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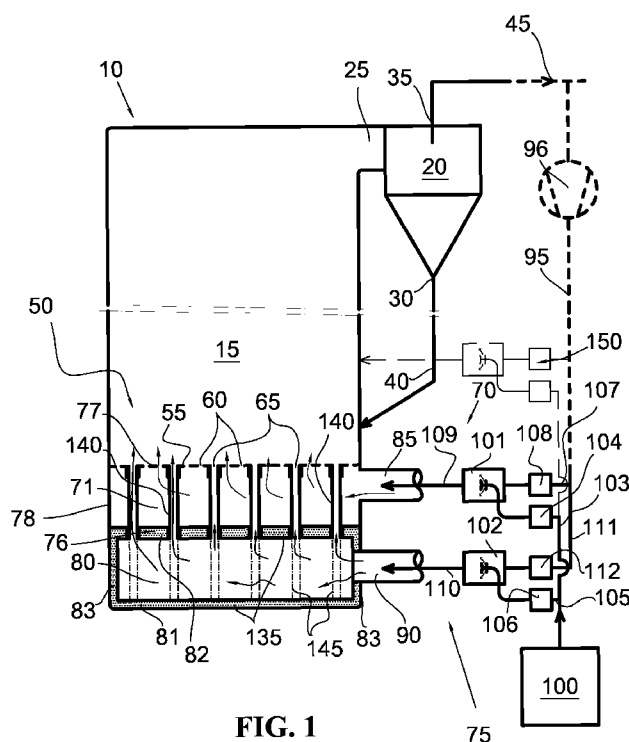
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(54) Title: OXYCOMBUSTION CIRCULATING FLUIDIZED BED REACTOR AND METHOD OF OPERATING SUCH A REACTOR



(57) Abstract: An oxycombustion circulating fluidized bed reactor comprising a reactor chamber (15) and a gas distribution arrangement (50) provided in the bottom section of the reactor chamber for introducing gas into the reactor chamber, which gas distributor arrangement comprises a first gas feeding system (70) and a second gas feeding system (75) for introducing oxygen-rich gas into the reactor chamber (15). The first gas feeding (70) system comprises a first wind box (71) and the second gas feeding system (75) comprises a second wind box (80) and that the first wind box has a common wall (77) with the reactor chamber and the second wind box arranged under the first wind box has a common wall (76) with the first wind box.

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**Oxycombustion Circulating Fluidized Bed Reactor
And
Method Of Operating Such A Reactor**

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Technical field

The present invention relates to oxycombustion fluidized bed reactors and their operation. The invention particularly relates to an oxycombustion circulating fluidized bed reactor comprising a reactor chamber and a gas distribution arrangement in the bottom section of the reactor chamber for introducing gas into the reactor chamber. Said gas distributor arrangement comprises a first gas feeding system for introducing recycled gas originating from the reactor chamber and a second gas feeding system for introducing oxygen-rich gas according to the preamble of claim 1. The invention also relates to a method of operating an oxycombustion circulating fluidized bed reactor comprising a reactor chamber and a gas distribution arrangement arranged in the bottom section of the reactor chamber, in which method gas is introduced into the reactor chamber through the gas distribution arrangement, the gas distributor arrangement further comprising a first gas feeding system through which recycled gas originating from the reactor chamber is introduced into the reactor chamber and a second gas feeding system through which oxygen-rich gas is introduced into the reactor chamber, according to the preamble of claim 10.

Background art

The development of new regulations and other demands limiting the gas emissions, e.g., relating to so called greenhouse effect has contributed to implementation of new technologies to decrease, e.g., carbon dioxide in the power stations using fossil carbonaceous fuels.

For example, US patent 6,505,567 discloses a circulating fluidized bed steam generator, in which the combustion is supported by recycled carbon dioxide, which

is a product gas of the combustion. The combustion is maintained by means of pure oxygen, which is introduced into the circulating fluidized bed steam generator. Introducing pure oxygen may create areas with a very high local temperature, which is not desired due to, e.g., the stresses caused to the constructional element close to those areas.

The introduction of oxygen into a circulating fluidized bed reactor is a particularly delicate process. Uneven distribution of oxygen may create local over heated spots, which are also prone to cause problems such as agglomeration of bed material. This is particularly the case when pure oxygen is in question.

WO 2005119126 discloses a fluidized bed device having a combustion chamber in which the bottom section is provided with first-type and second-type primary gas supply nozzles. Firstly, the first-type nozzles are provided for injecting a first gas mixture at a first level close to the base of the chamber by means of a conventional wind box and nozzles. Secondly, the second-type nozzles are provided for injecting a second gas mixture enriched in oxygen at a second level above the first level. According to WO 2005119126, said second-type nozzles comprise an arrangement for mixing oxygen with a second gaseous component within the nozzle, connected at the lower end thereof to an oxygen supply and to a supply of the second gaseous component. The second gaseous component is mentioned to be either the gas from the wind box or from separate gas collector.

In this kind of an arrangement in which the oxygen is mixed in the nozzle with the gas introduced from the wind box; the control of the oxygen ratio in the mixture is always dependent on the pressure prevailing in the wind box and the independent control is difficult, if not impossible.

In circulating fluidized bed reactors, the fluidization gas velocities vary considerably since also the variation of load requires respective changes in the gas amounts fed through a grid of the reactor. The operational range of the grid is determined, e.g., by the pressure drop, which should not be excessive during high loads and yet during low load operation, the pressure drop should be adequate to provide even distribution of gas flow over the cross sectional area of the grid. In practice, there is a certain minimum air flow which must be fed through the grid

also during low load operation, which in some cases may be the limiting factor of the lowest obtainable load from the reactor.

Particularly in oxycombustion circulating fluidized bed reactors, there is, in addition to variation of gas velocities due to load variations, also a question of a proper introduction of oxygen-rich gas into the process maintained in the oxycombustion circulating fluidized bed reactor.

US patent 4,628,831 discloses a grid for conveying gaseous fluidization fluid to a treatment chamber using fluidized bed. The grid comprises two separately supplied circuits of channels, a first circuit of channels with orifices widened towards the top, for providing a dense fluidized bed in the chamber, and a second circuit of tubular channels, opening out above the widened orifices, for providing a forced fluidized bed of particles in the chamber, respectively. This kind of a grid of two separate sets of nozzles and pipe networks is very complicated to manufacture.

An object of the invention is to provide an oxycombustion circulating fluidized bed reactor which provides an advanced solution for introducing both recycled gas and oxygen-rich gas into the oxycombustion circulating fluidized bed reactor.

Disclosure of the invention

Objects of the invention are met substantially as is disclosed in claims 1 and 10. The other claims present more details of different embodiments of the invention.

According to a preferred embodiment of the invention, an oxycombustion circulating fluidized bed reactor comprises a reactor chamber and a gas distribution arrangement provided in the bottom section of the reactor chamber for introducing gas into the reactor chamber, which gas distributor arrangement comprises a first gas feeding system and a second gas feeding system for introducing oxygen-rich gas into the reactor chamber. The first gas feeding system comprises a first wind box and the second gas feeding system comprises a second wind box. The first

wind box has a common wall with the reactor chamber and the second wind box arranged under the first wind box has a common wall with the first wind box.

The gas distribution arrangement is further in connection with a source of oxygen-rich gas. This arrangement allows an efficient and reliable operation of oxycom-
5 bustion circulated fluidized bed reactor having the oxygen content of the gas introduced into the reactor chamber at an elevated level, higher than the oxygen content of the air.

Advantageously the second, lower wind box has its inner walls lined with material withstanding the conditions resulted by the elevated oxygen content in the gas
10 therein.

The second wind box is in connection with the reactor via a plurality of conduits extending from the second wind box through the first wind box into the reactor chamber. This provides the feature of the gas in the second wind box possibly being maintained at lower temperature than the gas in the first wind box. Prefera-
15 bly, the conduits are removably arranged in the first wind box.

The reactor chamber is provided with a particle separator for separating fluidized particles which are entrained with the gases resulted in the reactions taken place in the reaction chamber, and the particle separator is provided with a gas outlet and an outlet for separated particles. The gas outlet is arranged in flow communi-
20 cation with the first wind box and the second wind box via a recycling conduit.

The recycling conduit is advantageously in connection with a first mixing element in the first gas feeding system through a conduit provided with a first flow control device and with a second mixing element in the second gas feeding system through a conduit provided with a second flow control device. This way the flow
25 rate of recycled gas into both of the first and second gas feeding system may be independently controlled.

The source of oxygen-rich gas is in connection with the first mixing element through a conduit provided with a third control valve and with a second mixing element through a conduit provided with a fourth control valve. This way the flow

rate of oxygen-rich gas into both of the first and second gas feeding system may be independently controlled and the method according to the invention may be practiced.

According to the invention, in a method of operating an oxycombustion circulating fluidized bed reactor, which comprises a reactor chamber and a gas distribution arrangement provided in the bottom section of the reactor chamber, gas is introduced into the reactor chamber through the gas distribution arrangement, the gas distributor arrangement further comprising a first gas feeding system and a second gas feeding system through which gas is introduced into the reactor chamber. Gas in is introduced into the reactor chamber through a first wind box of the first gas feeding system, and through a second wind box of the second gas feeding system in a manner that the oxygen-rich gas introduced through a second wind box is introduced through a plurality of conduits extending through the first wind box into the reactor chamber.

According to preferred embodiment of the invention the gas introduced into the reactor chamber contains recycled gas, which recycled gas is divided into streams comprising a stream which is controllably introduced into the first gas feeding system and a stream which is controllably introduced into the second gas feeding system. Oxygen-rich gas is introduced into the stream of recycled gas in the first gas feeding system so that the oxygen content of the gas in the first gas feeding system is less than or equal to a first oxygen content, and that oxygen-rich gas is introduced into the stream of recycled gas in the second gas feeding system so that the oxygen content of the gas in the second gas feeding system is more than or equal to the first oxygen content.

Preferably, the first oxygen content is adjusted such that a risk of self ignition, that is, ignition without external ignition, of any combustible material present in the gas distributor arrangement is minimized.

The oxygen content is controlled according to an embodiment of the invention by maintaining the O_2 concentration of the CO_2 - H_2O - O_2 gas mixture so low (typically $< 28\%$) that the adiabatic combustion temperature of the combustible material is lower than or equal to that of combustion with air.

The oxygen-rich gas in the second gas feeding system is fed to the second wind box and is subjected to heat flow from the reactor chamber which heat flow is decreased by warming up the gas in the first wind box. This way the oxygen-rich gas in the second wind box may be maintained easily at a lower temperature than the gas in the first wind box. Preferably, the oxygen-rich gas in the second wind box is introduced via a plurality of pipes extending through the first wind box into the reactor chamber being simultaneously heated by the gas in the first wind box.

Brief Description of Drawing

10 In the following, the invention will be described with reference to the accompanying schematic drawing, in which Figure 1 illustrates an oxycombustion circulating fluidized bed reactor provided with a gas distributor arrangement according to an embodiment of the invention.

15 Detailed Description of Drawing

Figure 1 schematically shows an oxycombustion circulating fluidized bed reactor 10, which comprises a reactor chamber 15 and a particle separator 20 connected to the upper part of the reactor chamber 15 via a connection conduit 25. Particle separator 20 is provided with a particle outlet 30 and a gas outlet 35. The particle outlet 30 is connected to a particle return channel 40. The particle separator 20 is preferably of centrifugal separator type. The return channel may be provided, e.g., with a separate particle cooler or other particle handling system (not shown herein).

Exhaust gas, which in normal operation of combustion contains mostly CO₂ and H₂O, is led further to the exhaust gas conduit 45 via the gas outlet 35. The exhaust gas conduit is shown here with a dotted line illustrating the fact that the exhaust gas is subjected to certain treatment processes, such as heat recovery process, provided in connection with the exhaust gas conduit 45, but not shown here for clarity reasons.

The bottom section of the reactor chamber 15 is provided with a gas distribution arrangement 50, which comprises a grid 55 through which fluidization gas and oxygen containing gas are introduced into the reactor chamber 15. Regardless of the contents of the gas all the gas introduced through the grid 55 participates to the fluidization of the bed material. The reactor chamber 15 is bordered by the grid 55 at its lower end. The grid is provided with two sets of openings 60, 65 which are in connection with a first gas feeding system 70 and a second gas feeding system 75, respectively, for introducing gas into the reactor chamber 15 in a manner to be described in the following. The openings are provided in practice with special nozzles which are not shown here for clarity reasons. The nozzles are distributed substantially evenly over the area of the grid.

The first gas feeding system 70 comprises a first wind box 71. The first wind box 71 is formed by its bottom wall 76, top wall 77 and side wall(s) 78. The number of sidewalls is determined by the cross sectional shape of first wind box; e.g. if circular, there is only one side wall encircling the wind box. The first feeding system 70 comprises additionally a first mixing element 101 through which the gas is arranged to flow into the first wind box 71.

The second gas feeding system 75 comprises a second wind box 80, which is respectively formed by its bottom wall 81, top wall 82 and side wall(s) 83. The second wind box 80 is arranged directly under the first wind box 71. The first wind box and the second wind box have a common wall with each other. The bottom wall 76 of the first wind box 71 and the top wall 82 of the second wind box are integrally attached to each other or they may be even formed of single common wall. In other words, the first wind box 71 is directly below the reactor 15 and the second wind box 80 is directly below the first wind box 71. The second feeding system 75 comprises a second mixing element 102 through which gas is arranged to flow into the second wind box 80.

Both of the first and the second wind boxes 71, 80 are provided with the gas inlets 85, 90 which open into the inner space of the wind box. The first 101 and the second 102 mixing elements are arranged in connection with the respective inlets, upstream thereof. The exhaust gas conduit 45 is provided with a recycling

conduit 95 provided with a blower device 96. The recycling conduit 95 is arranged for introducing product gas resulted from the reactions taken place in the reactor chamber 15 as recycled gas. In practice, during the normal operation of combustion the recycled product gas contains mostly CO₂ and H₂O.

- 5 The recycling conduit 95 is in connection with the first mixing element 101 through a conduit 107 and with the second mixing element 102 through a conduit 111. The conduits 107 and 111 are provided with first and second flow control devices 108 and 112, respectively.

The first and the second mixing elements are connected to the gas inlets 85, 90, respectively. In the mixing elements, the oxygen-rich gas is introduced into the stream of recycled gas with simultaneous mixing. The amount of recycled gas introduced into each wind-box is controlled by the first and the second flow control device 108, 102. The flow control devices may comprise, for example, a first and a second control valve. According to an embodiment of the invention, the flow control devices comprise dedicated inverter controlled blowers (not shown in the figure) provided in each of the conduits 107 and 111 in addition to or instead of a control valve. This provides an efficient way of controlling the amount of recycled gas introduced into the wind-boxes. Having a blower instead of a valve minimizes unnecessary pressure losses, because the blower 96 in the recycling conduit 95 needs not to produce as high pressure as in case of using valves.

This enables the operation of the oxycombustion circulating fluidized bed reactor in such a manner that the product gas of the reactions, which in case of combustion of carbonaceous fuel is taken place in the reactor is mainly CO₂ and H₂O, may be partly recycled back to the reactor 15 so that after a start-up phase, instead of air, the reactor may be operated with a mixture of the product gas and oxygen. This way the presence of nitrogen is avoided and recovery of CO₂ from the exhaust gases may be arranged easier.

The gas distribution arrangement 50 is also in connection with a source of oxygen-rich gas 100, like an Air Separation Unit (ASU). The source of oxygen-rich gas 100 is in connection with the first mixing element 101 through a conduit 103

provided with a third control valve 104 and with a second mixing element 102 through a conduit 105 provided with a fourth control valve 106.

The introduction of the gas into the reactor 15 through the first wind box 71 is arranged to take place in the following manner. The third control valve 104 for oxygen-rich gas and the control device 108 for recycled gas are operated so that the gas introduced through the first gas feeding system 70 has a lower oxygen content than a first oxygen content, which in practice is about 28 vol.-%, preferably 23 -28 vol.-%. The first oxygen content preferably is adjusted such that a risk of self ignition of any combustible material present in the gas distributor arrangement is minimized. This way the operation of the reactor is reliable and safe.

The introduction of the gas into the reactor 15 through the second wind box 80 is arranged to take place in the following manner. The fourth control valve 106 for oxygen-rich gas and the control device 112 for recycled gas are operated so that the gas introduced through the second gas feeding system 75 has an elevated oxygen content being more than the first oxygen content. Thus, the oxygen content of the gas in the second wind box is maintained substantially above the oxygen content of the air. Naturally, it is possible to adjust the oxygen content to be the same in both of the wind boxes, for example, when combustion with air is practiced, which is the case at least during the start-up phase.

The above-described arrangement makes it possible to introduce recycled gas with certain predetermined oxygen content into both of the wind boxes. The mixing elements 101, 102 ensure that the gas entering into the wind boxes has a substantially uniform composition. This minimizes the possibility of existence of high local oxygen concentrations, which may cause premature ignition of carbonaceous material in the wind box and also local, overheated areas in the reaction chamber.

The total flow rate of the gas introduced through both the first and the second gas inlets 85, 90 and nozzles 60 and 65 is regulated based on the load of the oxy-combustion circulating fluidized bed reactor and/or a predetermined requirement of the amount of fluidization gas flow rate. The amount of oxygen-rich gas introduced through the second gas inlet 90 and the nozzles 65 regulated based on

predetermined target value of oxygen content of the gas introduced into the reactor. In any case, it is preferable that the oxygen content of the gas introduced through the second wind box is greater than the oxygen content of the first wind box which is in connection with reactor chamber 15.

- 5 In case any combustible material would enter the second wind box having an elevated oxygen content, the risk of undesired ignition, despite of the higher oxygen content, is minimized by maintaining a lower temperature in the second wind box than in the first wind box.

10 The combination of introducing the oxygen-enriched recycled gas having an elevated oxygen content through the second wind box and arranging the second wind box to be separated from the reactor chamber 15 by the first wind box improves the safety of the circulating fluidized bed considerably. This is due to the fact that the temperature of the oxygen-rich gas in the second wind box, when in use, is maintained at a temperature lower than the temperature of the gas in the
15 first wind box.

According to a preferred embodiment of the invention, the second wind box 80 is connected to the reactor chamber 15 through a plurality of conduits 140 which extend through the first wind box 75. In the embodiment of Figure 1, the conduits are pipes. In the pipes 140, the oxygen-rich gas is heated by the recycled gas in
20 the first wind box 75. The oxygen-rich gas is introduced into the reactor chamber through a first wind box 71 of the first gas feeding system 70, and through a second wind box 80 of the second gas feeding system 75 in a manner that the oxygen-rich gas introduced through a second wind box 80 is introduced through a plurality of conduits 140 extending through the first wind box 71 into the reactor
25 chamber. This way the temperature of the oxygen-rich gas having elevated oxygen content may be maintained at a lower temperature in the second wind box and heated up just prior to introducing into the reactor chamber 15, which makes the operation reliable and safe.

According to an embodiment of the invention, the pipes 140 are removably installed between the bottom wall 76 and the top wall 77 of the first wind box 75,
30 which facilitates the removal of the pipes for accessing the space in the first wind

box 75 for maintenance and inspection purposes. In Figure 1, the pipes are movable to the space of the second wind box 80, which position is depicted by dotted lines 145. It is also conceivable that the pipes may be fastened with a compression spring arrangement (not shown), which facilitate a quick removal of the pipes
5 140 with basic tools.

In the method of operating an oxycombustion circulating fluidized bed reactor comprising a reactor chamber and a gas distribution arrangement arranged in the bottom section of the reactor chamber, gas is introduced into the reactor chamber
10 15 through the gas distribution arrangement 50. The gas distributor arrangement comprises a first gas feeding system and a second gas feeding system through which gas is introduced into the reactor chamber 15.

According to the invention, the gas introduced into the reactor chamber contains recycled gas. The recycled gas is divided into streams comprising a stream which
15 is controllably introduced into the first gas feeding system and a stream which is controllably introduced into the second gas feeding system.

Oxygen-rich gas is introduced into the stream of recycled gas in the first gas feeding system so that the oxygen content of the gas in the first gas feeding system is less than or equal to a first oxygen content. Additionally, oxygen-rich gas
20 is introduced into the stream of recycled gas in the second gas feeding system so that the oxygen content of the gas in the second gas feeding system is more than or equal to the first oxygen content, that is, at elevated oxygen content. The gas having an elevated oxygen content in the second wind box of the second gas feeding system is subjected to heat flow from the reactor chamber which heat
25 flow is decreased by warming the gas in the first wind box.

According to a preferred embodiment of the invention, the gas in the first wind box is maintained at a temperature of $<300\text{ }^{\circ}\text{C}$ and the gas in the second wind box is maintained at a temperature of $<200\text{ }^{\circ}\text{C}$. This way, despite of the presence of oxygen-rich gas, a reliable operation of the circulating fluidized bed is ensured
30 and the risk of self ignition of combustible material is minimized.

The surfaces of the second wind box are of fire proof material in the circumstances of elevated oxygen content gas, preferably non-flammable, prevailing in the second wind box. The arrangement may be further improved by providing base material, like carbon steel, of the first wind box with an oxidizing prevention layer. This protects the base material from the effects of the oxygen-rich gas and the temperature in the second wind box. The oxidizing prevention layer is according to an embodiment a lining 135 on the inner walls of the second wind box 80, the lining being of refractory material, for example, ceramic material. The base material, like carbon steel, may also be lined with austenitic steel of proper thickness. Protective liners and coatings of resistant alloys can also be used in conjunction with carbon steel or stainless steel.

The base material itself may be selected to withhold the circumstances caused by the presence of oxygen-rich gas. Thus, the prevention layer is according to another embodiment of the invention formed on the surface of the base material by the base material itself. For example, nickel or copper based super alloys may be successfully used. These alloys are oxidation and corrosion resistant materials and when heated a stable, passivating oxide layer is formed protecting the surface from further attack.

When operating the oxycombustion circulating fluidized bed reactor according to the invention in partial load circumstances, the present invention allows better controllability of the fluidization velocity due to the fact that the oxygen-rich gas is introduced independently on the introduction of the recycled gas. It is also clear that the described way of introducing gas into the reactor chamber may include further subsequent introduction of oxygen-rich gas for providing staged combustion as depicted with reference number 150.

While the invention has been described herein by way of examples in connection with what are, at present, considered to be the most preferred embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but is intended to cover various combinations or modifications of its features, and several other applications included within the scope of the invention, as defined in

the appended claims. The details mentioned in connection with any embodiment above may be used in another embodiment when technically feasible.

Claims

1. An oxycombustion circulating fluidized bed reactor, comprising a reactor chamber (15) and a gas distribution arrangement (50) provided in the bottom section of the reactor chamber for introducing gas into the reactor chamber, which
5 gas distributor arrangement comprises a first gas feeding system (70) and a second gas feeding system (75) for introducing oxygen-rich gas into the reactor chamber (15), **characterized** in that the first gas feeding (70) system comprises a first wind box (71) and the second gas feeding system (75) comprises a second wind box (80) and that the first wind box has a common wall (77) with the reactor
10 chamber and the second wind box arranged under the first wind box has a common wall (76) with the first wind box.
2. An oxycombustion circulating fluidized bed reactor according to claim 1, **characterized** in that the surfaces of the second wind box (80) are of fire proof material in the circumstances of elevated oxygen content gas, prevailing in the
15 second wind box (80).
3. An oxycombustion circulating fluidized bed reactor according to claim 1, **characterized** in that the second wind box (80) has its inner walls lined (135) with refractory material.
4. An oxycombustion circulating fluidized bed reactor according to claim 1,
20 **characterized** in that the second wind box (80) is in connection with the reactor via a plurality of conduits (140) extending from the second wind box (80) through the first wind box (71) into the reactor chamber (15).
5. An oxycombustion circulating fluidized bed reactor according to claim 3, **characterized** in that the conduits (140) are removably arranged.
- 25 6. An oxycombustion circulating fluidized bed reactor according to claim 1, **characterized** in that the reactor chamber is provided with a particle separator (20) for separating fluidized particles which are entrained with the gases resulted in the reactions taken place in the reaction chamber, and that the particle separator is provided with a gas outlet (35) and an outlet for separated particles (30),

and that the gas outlet is arranged in flow communication with the first wind box (71) and the second wind box (80) via a recycling conduit (95).

7. An oxycombustion circulating fluidized bed reactor according to claim 5, **characterized** in that the recycling conduit (95) is in connection with a first mixing element (101) in the first gas feeding (70) system through a conduit (107) provided with a first flow control device (108) and with the second mixing element (102) in the second gas feeding (75) system through a conduit (111) provided with a second flow control device (112).

8. An oxycombustion circulating fluidized bed reactor according to claim 5, **characterized** in that the gas distribution arrangement is in connection with a source of oxygen-rich gas (100).

9. An oxycombustion circulating fluidized bed reactor according to claim 7, **characterized** in that the source of oxygen-rich gas (100) is in connection with the first mixing element (101) through a conduit (103) provided with a third control valve (104) and with a second mixing element (102) through a conduit (105) provided with a fourth control valve (106).

10. A method of operating an oxycombustion circulating fluidized bed reactor comprising a reactor chamber (15) and a gas distribution arrangement (50) provided in the bottom section of the reactor chamber, in which method gas is introduced into the reactor chamber through the gas distribution arrangement (50), the gas distributor arrangement further comprising a first gas feeding system (70) and a second gas feeding system (75) through which gas is introduced into the reactor chamber (15), **characterized** in that the oxygen-rich gas is introduced into the reactor chamber through a first wind box (71) of the first gas feeding system (70), and through a second wind box (80) of the second gas feeding system (75) in a manner that the oxygen-rich gas introduced through a second wind box (80) is introduced through a plurality of conduits (140) extending through the first wind box (71) into the reactor chamber.

11. A method of operating an oxycombustion circulating fluidized bed reactor according to claim 10, **characterized** in that gas introduced into the reactor

chamber (15) contains recycled gas, which recycled gas is divided into streams comprising a stream which is controllably introduced into the first gas feeding system (70) and a stream which is controllably introduced into the second gas feeding system (75), and that oxygen-rich gas is introduced into the stream of recycled gas in the first gas feeding system (70) so that the oxygen content of the gas in the first gas feeding system (70) is less than or equal to a first oxygen content, and that oxygen-rich gas is introduced into the stream of recycled gas in the second gas feeding (75) system so that the oxygen content of the gas in the second gas feeding system is more than or equal to the first oxygen content.

12. A method of operating an oxycombustion circulating fluidized bed reactor according to claim 10, **characterized**, in that the first oxygen content is more than 23 vol-%.

13. A method of operating an oxycombustion circulating fluidized bed reactor according to claim 10, **characterized**, in that the oxygen content of the gas in the first gas feeding system is less than the oxygen content of the gas in the second gas feeding system.

14. A method of operating an oxycombustion circulating fluidized bed reactor according to claim 10, **characterized**, in that the oxygen-rich gas in the second gas feeding system is fed to the second wind box (80) and is subjected to heat flow from the reactor chamber which heat flow is decreased by heating the gas in the first wind box (71).

15. A method of operating an oxycombustion circulating fluidized bed reactor according to claim 10, **characterized** in that the oxygen-rich gas in the second wind box (80) is introduced through a plurality of pipes (140) extending through the first wind box (71) into the reactor chamber being simultaneously heated by the gas in the first wind box (71).

16. A method of operating an oxycombustion circulating fluidized bed reactor according to claim 10, **characterized** in that the temperature of the oxygen-rich gas in the second wind box (80) is maintained lower than the temperature of gas in the first wind box (71).

17. A method of operating an oxycombustion circulating fluidized bed reactor according to claim 10, **characterized**, in that the first oxygen content is adjusted such that a risk of self ignition of any combustible material present in the gas distribution arrangement is minimized.

