discharged into the heat exchange chamber on their way back to the furnace (see, for example, the prior art shown in FIG. 1). The interior of the heat exchange chamber is provided with heat exchange means for heat transfer from the solid material to the heat transfer medium flowing inside the heat exchange means.

[0006] Light, fine and/or moist fuels, such as, for example, fine coal powder or peat or sawdust or fine lignite, are problematic in two different aspects. Light, small density and fine particle size fuels are easily entrained with the fluidizing gas, and rise rapidly upwards, so that the combustion process starts a few meters above the grid, whereby only a small amount of fuel, not sufficient to maintain the bed temperature at a sufficient level, is combusted in the lower bed area, with most of the fuel being combusted higher up in the furnace. This may result, especially in low load conditions, in too low a bed temperature, and a higher temperature in the upper portion of the furnace, which, again, may lead to problems in emissions and in the load change rate of the boiler.

[0007] In a similar manner, the use of moist fuel may result in similar problems, but for a somewhat different reason. Though the moist fuel may not be too light, the drying thereof requires some time, such that the fuel is again (while it is drying and not yet capable of igniting) lifted by the fluidizing gas in the upper portion of the furnace. When the fuel is finally dry enough, ignites and is finally combusted, there may not be enough combustible fuel in the lower bed area, whereby the bed temperature may, again, be low, and result in the problems already discussed above.

[0008] A further problematic fuel type is a fuel that, for the most part, contains volatile components and a smaller amount of solid carbon. The volatile components form combustible gases such as CO, CH₄, H₂, etc., very close to the fuel feed opening, whereafter, the combustible gases move upwards with the fluidizing gas. This upward flow creates a gas column with which the oxygen is not able to mix quickly and efficiently, resulting in combustion of the gases in the upper portions of the furnace.

[0009] Normally, the fuel is introduced into the furnace via one or more openings in the wall of the furnace. The fuel is, depending on the type of fuel, proportioned in the furnace either as a fuel-air suspension, i.e., pneumatically, or by means of a screw feeder or some other mechanical feed means. Normally, the fuel opening is or the fuel openings are located in the (converging) bottom portion of the furnace walls.

[0010] The solids entering the furnace from the external circulation, i.e., directly from the separator or via a fluidized bed heat exchanger, are introduced into the furnace via one or more openings in the furnace walls, too.

SUMMARY OF THE INVENTION

[0011] An object of the invention is to ensure, for the light, fine volatile and/or moist fuel, sufficient residence time for drying and/or combustion in the lower bed area of the furnace for optimizing the entire combustion process. According to the present invention, the residence time of the fuel in the lower bed area is increased by retarding the movement of the fuel to the upper bed area by means of combining the fuel and the solids flowing towards the lower bed area from the internal and/or external circulation.

[0012] Another object of the invention is to prevent the formation of the upward flowing column of combustible gases above the fuel feed opening by introducing circulating bed material to the gas column, so that the column breaks, and turbulence increases, whereby oxygen reaches the combust-
tible gases more efficiently than before, and the combustion takes place lower in the furnace.

Several prior art documents discuss the mixing of the fuel and the returning bed material.

It is, for instance, known to introduce moist fuel and bed material into a separate mixer/drier device before feeding the fuel-solids mixture into the boiler. U.S. Pat. No. 4,529,911, No. 4,690,076, and No. 5,419,267 discuss various alternatives for separate mixers/driers. The separate mixer/drier units, however, increase costs in both the investment/building phase and running phase, and form yet one more piece of equipment that requires special maintenance.

It is also known to feed fuel into the external circulation between the particle separator and the furnace, as discussed, for instance, in U.S. Pat. No. 4,442,795.

However, the above-mentioned patent documents either do not address the problems discussed above, or if they do (moist fuel), they result in a very complicated arrangement with a separate particle dryer outside the boiler.

A further object of the present invention is to suggest a few alternative solutions to the problems discussed above relating to the feed and combustion of fine, light, volatile and/or moist fuels in circulating fluidized bed boilers.

All the alternative solutions are based on feeding the fuel in the furnace such that the heat transfer process between the fuel and the recirculating solids is improved by improving the mixing between the fuel and the circulating hot bed material.

A first preferred embodiment of the present invention is based on collecting bed material flowing downstream along the furnace wall to be fed in a consolidated form on top of the incoming fuel.

A second preferred embodiment of the present invention is based on arranging the feed of the recirculated material from the external circulation to take place on top of the fuel feed.

A third preferred embodiment of the present invention is based on arranging a fluidized heat exchange chamber to discharge bed material flow on top of the incoming fuel.

A fourth preferred embodiment of the present invention is based on arranging the exit of a bed material flow from the solids separator or from an external heat exchange chamber to introduce the bed material flow on top of the incoming fuel.

A fifth preferred embodiment of the present invention is based on taking a side flow of bed material from the internal circulation temporarily outside of the furnace, and to arrange such in communication with the fuel just prior to the fuel entering the furnace.

Other features of the method and the apparatus of the present invention can be seen in the appended claims.

By means of the present invention, at least some problems relating to the feeding and combustion of fine, light, volatile and/or moist fuel in a circulating fluidized bed boiler have been solved by means of a simple and an effective means of feeding fuel into a furnace of a circulating fluidized bed boiler. For instance, there is no need to design and to build external drying chambers, known from the prior art, to dry moist fuel. Also, the need of mixing light, powdery fuel with hot bed material in a separate mixing chamber has been obviated.

The present invention makes it possible to keep the bed temperature higher even in the lower portions of the furnace when light, fine, volatile and/or moist fuel is combusted. This is particularly true with lower boiling loads when the bed temperature tends to decrease for natural reasons, too. Compared to prior art arrangements, the present invention, when taken into use, accomplishes that:

- the moist fuel starts drying sooner,
- the dried fuel ignites and combusts sooner,
- a higher proportion of the light and fine fuel is taken down to the bed, whereby the bed temperature gets higher or remains at an acceptable level even in low load conditions,
- mixing burning fuel with a high density flux of recirculating solids will increase the temperature of the solids flux, which will then transport the heat to the bottom of the furnace, which further increases the bed temperature,
- mixing burning fuel with recirculating solids improves the lateral mixing of fuel and combustible gases as well, which will further improve the combustion at the lower portions of the furnace and will result in a more uniform combustion and heat flux distribution in a lateral direction, and
- the fuel feed may be arranged higher on the wall of the furnace, whereby the counter pressure is less.

The last two advantages are not necessarily related to light and fine fuels, but are related to all types of fuels.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following, the method and the arrangement of the present invention will be explained in more detail with reference to the following drawings.

FIG. 1 is a schematic representation of a circulating fluidized bed boiler of the prior art.

FIG. 2a is a schematic representation of a first preferred embodiment of the present invention.

FIG. 2b is a schematic side representation of the first preferred embodiment of the present invention.

FIG. 3 is a schematic representation of a second preferred embodiment of the present invention.

FIG. 4 is a schematic representation of a third preferred embodiment of the present invention.

FIG. 5 is a schematic representation of a fourth preferred embodiment of the present invention.

FIGS. 6a through 6c are schematic representations of several alternatives of a fifth preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 schematically illustrates a circulating fluidized bed boiler of the prior art. The boiler 10 comprises a furnace 12 with substantially vertical walls 32, a discharge passage 14 in the upper end of the furnace 12 for taking the flue gas and solid particles supplied thereby to a solids separator 16, a passage 18 arranged in the upper end of the solids separator 16 for the removal of the cleaned exhaust gas from the solids separator 16, a recirculation conduit 20 at the lower end of the solids separator 16 for returning at least a portion of the separated solids back to the lower part of the furnace 12, fuel feed means 22 arranged at a side wall 32 of the furnace 12, and air feed means 24 and 26 for introducing primary and secondary air, respectively, arranged at the lower portion of the furnace 12. The fuel feed means 22 may include
a screw feeder, a drop leg, or a pneumatic feeder, just to name a few alternatives. The primary air 24 is the primary combustion gas that is also used to fluidize the bed material, and is thus fed into the furnace 12 through the grid arranged at the bottom of the furnace 12. The secondary gas 26 is introduced into the furnace 12 through the side wall 32 thereof slightly above the grid. A gas lock 28 has been arranged in the recirculation conduit 20 for preventing the gas from flowing from the furnace 12 via the recirculation conduit 20 into the solids separator 16. Here, the recirculation conduit 20 is further provided with a fluidized bed heat exchange chamber 30 for collecting heat from the recirculating solids to a heat transfer medium. The side walls 32 of the boiler 10, as well as the ones of the solids separator 16, usually comprise water tubes, so that the water acts as the heat transfer medium.

[0043] FIGS. 2a and 2b illustrate a first preferred embodiment of the present invention showing the lower end of the furnace 12 such that an inclined side wall 32 of the furnace 12 is supposed to have two fuel feed means 22. The inner surface of the side wall 32 of the boiler 10 has been provided with two inclined guide plates 34 above each fuel feed means 22. The guide plates 34 are preferably, but not necessarily, made of refractory material, and fastened on the side wall 32 such that they are at substantially right angles to the side wall 32, and inclined towards the fuel feed means 22, which, in fact, may appear as an opening 36 in the side wall 32. The lower ends of the guide plates 34 leave a gap therebetween, the gap preferably corresponding to the diameter of the fuel feed opening 36. The purpose of the guide plates 34 is to collect the solids, i.e., the bed material flowing down the side wall 32 of the boiler 10 and to consolidate the bed material flow above the fuel feed opening 36. Now that the consolidated bed material flows on top of the fuel feed, it takes at least a portion of the fuel downwards and mixes the fuel with the actual bed material at the bottom of the furnace 12. FIGS. 2a and 2b show as an additional feature, in addition to the guide plates 34 fastened on the furnace side wall 32, a cover 38 for the fuel feed opening 36. The purpose of the cover 38 is to direct the fuel feed down along the side wall 32 of the furnace 12, and thus, to facilitate the passage of the fuel towards the bottom of the furnace 12. Another purpose of the cover is to form a kind of a curtain between the fuel and the turbulent bed material deeper in the furnace 12, so that as much fuel as possible could flow down on the grid. Preferably, the guide plates 34 are provided with substantially vertical extensions 34' that go along the sides of the cover 38, such that they guide the bed material flow B on top of the fuel F entering the furnace 12 from below the cover 38, as shown by arrows F and B. These extensions enhance even more the formation of the solids curtain to the side of the fuel flow facing the interior of the furnace 12. Thus, now that the residence time of the fuel at the lower portion of the furnace 12 has been extended, on the one hand, in case the fuel is moist, the fuel has more time to dry, so that the combustion may take place in the bed area or, on the other hand, if the fuel is light, volatile and/or fine, it has more time to be combusted at the lower portion of the furnace 12, compared to a prior art fuel feed arrangement, in which the fuel is introduced into the furnace 12 at a distance above the grid, so that the fuel enters the upwardly moving fluidized bed, and is taken quickly to the upper portion of the furnace 12. The result in both alternatives is that the fuel is combusted lower in the furnace 12, whereby the temperature of the bed material lower in the furnace 12 is raised.

[0044] As to the dimensioning of the guide plates 34 and 34', the basic dimensions are dependent, on the one hand, on the dimensions of the furnace 12, and, on the other hand, on the properties of the bed material. Normally, the height (measured from the surface of the furnace wall outwards) of the guide plates is on the order of about 200 to about 500 mm, and the inclination angle (measured from the horizontal direction) from about thirty to about seventy degrees. However, if the guide plates form a curtain leading the recycled bed material from, for instance, a fluidized bed heat exchanger to the bottom portion of the furnace 12, the guide plates may be vertical, too, so that their inclination may, in fact, range from thirty to ninety degrees. In other words, it is possible that the chute collects circulating solids not only from the fluidized bed heat exchanger, but also from the furnace wall, whereby it is understandable that the side walls of the chute act in a similar manner as the guide plates 34 discussed above. As to the cover 38, it may be formed of a planar top plate, and two planar side plates (as shown in FIGS. 2a and 2b), but the cover may as well follow the shape of the circumference of the opening 36, whereby the cover 38 is a side plate. As a further option, the guide plates 34 and 34' (if used) may either introduce the solids substantially to the width of the fuel feed opening 36, but they may as well introduce the solids to a somewhat larger area, i.e., to an area extending on both sides of the opening 36, whereby it is ensured that the fuel entering the furnace 12 is covered from all (free) sides by the fuel, i.e., a complete covering curtain is formed. For some reason, however, it is desired that the fuel is allowed to more freely enter the furnace 12, the bed material feed on top of the fuel may be made narrower, whereby the fuel is able to escape from the sides of the solids flow. And, finally, the amount of bed material collected by the guide plates and introduced on top of the fuel feed may be designed for each case separately.

[0045] FIG. 3 schematically illustrates a second preferred embodiment of the present invention. Here, the consolidated solids flow B from the solids separator 16 (see FIG. 1) or from the heat exchange chamber 30 (see FIG. 1) is recirculated via solids discharge conduit 20 into the furnace 12 on top of the fuel F entering the furnace 12 through the feed opening in the wall 32 of the furnace 12. Introducing the solids from the external circulation and the fuel into the furnace 12 in the above-described manner ensures that the fuel is first mixed efficiently with the recirculating solids, unless it forms a curtain-like cover between the fuel and the turbulent bed deeper in the furnace 12, allowing the fuel to descend to the bottom of the furnace 12 substantially uninterrupted. Second, the fuel-solids mixture or the fuel and returned solids is/are mixed efficiently with the bed material at the bottom of the furnace 12. The solids introduction conduit 20 is planned to be positioned as close above the fuel feed means 22 as possible, in view of the structural requirements and limitations.

[0046] Naturally, similar arrangements as shown in connection with the embodiment of FIGS. 2a and 2b, such as the cover of the fuel feed opening 36, may be used here, too. In this embodiment, it might be advantageous to arrange such a cover in connection with both feeders, not only in the flow direction of both the solids feed and the fuel feed is diverted parallel to the wall 32. In this manner, the curtain effect of the solids flow is also ensured.

[0047] FIG. 4 schematically illustrates a third preferred embodiment of the present invention. Here, the recirculating solids are collected from the internal circulation in a chute or funnel 21 that is arranged in connection with the lower
inclined wall 32 of the furnace 12. The chute 21 may collect solids not only from the wall 32 of the furnace 12, but also, for instance, from a fluidized bed heat exchanger arranged in the upper portion of the furnace 12. The chute 21 is preferably arranged to terminate near the bottom of the furnace 12, such that the bottom surface of the chute 21 is inclined, so that it is parallel with the fuel feed means 22 entering the furnace 12. As an additional feature, the chute 21 is provided with a guide plate 23, parallel to the fuel feed means 22 and positioned above the fuel feed means 22, so that it guides the solids flow on top of the fuel flow entering the furnace 12. As another alternative, the chute 21 may terminate to the plate 23, and the fuel feed opening 36 or, more generally, fuel feed means 22, may be positioned in the wall 32 below a chute bottom 33. In both cases, the plate 23 ensures a proper solids curtain on the fuel. Thus, the operation of the chute 21 and the cover plate 23 are basically the same as explained above in connection with the embodiment of FIGS. 2a and 2b. And, the fuel feed means 22 referred to above may be just an opening in the inclined wall of the chute 21, or it may be a pipe-like conduit extending a distance into the chute 21, as shown in FIG. 4, or an opening in the furnace wall 32 just below the chute 21.

FIG. 5 schematically illustrates a fourth preferred embodiment of the present invention. As in the earlier embodiments, here, the solids from the internal circulation also mix efficiently with the fine, volatile and/or light and/or moist fuel, take the fuel down in the furnace 12, and mix the fuel with the actual bed material. Here, aspects of the invention are again positioned at the lower portion of the furnace 12 in connection with the inclined side walls 32 of the furnace 12.

In this embodiment of the present invention, the fuel feed means 22 is a fuel feed opening 40 arranged in a specific manner in the wall 32 of the furnace 12 of the boiler 10. The fuel feed opening 40 is arranged in the substantially vertical bottom of a vertically oriented channel 42 integrated in the inclined side wall 32 of the furnace 12. The channel 42 is, in this specific embodiment, formed of a somewhat inclined (almost vertical) bottom wall 43, and substantially vertical side walls 46. In FIG. 5, the bottom wall 43 of the channel 42 has been shown to be slightly inclined, but the vertical wall 43 may as well be exactly vertical or even more inclined. The substantially vertical channel 42 brings solids from, for instance, the internal circulation back towards the bottom of the furnace 12. This construction works independently in a similar manner as with the earlier embodiments, i.e., introducing a consolidated solids flow on top of the fuel entering the opening 40 of the furnace 12. In other words, the vertical, substantially U-shaped channel may receive the downward solids flow from a fluidized bed heat exchanger arranged on a higher level in the furnace 12 or from the internal circulation along the wall of the furnace 12. The channel 42 is able to collect solids efficiently from the turbulent bed material in the furnace 12, as the state of turbulence in the channel 42 is clearly weaker. The substantially deep cross section of the channel 42 creates a peaceful cavity where solids may collect, and flow down as a consolidated flow, i.e., as a flow that is more dense than is the internal circulation on the wall 32.

In this preferred embodiment, however, an internal fluidized bed heat exchange chamber 44 has been arranged in flow communication with a side wall 46 of the substantially vertical channel 42 discussed above. The fluidized bed heat exchange chamber 44 receives solids from the internal circulation via an opening 48 arranged thereafter in a wall 32 of the furnace 12. The solids entering the fluidized bed heat exchange chamber 44 are fluidized by means of air current through the bottom 50 of the chamber 44. At the side of the chamber 44, in fact, between the fluidized bed heat exchange chamber 44 and the substantially vertical channel 42, there is a so-called lift-leg 52 connecting the heat exchanger chamber 44 to the vertical channel 42. The lift-leg 52 is a small chamber having, at a lower end of its side wall facing the heat exchange chamber 44, an opening for allowing the solids flow in the chamber 44, and at an upper end of the opposite side wall, an opening for allowing the solids flow out of the lift-leg chamber 52 to the substantially vertical channel 42. Thus, both the internal circulation flowing down the substantially vertical channel 42 and the bottom 54 of the substantially vertical channel 42.

It has to be understood that there may be fluidized bed heat exchange chambers 44 on both sides of the substantially vertical channel 42. Also, the position of the fluidized bed heat exchanger chambers 44 may be, in relation to the fuel feed opening 40, either higher or lower than that shown in FIG. 5. In a similar manner, the side wall or walls 46 of the substantially vertical channel 42 may be inclined, such that the side walls 46 collect internal circulation from a wider area than that shown in FIG. 5. It is also possible to arrange, above the substantially vertical channel 42, inclined guide plates like the ones shown in FIG. 2, to collect internal circulation into the channel 42. Likewise, it is possible to arrange a further opening above the fuel feed opening 40 to introduce solids from the external circulation into the substantially vertical channel 42 to be fed on top of the fuel feed.

Thus, it is clear that the present embodiment is mainly concerned with using the solids flow from the fluidized bed heat exchanger 44 to force the fuel flow down to the bed area irrespective of the positioning of the fluidized bed heat exchanger 44. In other words, recycled bed material may be introduced from one or several fluidized bed heat exchange chamber (or chambers) 44 along a channel 42 to be introduced on top of the fuel feed. In its simplest form, the fuel feed opening 40 is arranged below the solids exit opening of a fluidized bed heat exchange chamber 44, whereby a separate channel is not necessarily needed.

A further advantageous way of using a fluidized bed heat exchanger 44 relates to low load conditions when there is, in practice, no external circulation, and the internal circulation is marginal. Now, by introducing bed material into the heat exchanger 44 via an overflow or auxiliary channel (discussed in more detail in U.S. Pat. No. 7,240,639 B2), it is possible to discharge particulate material on the incoming fuel, provided that the heat exchanger discharge opening is above the fuel feed opening 40.

As a further improvement, compared to the prior art, the fuel-solids mixture is taken down on the grid to be fluidized. In accordance with a further preferred embodiment of the present invention, the bottom 54 of the vertically oriented channel 42 is provided with a grid forming a so-called fluidization zone where the mixture of fuel and solids is fluidized, such that the velocity is in the range of about 10 to about 20 Um/s for D50 sized particles (Um/s equals the minimum fluidization velocity), to obtain high mixing between the fuel and the solid material. In the neighborhood of the channel bottom grid, there is a second grid area 56 that forms a so-called low velocity zone in a portion of the bottom of the
furnace 12, where the velocity is in the range of about 40 to about 50 Unm/s for D50 sized particles. In this zone, material is transported and sprayed to other parts of the furnace 12, but with the velocity below the terminal velocity, so fuel particles have time to dry (in the case of moist fuel) and to heat enough, such that the ignition and combustion process will start in the lower portion of the combustion chamber. Both the first and second grid areas may be provided with either directional nozzles, or a so-called step grid, for moving the solids in the horizontal direction along the grid. Outside this second grid area 56 is the area of normal grid velocity where the gas flow from below the grid is sufficient for initiating the circulation of the fuel and bed material in the furnace 12.

[0055] This kind of stepwise grid velocity arrangement also gives internal circulation of solid particles from the wall (where fuel feeds are installed) towards the lower portion of the furnace 12 along the grid and up along the wall, and to the fluidized bed heat exchanger 44 somewhat in the upper portion of the furnace 12. This increases the solid material amount, which is going to the fluidization zone and also recirculates some fuel particles.

[0056] FIGS. 6a through 6e show a fifth preferred embodiment of the present invention, with three different alternatives. In the arrangement of FIGS. 6a through 6c, the basic principle is to take a portion of the internal circulation flowing down along the furnace walls 32 temporally out of the furnace 12 as a side flow, and to introduce the side flow into communication with the fuel flow prior to feeding the fuel into the furnace 12.

[0057] FIG. 6a shows a first alternative where some bed material from the internal circulation (IC) is taken out of the furnace 12 through at least one opening 58 in the inclined wall 32 of the furnace 12, and introduced along conduit 60 directly into the fuel feed conduit 22, where the bed material and fuel are efficiently mixed together due to the operation of the fuel feed means, such as, for instance, a screw feeder, a pneumatic feeder, etc.

[0058] FIG. 6b shows a second alternative where some bed material is again taken from the internal circulation IC out of the furnace 12 through at least one opening 58 in the inclined wall 32 of the furnace 12, and introduced along conduit 60 into communication with the fuel flowing towards the furnace 12 along feed conduit 22. In this embodiment, however, the flow of the circulated bed material is controlled by means of a loop-seal type control 62, whereby the amount of bed material introduced to the fuel feed may be adjusted.

[0059] FIG. 6c shows a third alternative, which is very close to the second one. In fact, the only difference that can be seen is in the way the fuel and the recirculating bed material are mixed. In the alternative of FIG. 6b, the bed material is introduced into the fuel flow via conduit 22, whereas in the alternative of FIG. 6c, the fuel flow conduit 22 introduces fuel into the bed material conduit 60 after the loop-seal type control 62.

[0060] The bed material-fuel mixture formed as shown in FIGS. 6a through 6e may be introduced as is in the furnace 12, but it may as well be introduced into the furnace 12, such that the initial opening of the mixture is arranged in a channel similar to the ones shown in FIGS. 4 and 5. The mixture may also be treated in a similar manner as a fuel feed in the earlier embodiments discussed in connection with FIGS. 2 through 5. In other words, its inlet opening may be provided with a cover for directing the mixture flow down towards the grid of the furnace 12, and also, some other solids either circulating in the furnace 12 (either along the wall thereof, or along a channel) or returning in the furnace 12 may be introduced on top of the mixture flow to force the mixture down towards the grid.

[0061] In view of the above description, it has to be understood that only a few most preferred embodiments of the present invention have been discussed. Thus, it is obvious that the invention is not limited only to the embodiments discussed above, but that it can be modified in many ways within the scope of the appended claims. It has to be understood, too, that features of a specific embodiment of the invention may be applied in connection with features of other embodiments within the basic idea of the present invention, or to combine features from different embodiments to result in a working and technically feasible construction.

1-20. (canceled)
21. A method of feeding at least one of light, fine, volatile and moist fuel into a furnace of a circulating fluidized bed boiler, the method comprising:

introducing a fuel flow into a furnace of a circulating fluidized bed boiler, the fuel flow being selected from at least one of light, fine, volatile and moist fuel; combusting the fuel in the presence of a fluidized bed material in the furnace of the boiler to form flue gases; circulating the fluidized bed material both inside the furnace in an internal circulation, in which bed material returns along walls of the furnace down to the bottom of the furnace, and outside the furnace in an external circulation that includes at least a solids separator arranged in flow communication with the furnace; separating bed material from the flue gases in the separator; removing the flue gases from the separator for further treatment; returning the separated bed material to the furnace; collecting circulating bed material from at least the internal circulation flowing down along the furnace walls to a return flow; and introducing the return flow in consolidated form into communication with the fuel being introduced in the furnace, so that the bed material return flow and the fuel flow are mixed together and flow downwards in the furnace, in order to increase the residence time of the fuel in the furnace.
22. The method as recited in claim 21, further comprising introducing the return flow on top of the fuel flow, while the fuel is being introduced in the furnace.
23. The method as recited in claim 22, further comprising guiding the return flow to cover the fuel flow being introduced into the furnace.
24. The method as recited in claim 21, further comprising directing the fuel flow being introduced into the furnace down towards the bottom of the furnace.
25. The method as recited in claim 21, further comprising taking a portion of the solids from the external circulation outside of the furnace to be introduced into communication with the fuel about to be introduced into the furnace.
26. The method as recited in claim 21, further comprising taking a portion of the solids from the internal circulation to be introduced into communication with the fuel about to be introduced into the furnace.
27. The method as recited in claim 21, further comprising arranging a collector on or in the wall of the furnace to collect the return flow, and for introducing the collected return flow on top of the fuel flow.
28. An arrangement for feeding at least one of light, fine, volatile and moist fuel into a furnace of a circulating fluidized bed boiler, the boiler comprising:
   a furnace delimited at least by a grid at the bottom of the boiler, side walls, and a roof;
   a solids separator arranged in flow communication with an upper portion of the furnace;
   at least one air feed for providing the furnace with primary and secondary air;
   a return for returning the solids separated from the flue gases in the separator into the furnace;
   a feed for feeding fuel into the furnace, the fuel being selected from at least one of light, fine, volatile and moist fuel; and
   a conduit for introducing in consolidated form at least solids circulating inside the furnace and flowing down along the furnace walls into communication with the fuel to force the fuel flow down towards the grid in order to increase the residence time of the fuel in the furnace.

29. The arrangement as recited in claim 28, wherein the feed for feeding fuel into the furnace comprises a fuel feed opening in the wall of the furnace, and the conduit for introducing solids into communication with the fuel are arranged substantially above the feed opening.

30. The arrangement as recited in claim 29, wherein the conduit for introducing solids into communication with the fuel comprises a channel arranged in or on the wall of the furnace above the fuel feed opening.

31. The arrangement as recited in claim 30, wherein the channel is arranged in flow communication with one of a fluidized bed heat exchange chamber and the solids separator.

32. The arrangement as recited in claim 30, wherein the channel has side walls, and the side walls are inclined for collecting solids flowing down along the furnace side walls.

33. The arrangement as recited in claim 29, wherein the conduit for introducing solids into communication with the fuel comprises inclined guide plates arranged on the wall of the furnace above the fuel feed opening for collecting solids flowing down along the wall and for introducing such on top of the fuel feed.

34. The arrangement as recited in claim 29, wherein the conduit for introducing solids into communication with the fuel comprises an opening substantially above the fuel feed opening in the wall of the furnace.

35. The arrangement as recited in claim 29, wherein the feed for feeding fuel into the furnace comprises, in addition to the fuel feed opening, a cover arranged above the fuel feed opening to direct the fuel entering the furnace through the opening down towards the grid of the furnace.

36. The arrangement as recited in claim 35, wherein the conduit for introducing solids into communication with the fuel comprises at least one guide plate being arranged in connection with the cover.

37. The arrangement as recited in claim 28, wherein the fluidized bed heat exchanger is arranged one of (i) adjacent to an upper portion of the furnace, (ii) adjacent to a converging bottom portion of the furnace, and (iii) in connection with the separator.

38. The arrangement as recited in claim 28, wherein the conduit for introducing solids into communication with the fuel comprises an opening in the inclined walls of the furnace for taking some solids flowing down along the furnace wall out of the furnace, a conduit outside of the furnace in flow communication, at one end thereof, with the opening, and, at the opposite end thereof, with the fuel feed.

39. The arrangement as recited in claim 28, further comprising a loop-seal type control arranged in the conduit outside of the furnace for controlling the solids flow out of the furnace.