The invention relates to a treatment system (20) for removing bed material of a fluidized bed reactor (10) from the fluidized bed reactor and for cooling the bed material to be removed, which treatment system (20) comprises a treatment chamber (24) in connection with the fluidized bed reactor, which treatment chamber is provided with means (26) for supplying fluidizing gas to the lower portion of the treatment chamber, a heat exchanger system (34) arranged in an internal space formed by the treatment chamber (24), feeding arrangement (36) for bed material, opening on one hand to the treatment chamber and being on the other hand in connection with the fluidized bed reactor; a first discharge connection (32) arranged in the bottom portion of the treatment chamber for removing cooled bed material from the treatment chamber. The feeding arrangement (36) of the bed material opens through at least two different inlet openings (38, 38', 38") to the reaction chamber (12) of the fluidized bed reactor at different horizontal levels. The invention also relates to a corresponding method.
as to the applicant’s entitlement to claim the priority of the earlier application (Rule 4.17(H))

Published:
— with international search report (Art. 21(3))
TREATMENT SYSTEM FOR REMOVING BED MATERIAL FROM A FLUIDIZED BED REACTOR AND METHOD OF REMOVING BED MATERIAL FROM A FLUIDIZED BED REACTOR

[001] The present invention relates to a treatment system in accordance with the preamble of claim 1 for removing bed material of a fluidized bed reactor from the fluidized bed reactor and for cooling the bed material to be removed. The treatment system comprises a treatment chamber in connection with the fluidized bed reactor, which treatment chamber is provided with means for supplying fluidizing gas to the lower portion of the treatment chamber, a heat exchanger system arranged in an internal space formed by the treatment chamber, feeding arrangement for bed material, opening to the treatment chamber and being in connection with the fluidized bed reactor; and a first discharge connection arranged in the bottom portion of the treatment chamber for removing cooled bed material from the treatment chamber.

[002] The present invention also relates to a method in accordance with the preamble of claim 9 of removing bed material of the fluidized bed reactor from the fluidized bed reactor and of cooling the bed material to be removed, in which method bed material is transferred to a treatment system in connection with the fluidized bed reactor, in which system the bed material to be treated is fluidized by supplying fluidizing gas to the lower portion of the treatment chamber; transferring heat from the bed material by means of a heat exchanger system which is arranged in an internal space formed of the treatment chamber; guiding bed material from the fluidized bed reactor by means of a feeding arrangement in connection with the fluidized bed reactor and opening to the treatment chamber; and removing cooled bed material by a first discharge connection through a bottom portion of the treatment chamber out of the treatment chamber.

[003] The fluidized bed reactor is an apparatus known as such for accomplishing different reactions and treatment processes. A characteristic feature of a fluidized bed reactor is a fluidized bed, which is formed by conducting an ap-
appropriate amount of fluidizing gas thereto. In many processes, especially in oxidizing processes, such as a combustion or gasification process, the reaction medium and the possible additives form substance that is coarser in the grain size, which must in practice be removed from the fluidized bed reactor. Such a substance is generally called bottom ash. In circulating fluidized bed reactors, in which the fluidizing velocity is so high that a portion of the solid material is entrained with the reaction and/or fluidizing gas, it is possible to remove a portion of the solid material from a so called "external circulation", which refers to the circulation of solid material with the reaction and/or fluidizing gas to a solids separator and to the recirculation flow of the solid material separated from the gas back to the reactor. The particles of the external circulation are, however, typically relatively small of the grain size.

[004] One of the basic problems of the fluidized bed technology in the fuel combustion applications is the removal of the bottom ash, especially with fuels generating a lot of ash, and especially in large scale boilers. Conventionally, it is known to transfer ash removed from the reactor by means of a screw conveyor. A problem with the screw conveyor is, for example, the limited capacity of one screw. The capacity is limited by the cooling capacity of a screw when the ash is at the operating temperature of the reactor bed (e.g. 900°C). For example, in a large boiler, the number of the screws needed may easily rise to tens (e.g. to 50), whereby the screw removal becomes in practice difficult, if not impossible to perform. Another disadvantage of the screw removal is that the thermal energy in the bottom ash cannot be recovered, which affects the efficiency of the boiler.

[005] Publication EP 0062092 B1 discloses a cooling apparatus for the bottom ash of the fluidized bed reactor and a method, in which the cooler is used in different manners. Here, bed material can be transferred to the cooler of the bottom ash determined by the drive mode of the reactor.

[006] So called stripper-cooler type external heat exchangers are also bottom ash removal arrangements known in the prior art, in which the ash to be removed is transferred through one or more fluidizing chambers, in which it cools
down and, on the other hand, the finer ash fraction is recirculated with the fluidizing gas back to the furnace. A problem with these solutions is that the mass flow and the grain size of the solid material flowing in cannot be controlled, which causes clogging and problems in the temperature control. Complicated structure and large size can also be considered problematic in these solutions.

[007] Publication US 4969404 discloses a cooling system for bottom ash, in which the bottom ash to be removed from the reactor is fluidized in such a way that the lighter material is separated from the bottom ash and supplied with the fluidizing gas back to the reactor, when heavier material is removed. In the disclosed arrangement, there is no possibility to control the size of the bottom ash flowing into the system, so it can easily clog, if too large particles are allowed in. Publication US 4227488 discloses a principally similar bottom ash cooler with a difference that it also discloses a heat exchanger arranged into the cooler. For this reason, this solution has even a bigger risk to clog.

[008] Publication US 7240639 B2 discloses a fluidized bed heat exchanger arranged in connection with a fast fluidized bed reactor, through which heat exchanger bed material of the fluidized bed reactor is recirculated and cooled down prior to the return of the bed material to the fast fluidized bed reactor. According to the publication, bed material is supplied to the fluidized bed heat exchanger to a level which is to a certain extent above the grid of the fast fluidized bed reactor so as to avoid the entrance of larger particles possibly in the bottom of the fast fluidized bed reactor to the fluidized bed heat exchanger.

[009] Publication WO 9620782 A1 also discloses a bottom ash cooler arranged in connection with a fast fluidized bed reactor. Here the cooler is arranged to operate in two stages, in which the first stage is for separating and removing a coarser solids portion from the bottom ash by fluidizing appropriately and transferring the finer solids portion to the second stage. Only at the second stage solids portion is cooled by fluidizing the solids portion in a space comprising a heat exchanger. Such an arrangement a rather space-consuming and complicated to operate. The publication also discloses a second alternative for realization, in which a special route formed of slots or holes, in which the
slots/holes prevent the transfer of particles that are larger than the predetermined size from the reactor to the ash cooler. A disadvantage of such an arrangement is a risk of clogging, for example, slots/holes.

[0010] Publication EP 0 700 316 B1 discloses an apparatus for processing bed material of the fluidized bed reactor, in which bed material is removed from the fluidized bed reactor and transferred to a higher level in the process chamber by means of a special lifting chamber. The publication discloses a flow path formed of special slots or holes between the fluidized bed reactor and the lifting chamber, in which slots/holes prevent the transfer of particles of larger than the predetermined size from the reactor to the lift chamber. The publication discloses the removal of such larger particles from the lifting chamber, which are not transferred with the fluidizing gas to the processing chamber. A disadvantage in such an arrangement is, for example, a risk of clogging the slots/holes.

[0011] An object of the invention is to provide a treatment system for removing bed material of the fluidized bed reactor from the fluidized bed reactor and cooling said bed material, which enables better than before the control in the removal of the bed material and a more reliable operation.

[0012] Another object of the invention is to provide a method of removing bed material of a fluidized bed reactor from the fluidized bed reactor and cooling it.

[0013] Objects of the invention are achieved by a treatment system for removing bed material of the fluidized bed reactor from the fluidized bed reactor and for cooling the bed material to be removed, said treatment system comprising a treatment chamber in connection with the fluidized bed reactor, which treatment chamber is provided with means for supplying the fluidizing gas to the lower portion of the treatment chamber; a heat exchanger system, which is arranged to an internal space formed by the treatment chamber; a feeding arrangement for bed material, which on one hand opens to the treatment chamber and on the other hand is in connection with the fluidized bed reactor; a first discharge connection arranged to the bottom portion of the treatment chamber for removing cooled bed material from the treatment chamber. It is mainly characteristic
to the invention that the feeding arrangement opens at least through two different inlet openings to different horizontal levels in the reaction chamber of the fluidized bed reactor.

5 [0014] Advantageously, in operational proximity of said two inlet openings there are means for guiding the flow of the bed material from the fluidized bed reactor to the treatment chamber that are independent from the fluidization of the fluidized bed reactor.

10 [0015] According to an advantageous embodiment, in operational proximity of said at least two inlet openings there are independently controllable means for controlling the flow of the bed material from the fluidized bed reactor to the treatment chamber.

15 [0016] Preferably, the feeding arrangement of the bed material is formed of at least two separate feed channels, which each have a separate inlet opening and feed opening, through which bed material can be transferred from the reaction chamber to the treatment chamber.

20 [0017] Preferably all inlet openings, through which bed material is supplied to the treatment chamber, open to the treatment chamber substantially at the same horizontal level, which is above the heat exchanger system of the treatment chamber.

25 [0018] At least one inlet opening of the feeding arrangement of the bed material opens to the reaction chamber substantially to the level of the grid thereof.

[0019] Furthermore, it is advantageous that the means for supplying the fluidizing gas to the lower portion of the treatment chamber comprise a grid structure, arranged vertically at a lower lever than the grid structure.
[0020] The treatment chamber and the reaction chamber are preferably provided with a common wall portion, in which said feeding arrangement for bed material is arranged.

[0021] The objects of the invention are also achieved by means of a method of removing bed material of a fluidized bed reactor from the fluidized bed reactor and cooling the bed material of the fluidized bed reactor, in which method bed material is transferred to a treatment system in connection with a fluidized bed reactor, in which system the bed material to be treated is fluidized by supplying fluidizing gas to the lower portion of the treatment chamber; transferring heat from the bed material by means of a heat exchange arrangement, which is arranged to an internal space formed by a treatment chamber; guiding bed material from the fluidized bed reactor by means of a feeding arrangement which is in connection with a fluidized bed reactor and opens to the treatment chamber; and removing cooled bed material by means of a first discharge connection through a bottom portion of the treatment chamber from the treatment chamber. It is characteristic to the invention that bed material is transferred to the treatment chamber from the fluidized bed reactor at least at two locations arranged at different horizontal levels.

[0022] In accordance with a preferred embodiment, the transfer of bed material at said two different locations is controlled by independently guiding the flow of the bed material from the fluidized bed reactor to the treatment chamber.

[0023] The transfer of the bed material at two different locations is controlled by locally affecting the fluidization of the bed material.

[0024] Further, it is advantageous that the fluidization of the bed material is locally affected in such a way that the transfer of particles having a grain size and/or weight less than a set value is allowed.

[0025] Substantially all bed material transferred to the treatment chamber is cooled and removed through a connection in the bottom portion of the treat-
ment chamber from the treatment chamber without recirculating it back to the reaction chamber.

[0026] Other characteristic features of the invention become apparent in the enclosed patent claims and in the description of the embodiments of the drawings below.

[0027] For example, following advantages are achieved by the invention:
- inlet flow of the bed material to the treatment system (mass flow, grain size) can be controlled, also batch mode possible
- low temperature of the bed material to be removed can be achieved without limiting the screw capacity
- thermal energy content of the bed material to be removed is efficiently recovered
- simple structure

[0028] The present invention and the operation thereof are discussed in the following with reference to the accompanying schematic drawings, in which

20 Fig. 1 schematically illustrates an embodiment of a treatment system of the bed material of a fluidized bed reactor; and Fig. 2 illustrates a section II-II of Fig. 1.

[0029] Fig. 1 illustrates a preferred embodiment of the invention of a treatment system 20 arranged in connection with a fluidized bed reactor 10 for removing bed material of a fluidized bed reactor from the fluidized bed reactor. The system can especially be used for efficiently controlling the amount of the bed material to be removed and grain size thereof. The fluidized bed reactor 10 is preferably a fast fluidized bed reactor, in other words a circulating fluidized bed reactor for combusting or gasifying fuel. The main elements of a circulating fluidized bed reactor are a reaction chamber 12, which is called a furnace in combustion applications, a solids separator system 14 and a solids recirculating system 16. The solids separator system preferably comprises one or more eye-
lone separators arranged to separate bed material, in other words solid material entrained with gases from the furnace. The separated solid material is recirculated completely or partially through the recirculation system 16 back to the furnace. There are feed means 11 for fluidizing gas in the bottom portion of the reaction chamber, which comprise at least a so called wind box 11.1, a grid 11.2 and control means 11.3 arranged in the channel leading gas to the wind box for controlling the flow rate of the fluidizing gas. The bottom portion of the reaction chamber also contains a discharge connection 17 for removing particularly large particles formed of the bed material.

[0030] When the fluidized bed reactor 10 is operating, for example, as combustion device for fuel material, unburned substances, which must be removed from the reaction chamber 12, are formed to the bed material. The unburned substances are of grain size such that they cannot be fluidized normally among other material, but they have to be removed from the bottom of the chamber 12 or from the close proximity thereof. As the bed material to be removed contains heat, it is advantageous to recover it in order to improve the efficiency. A treatment system 20 is provided in connection with the lower portion of the reactor, which system preferably operates as fluidized bed cooler 20, in which unburned substances of the bed material removed from the reaction chamber are treated. The cooler 20 and the treatment chamber 24 thereof are preferably provided with a wall portion 22 common with the reaction chamber 12.

[0031] A treatment system in accordance with the invention is arranged in connection with the fluidized bed reactor 10 for removing a desired portion of the bed material. The treatment system 20 comprises a treatment chamber 24, provided with means 26 for introducing the fluidizing gas to the lower portion of the treatment chamber 24, whereby the treatment system comprises a fluidized bed cooler 21. The means 26 for supplying fluidizing gas preferably comprise a bottom portion provided with gas inlet openings and gas supplying device 30 provided with control means 28. Means 26 of the treatment chamber 24 for supplying fluidizing gas to the lower portion of the treatment chamber comprise a grid structure 30.1 provided with gas nozzles, which are preferably provided
vertically lower than the grid structure \(1 1.2\) of the fluidized bed reactor. A first discharge connection \(3 2\) is provided at the level of the bottom portion of the treatment chamber \(2 4\), for removing cooled bed material from the treatment chamber \(2 4\). The first discharge connection \(3 2\) is provided with a control means \(3 1\) for removing the bed material in such a manner that the gas flow through the discharge connection is substantially prevented or diminished at the same time. The control means can be, for example, a rotary valve feeder or like. A discharge connection \(3 2\) is preferably connected to a screw conveyor \(4 6\), by means of which the cooled solid material is transferred to be further treated. The temperature of the bed material to be removed at the bottom of the cooler is considerably lower than the bed temperature of the furnace \(1 2\), whereby owing to the invention the temperature of the bed material to be removed does not considerably limit the capacity of the screw(s) to be used.

[0032] A heat exchange system \(3 4\) is provided in the treatment chamber, which system comprises heat exchange surfaces arranged in connection with the bed material. The heat exchange surfaces are arranged, while the apparatus is running, below the surface of the fluidized bed to be formed in the treatment chamber. By means of the heat exchange system heat is recovered from the bed material to be removed and cooled down before guiding it to the discharge connection \(3 2\). The treatment system \(2 0\) also comprises a second discharge connection \(3 4\), which is arranged to the upper portion of the treatment chamber to connect a gas space of the treatment chamber to the reaction chamber \(1 2\). It is possible to remove the fluidizing gas supplied to the treatment chamber through the second discharge connection \(3 4\) to the reaction chamber \(1 2\). The second discharge connection \(3 4\) is arranged in such a manner that it is not possible to transfer considerable amounts of bed material from the reaction chamber \(1 2\) to the treatment chamber \(2 4\).

[0033] The treatment system \(2 0\) comprises feeding arrangement \(3 6\) for bed material, by means of which it is possible to remove a controlled amount of material with a controlled grain size from the furnace \(1 2\). The feeding arrangement \(3 6\) is in connection with the reaction chamber \(1 2\) of the fluidized bed reactor
through inlet opening 38 and it opens to the treatment chamber 24 through feed opening 40. A feed channel 42 connects the inlet opening and the feed opening. The feed opening 40 is at a higher horizontal level than the inlet opening 38, whereby the bed material does not flow nor transfer from the reaction chamber 12 to the treatment chamber by itself practically at all. The feed channel 42 delimits such a space that the fluidization of the furnace 12 alone does not enable the transfer of the bed material through the inlet channel to the treatment chamber 24.

[0034] Independently controlled means 44 for guiding the flow of the bed material from the fluidized bed reactor to the inlet opening 38 and through the inlet opening to the treatment chamber 24 are provided in the close operational proximity of the inlet opening 38 to the inlet opening 38 in order to generate the flow of the bed material and the transfer of the bed material from the reaction chamber 12 to the treatment chamber. Preferably the means 44 for guiding the flow of the bed material from the fluidized bed reactor to the treatment chamber comprise an inlet arrangement for fluidizing gas arranged substantially at the inlet opening in such a way that the fluidizing gas to be supplied can be adjusted independently from the supply of the fluidizing gas of the reaction chamber. Said inlet arrangement of the fluidizing gas is preferably arranged in such a way that the fluidizing gas to be supplied therethrough is guided to the inlet channel and flows therethrough to the treatment chamber 24.

[0035] Such a feeding arrangement 36 enables the possibility to control by means of the amount of the fluidization both the amount of the bed material to be transferred and the grain size thereof. There the inlet opening 38 does not operate as primary means to determine the grain size of the bed material, so the inlet opening can be so large that the risk of clogging is avoided practically speaking completely. The furnace comprises a discharge connection 17 for the removal of the possible oversized agglomerates.

[0036] In accordance with an embodiment of the invention, means 26 of a fluidized bed cooler 20 for supplying fluidizing gas to the lower portion of the treatment chamber 24 is in connection with a discharge gas channel 9 of the
fluidized bed reactor 10. When the reactor is a combustion device, gas, which
does not contain oxygen, and which is available in the reactor is used as fluidizing
gas. This provides that the possibly combustible portion of the bed material
to be cooled does not burn, whereby the cooling continues to be efficient. Also
other non-oxygenous gas can be used, if desired, as fluidizing gas of the treat-
ment system.

[0037] In accordance with an embodiment of the invention, the fluidized bed
cooler shown in Fig. 1 will be run in batch mode. There, at the first stage the
inlet arrangement 44 for the fluidizing gas is switched on, whereby material is
transferred from the proximity of the inlet opening 38 through the inlet channel
42 to an upper level and through the inlet opening 40 to the treatment chamber
24. The grain size of the transferred material is controlled by the fluidizing ve-
locity. This will be continued until there is a desired amount of cooled bed ma-
terial in the treatment chamber. At the latest, at this stage, the feed of the flui-
dizing gas is started by means of the means 26 for supplying fluidizing gas to
the lower portion of the treatment chamber 24. Simultaneously heat is recov-
ered from the bed material removed from the reaction chamber by means of
heat exchanger system 34 and the bed material is cooled. When the tempera-
ture of the bed material has decreased to the pre-determined temperature,
cooled bed material batch is removed through the discharge connection 32.

[0038] The above described adjustability of the bed material flowing into the
treatment chamber, thus, enables the operation of the cooler in a so called
batch mode, in which there is no continuous inlet of the bed material, but the
inlet and discharge alternate. Thus, the obtained temperature of the exiting bed
material can be lower than in the continuous operation mode.

[0039] Fig. 2 discloses a partial section ll-ll of Fig. 1, which illustrates a detail of
an embodiment in accordance with a preferred embodiment. The Figure illu-
strates a wall of a reaction chamber 12 and a feeding arrangement 36 of the
treatment system 20 in connection therewith. The feeding arrangement 36 of
the bed material opens through at least two, here through three different inlet
openings 38, 38', 38" to the fluidized bed reactor 10. Each inlet opening is arranged to a controlled reception of bed material from the reaction chamber 12 in such a manner that the operation thereof is independent from the fluidization of the reaction chamber. The inlet opening 38 operates as flow path to the inlet channel 42, which further leads through the inlet opening 40 at the upper end thereof to the treatment chamber 24. As for the flow of the bed material it is advantageous that the grid structure 30.1 of the treatment chamber of the treatment system is at the lower level than the grid structure 11.2 of the reaction chamber 12 of the fluidized bed reactor 10.

[0040] Fig. 2 illustrates three different inlet openings 38, 38', 38" and they are located at different levels in regard to the grid 11.2 of the reaction chamber. The lowermost thereof is substantially at the level of the grid 11.2 of the reaction chamber. The horizontal distance of the inlet openings from each other is preferably such that the independent operation of each inlet opening is possible especially as for the supply 44 of the fluidizing gas. The inlet openings 38, 38', 38" may be different from their surface areas depending, for example, on the vertical location of the portion to be removed in the fluidized bed of the reaction chamber.

[0041] It is elementary that at least two different inlet openings are at different heights in relation to the grid 11.1. Also then, it is possible to control the mass flow of the bed material flowing from the reaction chamber to the treatment chamber by fluidization. Further it is advantageous that each inlet opening comprises fluidizing means 44 for the control of the flow of the bed material from the fluidized bed reactor to the treatment chamber, which means 44 can be individually controlled. There, by conducting fluidizing gas in a different manner to connection with inlet openings at different heights, it is possible to efficiently control the grain size of the material flowing in the cooler. This is based on the fact the in the fluidized bed of the furnace, larger particles typically tend to flow lower, in other words closer to the surface of the grid 11.1.

[0042] The apparatus illustrated in Figs. 1 and 2 is used in such a way that bed material is transferred to a treatment system 20 in connection with the fluidized
bed reactor, in which it is fluidized by supplying fluidizing gas 26 to the lower portion of the treatment chamber. As mentioned above, the fluidizing gas is non-oxygenous gas. A slow fluidized bed is maintained in the treatment chamber, the upper surface of which is arranged above the heat exchanger system 34 and to which heat exchanger system heat is transferred from the bed material. Bed material is guided by a feeding arrangement opening to the treatment chamber and being in connection with the fluidized bed reactor from the fluidized bed reactor 20 from a location arranged at least at two different horizontal levels.

[0043] Thus, it is possible to efficiently control, for example, the grain size of the bed material to be removed.

[0044] It is also advantageous to adjust independently the transfer of the bed material at two locations guiding the flow of the bed material from the fluidized bed reactor to the treatment chamber. Substantially all bed material transferred to the treatment chamber 24 is finally removed from the treatment chamber cooled through the connection 32 of the bottom portion of the treatment chamber. This can be performed either in continuous or batch mode.

[0045] The feeding arrangement can comprise inlet openings the number of which deviates from the embodiment shown in the Figure. Some of them may also be at the same vertical distance from the grid 11.2. In some cases, more than one inlet opening and/or feed opening can be connected to the same inlet channel 42.

[0046] The medium used in the heat exchange arrangement 34 is preferably low temperature medium, for example, feed water or a separate water circuit, through which heat is transferred, for example, to combustion air. The pipe distribution of the heat exchanger is sparse enough to enable the easy access of coarser material to the bottom of the chamber, too.

[0047] The treatment system in accordance with the invention can also be applied in connection with an existing fluidized bed reactor, whereby it is also
possible to utilize the existing appropriate treatment chamber. Thereby, it is needed to form at least a feeding arrangement for the bed material to the wall between the treatment chamber and reaction chamber or in connection therewith in such a manner that the feeding arrangement opens through at least two different inlet openings 38, 38', 38" to different horizontal levels in the reaction chamber 12 of the fluidized bed reactor.

[0048] The treatment chamber is provided, if such do not yet exist, with means 26 for supplying fluidizing gas to the lower portion of the treatment chamber 24; a heat exchanger system 34 to the internal space formed by the treatment chamber; and a discharge connection 32 for the discharge gases of the treatment chamber. Otherwise, the treatment system will be formed as described above.

[0049] It must be noted that only some most preferred embodiments of the invention are described above. Thus, it is obvious that the invention is not limited to the above described embodiments, but it may be applied in many ways. The features disclosed in connection with different embodiments can also be used with other embodiments within the basic concept of the invention and/or it is possible to form different combinations of the features illustrated, if such is desired and is technically feasible.
Claims

1. A treatment system (20) for removing bed material of a fluidized bed reactor (10) from the fluidized bed reactor and for cooling the bed material removed, said treatment system (20) comprising a treatment chamber (24) in connection with the fluidized bed reactor, which treatment chamber (24) is provided with

- means (26) for supplying fluidizing gas to the lower portion of the treatment chamber (24) in order to fluidize bed material,

- a heat exchanger system (34) arranged in internal space formed by the treatment chamber,

- feeding arrangement (36) for bed material, opening on one hand to the treatment chamber and being on the other hand in connection with the fluidized bed reactor;

- a first discharge connection arranged in the bottom portion of the treatment chamber for removing cooled bed material from the treatment chamber; characterized in that the feeding arrangement (36) opens at least through two different inlet openings (38, 38', 38'') to different horizontal levels in the reaction chamber (12) of the fluidized bed reactor

2. Treatment system in accordance with claim 1 for removing bed material of a fluidized bed reactor from the fluidized bed reactor and cooling it, characterized in that in operational proximity of said at least two inlet openings there are means (44, 44', 44'') which are independent from fluidization of the fluidized bed reactor, for controlling the flow of the bed material from the fluidized bed reactor to the treatment chamber.

3. Treatment system in accordance with claim 1 or 2 for removing bed material of a fluidized bed reactor from the fluidized bed reactor and cooling it, characterized in that in operational proximity of said at least two inlet openings there are independently controllable means (44, 44', 44'') for controlling the flow of the bed material from the fluidized bed reactor to the treatment chamber.

4. Treatment system in accordance with claim 1 or 2 for removing bed material of a fluidized bed reactor from the fluidized bed reactor and cooling it, characterized in that a feeding arrangement (36) of the bed material is formed
of at least two separate feed channels, each provided with an inlet opening (38,38',38") and a feed opening (40).

5. Treatment system in accordance with claim 4 for removing bed material of a fluidized bed reactor from the fluidized bed reactor and cooling it, characterized in that all inlet openings open to the treatment chamber (24) substantially at the same horizontal level, which is above the heat exchanger system (34) of the treatment chamber.

6. Treatment system in accordance with claim 1 for removing bed material of a fluidized bed reactor from the fluidized bed reactor and cooling it, characterized in that at least one inlet opening (38) opens to the reaction chamber (12) substantially to the level of the grid (11.2) thereof.

7. Treatment system in accordance with any of the preceding claims for removing bed material of a fluidized bed reactor from the fluidized bed reactor and cooling it, characterized in that means (26) of the treatment chamber (24) for supplying fluidizing gas to the lower portion of the treatment chamber comprise a grid structure (30.1) vertically arranged to a level lower than the grid structure (11.2) of the fluidized bed reactor.

8. Treatment system in accordance with any of the claim 1 to 6 for removing bed material of a fluidized bed reactor from the fluidized bed reactor and cooling it, characterized in that the treatment chamber (24) is preferably provided with a wall portion (22) common with the reaction chamber (12).

9. A method of removing bed material of a fluidized bed reactor (10) from the fluidized bed reactor and cooling the bed material to be removed, in which method bed material is transferred to a treatment system (20) in connection with a fluidized bed reactor, in which the bed material to be treated is fluidized by supplying fluidizing gas (26) to the lower portion of the treatment chamber, heat is transferred from the bed material by means of a heat exchanger system (34), which is arranged in an internal space formed by a treatment chamber; guiding bed material from the fluidized bed reactor (20) by means of a feeding arrangement (36) in connection with a fluidized bed reactor and opening to the treatment chamber; and removing cooled bed material by
means of a first discharge connection (32) via a bottom portion of the treatment chamber (24) from the treatment chamber; characterized in that bed material is transferred to the treatment chamber (24) from the fluidized bed reactor at least at two locations arranged at different horizontal levels.

10. Method of removing bed material of a fluidized bed reactor (10) from the fluidized bed reactor and cooling the bed material of the fluidized bed reactor in accordance with claim 9, characterized in that the transfer of bed material at said two different locations is controlled independently guiding the flow of the bed material from the fluidized bed reactor to the treatment chamber.

11. Method of removing bed material of a fluidized bed reactor (10) from the fluidized bed reactor and cooling the bed material of the fluidized bed reactor in accordance with claim 10, characterized in that the transfer of the bed material at two different locations is controlled by locally affecting the fluidization of the bed material.

12. Method of removing bed material of a fluidized bed reactor (10) from the fluidized bed reactor and cooling the bed material of the fluidized bed reactor in accordance with claim 11, characterized in that the fluidization of the bed material is locally affected in such a way that the transfer of particles having grain size and/or weight less than a set value is allowed.

13. Method of removing bed material of a fluidized bed reactor (10) from the fluidized bed reactor and cooling the bed material of the fluidized bed reactor in accordance with any of the claims 10-12, characterized in that substantially all bed material in the treatment chamber (24) is cooled and removed through a connection (32) in the bottom portion of the treatment chamber from the treatment chamber.

14. Method of removing bed material of a fluidized bed reactor (10) from the fluidized bed reactor and cooling the bed material of the fluidized bed reactor in accordance with any of the claims 10-12, characterized in that bed material is transferred to the treatment chamber (24) to a level lower than the fluidized bed reactor.
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC: F23C, F27B, F22B, B01J, F28D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

FI, SE, NO, DK

Electronic database consulted during the international search (name of database and, where practicable, search terms used)

EPO-Internal, WPI

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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</thead>
<tbody>
<tr>
<td>Y</td>
<td>US 416781 9 A (WEAVER R et al.) 18 September 1979 (18.09.1979)</td>
<td>1-14</td>
</tr>
<tr>
<td>Y</td>
<td>US 3737283 A (NIKLES F) 05 June 1973 (05.06.1973)</td>
<td>1-14</td>
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Further documents are listed in the continuation of Box C.  

See patent family annex.

* Special categories of cited documents:
  "A" document defining the general state of the art which is not considered to be of particular relevance
  "E" earlier application or patent but published on or after the international filing date
  "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  "O" document referring to an oral disclosure, use, exhibition or other means of publication prior to the international filing date but later than the priority date claimed
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**Date of the actual completion of the international search**  
02 December 2011 (02.12.2011)

**Date of mailing of the international search report**  

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Int.Cl.

F23C 10/24 (2006.01)
F27B 15/09 (2006.01)
F22B 31/00 (2006.01)
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