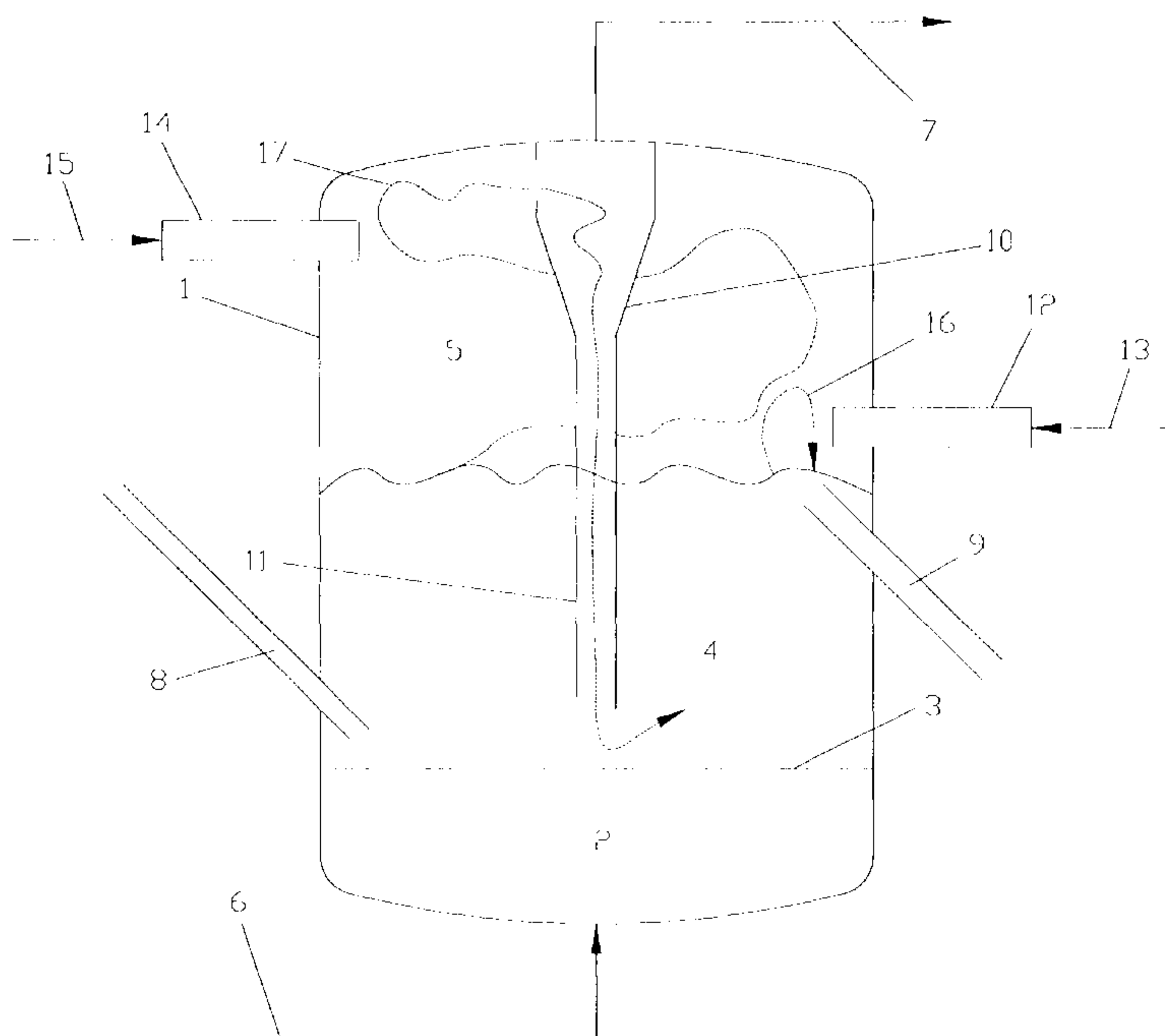




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(54) Titre : PROCEDE ET DISPOSITIF POUR TRAITER UNE CHARGE SOUS FORME DE FINES PARTICULES ET NOTAMMENT METALLIFERE
(54) Title: METHOD AND DEVICE FOR TREATING A FINE-PARTICLED FEEDSTOCK ESPECIALLY CONTAINING METAL



(57) **Abrégé/Abstract:**

The invention relates to a method for treating a fine-particled feedstock especially containing metal, wherein the feedstock and a treatment gas, especially a reduction gas, are introduced into a fluidized bed chamber (1), e.g. a fluidized bed reactor, in order to form a fluidized bed. The treatment gas is discharged from the fluidized bed after an at least partial reaction in the fluidized bed (4) and is subsequently partially utilized, preferably oxidated, outside the fluidized bed by means of an especially exothermic, chemical reaction with a reactive agent, preferably with a gaseous and/or liquid oxidizing agent. The thermal energy of said reaction is at least partially introduced into the fluidized bed chamber, especially into the fluidized bed or discharged therefrom. The invention also relates to a unit for operating a fluidized bed.



Abstract

The invention relates to a process for treating a finely particulate, in particular metal-containing charge material, the charge material and a treatment gas, in particular a reduction gas, being introduced into a fluidized-bed chamber 1, for example into a fluidized-bed reactor, in order to form a fluidized bed. In this process, the treatment gas, after at least partial reaction in the fluidized bed 4, is discharged from the fluidized bed and then, outside the fluidized bed, is at least partially reprocessed, preferably oxidized, by an, in particular, exothermic, chemical reaction with a reactant, preferably with a gaseous and/or liquid oxidizing agent, the thermal energy of this reaction being at least partially introduced into the fluidized-bed chamber, in particular into the fluidized bed, or being discharged therefrom. The invention also relates to a unit for operating a fluidized bed.

Process and apparatus for treating a finely particulate, in particular metal-containing, charge material

5 The invention relates to a process for treating a finely particulate, in particular metal-containing charge material, the charge material and a treatment gas, in particular a reduction gas, being introduced into a fluidized-bed chamber, for example into a
10 fluidized-bed reactor, in order to form a fluidized bed. The invention also relates to a unit for operating a fluidized bed, for example a fluidized-bed reactor.

The efficiency of a fluidized-bed process can be
15 controlled inter alia, by means of the composition of the treatment gas and by means of the temperature in the fluidized bed.

It is known from the prior art to set the temperature
20 of a treatment gas in a fluidized-bed process to a temperature level which is appropriate for the particular application by means of suitable measures, for example by admixing a cooling gas.

25 It is an object of the present invention to further develop a process in accordance with the preamble of claim 1 and an apparatus in accordance with the preamble of claim 10, making it possible to achieve a particularly efficient and therefore economical form of
30 the thermal influencing of a fluidized-bed process.

According to the invention, this object is achieved by the process according to the invention described in the characterizing clause of claim 1 and the apparatus
35 according to the invention described in the characterizing clause of claim 10.

The proposed process is particularly suitable for the treatment, in particular the reduction of a finely

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particulate metal oxide, in particular a finely
particulate iron oxide. However, the invention is not
restricted to this particular application, and
consequently all statements made in connection with the
5 reduction are to be considered purely as examples.

These specific statements also apply, with appropriate
modifications which it will be possible for the person
skilled in the art to perform, to all other, in
10 particular equivalent industrial treatments in which a
fluidized-bed process is employed. By way of example,
the invention may also be employed in the cement
industry.

15 According to a particular embodiment of the process
according to the invention, the fluidized bed forms in
a partial section, in particular in a lower partial
section, of the fluidized-bed chamber, and/or the at
least partially reacted treatment gas is reprocessed
20 within the fluidized-bed chamber, preferably above the
fluidized bed, and/or the at least partially
reprocessed treatment gas is discharged from the
fluidized-bed chamber, preferably above the fluidized
bed.

25 According to a particular embodiment of the process
according to the invention, a device for reprocessing
the treatment gas which has at least partially reacted
in the fluidized bed, for example an oxygen burner
30 and/or a oxygen nozzle, is operated in the fluidized-
bed chamber above the fluidized bed, with thermal
energy being generated or consumed during the at least
partial reprocessing, in particular during an, if
appropriate exothermic, oxidation, of the treatment
35 gas.

According to a preferred embodiment of the process
according to the invention, the thermal energy is

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generated or consumed above the fluidized bed in the fluidized-bed chamber.

According to a preferred embodiment of the process according to the invention, thermal energy which is generated or consumed above the fluidized bed is introduced into the fluidized-bed chamber above the fluidized bed or removed from the fluidized-bed chamber above the fluidized bed.

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According to a preferred embodiment of the process according to the invention, an oxidizing agent, for example oxygen and/or air, is introduced directly into the fluidized-bed chamber above the fluidized bed, if appropriate via the device for reprocessing the treatment gas which is arranged above the fluidized bed in the fluidized-bed chamber, for the purpose of reprocessing the treatment gas.

20 According to a preferred embodiment of the process according to the invention, the at least partially reacted treatment gas, in particular reduction gas, is at least partially burnt, in particular, at least partially oxidized, in the fluidized-bed chamber above the fluidized bed, if appropriate by the device for reprocessing the treatment gas which is arranged above the fluidized bed in the fluidized-bed chamber.

A combustion represents, for example, a chemical reaction in order to obtain thermal energy, for example an exothermic oxidation.

According to a preferred embodiment of the process according to the invention, finely particulate charge material which emerges from the fluidized bed and is in particular at least at times located above the fluidized bed is at least partially heated and/or cooled, if appropriate by the treatment gas, which is

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guided above the fluidized bed in the fluidized-bed chamber and has been at least partially reprocessed, in particular burnt and/or oxidized and/or heated, and/or by the device for reprocessing the treatment gas
5 itself.

According to a particular embodiment of the process according to the invention, a cyclone is arranged in the fluidized-bed chamber above the fluidized bed, the
10 finely particulate charge material being heated or cooled in the region of the cyclone, in particular of the cyclone inlet, by the treatment gas, which is guided above the fluidized bed in the fluidized-bed chamber and has been at least partially reprocessed, in
15 particular oxidized and/or heated, and/or by the device for reprocessing the treatment gas itself.

According to a particular embodiment of the process according to the invention, the finely particulate
20 charge material, which is situated above the fluidized bed and has been heated or cooled, is at least partially introduced into the fluidized bed, in particular recycled.

25 Furthermore, the invention is characterized by an apparatus as described in claim 10, preferably for carrying out the process as claimed in one or more of claims 1 to 9.

30 According to a preferred embodiment of the apparatus according to the invention, the device for reprocessing the treatment gas which is arranged in the fluidized-bed chamber above the fluidized bed is designed to introduce a liquid and/or solid combustion agent,
35 preferably an oxidizing agent and/or an oxygen carrier, particularly preferably oxygen and/or air, into the fluidized-bed chamber.

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According to a preferred embodiment of the apparatus according to the invention, the device for reprocessing the treatment gas which is arranged above the fluidized bed in the fluidized-bed chamber is arranged in the
5 region of the splash zone, so that the finely particulate charge material which is present in the region of the splash zone can be at least partially heated and/or cooled by the device itself and/or by the at least partially reprocessed, in particular oxidized
10 and/or heated, treatment gas.

In this context, the splash zone characterizes that part of the free space above the fluidized bed in which fine and solid particles are thrown up and then at
15 least partially dropped back into the fluidized bed.

According to a particular embodiment of the apparatus according to the invention, the unit has a cyclone which is arranged above the fluidized bed in the
20 fluidized-bed chamber, a dipleg which extends into the fluidized bed adjoining the cyclone outlet if appropriate, and, furthermore, the device for reprocessing the treatment gas which is arranged above the fluidized bed in the fluidized-bed chamber being
25 arranged at the level of the cyclone, in particular the cyclone inlet, and it being possible for the finely particulate charge material, in the region of the cyclone, in particular of the cyclone inlet, to be at least partially heated or cooled by the device itself
30 and/or by the at least partially reprocessed, in particular oxidized, heated treatment gas.

According to a particular embodiment of the invention, a dipleg represents a device for returning material
35 which has been separated out in a cyclone into a fluidized bed.

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In various fluidized-bed reduction processes, the charge ore is heated and reduced in countercurrent in 3 to 4 fluidized-bed reactors. In this application, the temperature profile is set by means of the heat content
5 of the reduction gas and the heats of reaction.

Therefore, the thermal budget process management of a corresponding process can be altered only within narrow limits.

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The prior art has disclosed external preheating of the reduction gas, but this has proven uneconomical. The partial combustion of reduction gas upstream of the fluidized bed has an adverse effect on the reduction
15 potential of the reduction gas and therefore on the reduction work which can be achieved.

Extensive tests relating to the use of burners, in particular of oxygen burners, in fluidized-bed units
20 have shown that slag formations which destabilize the fluidized-bed process generally occur in the region of the flame on account of the high particle concentration in the fluidized-bed unit. Moreover, in this region reliable flame monitoring and ignition assistance are
25 very difficult to realize.

The present invention optimizes the energy budget, in particular the introduction of energy.

30 According to the process according to the invention, in a particular embodiment of the invention, at least one oxygen burner is arranged above the fluidized bed in order to increase the fluidized-bed temperature. Compared to conventional burners, the oxygen burner
35 according to the invention is distinguished by the fact that the combustion, in particular the oxidation, of the treatment gas, in particular of the reduction gas, takes place upstream of the oxygen burner, as early as

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in the fluidized-bed chamber. In its most simple embodiment, the oxygen burner represents a nozzle for feeding an oxygen carrier into the fluidized-bed chamber.

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According to a particular embodiment of the process according to the invention, the term oxygen carrier by definition encompasses all oxygen-containing substances and all substances which provide and/or release oxygen under the ambient conditions prevailing in the fluidized-bed chamber for at least partial oxidation of the treatment gas and/or of the finely particulate charge material, i.e. in particular pure oxygen and/or air.

15

According to a particular embodiment of the invention, as a result of the particles being thrown up out of the fluidized bed, the particles are heated in the free space above the fluidized bed by the oxygen burner and then dropped back into the fluidized bed.

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According to a particular embodiment of the invention, the particles or dust, which is heated further, are separated out at an optional cyclone and then returned to the fluidized bed again.

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Unlike with the concept of the gas heating upstream of the fluidized bed, according to a particular embodiment of the invention with the proposed arrangement, the reduction potential of the reduction gas only deteriorates downstream of the fluidized bed. This makes it possible to make use of the reduction potential of the gas at an elevated bed temperature. A high gas temperature when the working gas enters the reactor is prevented. This counteracts the known problems of caking occurring at the distributor bases.

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Furthermore, the risk of slag formation (caking) occurring in the region of the fluidized bed or the fluidized-bed chamber is reduced by the lower particle concentration in the region of the flame.

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The following particular advantages can be realized by the subject matter of the invention:

- 10 • efficient and simple flame monitoring and ignition assistance
- 15 • better and more uniform treatment, in particular reduction, on account of the increase in the fluidized-bed temperature while maintaining an approximately constant quality of treatment gas
- efficient and simple influencing of the temperature profile of the fluidized bed
- 20 • longer service lives of the distributor base
- higher productivity resulting from improved efficiency of the fluidized-bed process.

25 The proposed invention has proven particularly efficient when it is employed in a process with a plurality of fluidized beds operated in parallel and/or in series, since in this case the individual fluidized beds can be particularly flexible matched to one
30 another in terms of the temperatures employed.

 According to a particular embodiment of the invention, it is possible for the fluidized-bed reaction, for example the reduction of the fine metal oxide, to be
35 carried out in the fluidized bed prior to the further reprocessing of the treatment gas, for example partial combustion, yet nevertheless to control the temperature in the fluidized bed, in particular by means of

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recycled particles, preferably of the finely particulate charge material.

According to particular embodiments of the invention,
5 the recycling is effected on the one hand by cyclone recycling, for example via a dipleg, and/or on the other hand by the particles which have been thrown out of the fluidized bed dropping back into it. According to these embodiments, heating of the fluidized bed is
10 achieved without the treatment gas being influenced before or during the reaction in the fluidized bed.

The invention is explained below, in accordance with a particular, non-limiting embodiment, on the basis of a
15 diagrammatic drawing, in which:

Fig. 1 shows a process for treating a finely particulate, in particular metal-containing, charge material

20 Fig. 1 shows a unit 1 for operating a fluidized bed, for example a fluidized-bed reactor, which has a wind chamber 2 and a fluidized-bed chamber for holding a fluidized bed 4 and a free space 5. Furthermore, the unit 1 has a distributor base 3 for distributing the
25 treatment gas 6, in particular a reduction gas.

A finely particulate charge material, in particular iron oxide, is fed to the unit 1 via a line 8, and is removed again, in at least partially treated form, via
30 a line 9.

In the unit 1 there is a cyclone 10 and a dipleg 11, which is used to separate out the dust or fine charge material and recycle it into the fluidized bed 4. As is
35 known to the person skilled in the art, the fluidized bed 4 behaves similarly to a boiling liquid and is delimited at the top by a defined, albeit blurred, surface which is diagrammatically depicted in the

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figure. Immediately above this blurred boundary is what is known as the splash zone, which is distinguished by the occurrence of fine particles therein, which are thrown up out of the fluidized bed and then dropped
5 back into it.

In the fluidized-bed chamber there is an oxygen burner 12 for feeding oxygen 11 into the fluidized-bed chamber above the fluidized bed 4. According to a particular
10 embodiment, the oxygen burner itself is located in the splash zone (as illustrated in Fig. 1) or at any rate is used to introduce heat directly into the splash zone. A particle 16 is heated by the oxygen burner 12 in the splash zone before dropping back into the
15 fluidized bed, thereby making a contribution to the heating of the latter.

According to a further embodiment of the invention, a burner 14 for supplying an oxygen carrier 15 is
20 provided in the region of the cyclone 10, in particular of the cyclone inlet.

In this way, treatment gas is burned in the fluidized-bed chamber and heat is generated above the fluidized
25 bed 4, this heat being used directly to heat the fluidized bed 4 (or to heat it through), for example by means of the solid particles which have been separated out in the cyclone 10 through the dipleg 11.

30 By way of example the arrow 17 sketches the path of a fine solid particle out of the fluidized bed 4 via the splash zone into the free space 5, this particle being correspondingly heated by the oxygen burner 14 and then recycled into the fluidized bed 4 via the cyclone 10
35 and the dipleg 11.

The at least partially reacted treatment gas is discharged again via a line 7.

Patent claims:

1. A process for treating a finely particulate, in particular metal-containing charge material, the charge material and a treatment gas, in particular a reduction gas, being introduced into a fluidized-bed chamber, for example into a fluidized-bed reactor, in order to form a fluidized bed, a cyclone being arranged in the fluidized-bed chamber above the fluidized bed characterized in that the treatment gas, after at least partial reaction in the fluidized bed, is discharged from the fluidized bed and then, outside the fluidized bed, is at least partially reprocessed, preferably oxidized, by an, in particular, exothermic, chemical reaction with a reactant, preferably with a gaseous and/or liquid oxidizing agent, a device for reprocessing the treatment gas which has at least partially reacted in the fluidized bed, for example an oxygen burner and/or oxygen nozzle, being operated in the fluidized-bed chamber above the fluidized bed, and the thermal energy of the chemical reaction being at least partially introduced into the fluidized-bed chamber, in particular into the fluidized bed, or being discharged therefrom, the finely particulate charge material being heated or cooled in the region of the cyclone, in particular of the cyclone inlet, by the treatment gas, which is guided above the fluidized bed in the fluidized-bed chamber and has been at least partially preprocessed, in particular heated or cooled, and/or by the device for reprocessing the treatment gas itself.
2. The process as claimed in claim 1, characterized in that the fluidized bed forms in a partial section, in particular in a lower partial section,

of the fluidized-bed chamber, and the at least partially reacted treatment gas is reprocessed within the fluidized-bed chamber, preferably above the fluidized bed, and the at least partially reprocessed treatment gas is discharged from the fluidized-bed chamber, preferably above the fluidized bed.

3. The process as claimed in one or more of claims 1 or 2, characterized in that the thermal energy is generated or consumed above the fluidized bed in the fluidized-bed chamber.

4. The process as claimed in one or more of claims 1 to 3, characterized in that an oxidizing agent, for example oxygen and/or air, is introduced directly into the fluidized-bed chamber above the fluidized bed, if appropriate via the device for reprocessing the treatment gas which is arranged above the fluidized bed in the fluidized-bed chamber, for the purpose of reprocessing the treatment gas.

5. The process as claimed in one or more of claims 1 to 4, characterized in that the at least partially reacted treatment gas, in particular reduction gas, is at least partially burnt, in particular at least partially oxidized, in the fluidized-bed chamber above the fluidized bed, if appropriate by the device for reprocessing the treatment gas which is arranged above the fluidized bed in the fluidized-bed chamber.

6. The process as claimed in one or more of claims 1 to 5, characterized in that finely particulate charge material which emerges from the fluidized bed and is at least at times located above the fluidized bed, is heated or cooled, if appropriate

by the treatment gas, which is guided above the fluidized bed in the fluidized-bed chamber and has been at least partially reprocessed, and/or by the device for reprocessing the treatment gas itself.

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7. The process according to claim 5 or 6, characterized in that the finely particulate charge material, which is situated above the fluidized bed and has been heated or cooled, is at least partially introduced into the fluidized bed.
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8. A unit for operating a fluidized bed, for example for reduction of a finely particulate iron oxide, which has
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- if appropriate a distributor base (3) for distributing a treatment gas, in particular a reduction gas, and
 - a line (8) for supplying a finely particulate, in particular fluidizable, charge material, in particular a finely particulate metal oxide, and

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 - a line (9) for discharging the treated charge material, and
 - a line (6) for introducing the treatment gas, and

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 - a line (7) for discharging the treatment gas, and
 - a fluidized-bed chamber (1) for holding the fluidized bed (4), and
 - a cyclone (10), which is arranged above the fluidized bed (4) in the fluidized-bed chamber (1), a dipleg (11) which extends into the fluidized bed (1) adjoining the cyclone outlet if appropriate,

30
- characterized in that, in the fluidized-bed chamber above the fluidized bed (4), there is a device (12) for reprocessing the at least partially reacted treatment gas of the fluidized bed, via which device thermal energy can be
- 35

introduced to or discharged from the fluidized bed (4), the device for reprocessing the treatment gas which is arranged above the fluidized bed (4) in the fluidized-bed chamber (1) being arranged at the level of the cyclone (10), in particular of the cyclone inlet, and it being possible for the finely particulate charge material, in the region of the cyclone (10), in particular of the cyclone inlet, to be heated or cooled by the device (12) itself and/or by the at least partially reprocessed, in particular oxidized, treatment gas.

9. The unit as claimed in claim 8, characterized in that the device for reprocessing the treatment gas which is arranged in the fluidized-bed chamber (1) above the fluidized bed is designed to introduce a liquid and/or solid oxidizing agent, preferably an oxygen carrier, particularly preferably oxygen and/or air, into the fluidized-bed chamber.

10. The unit as claimed in claim 8 or 9, characterized in that the device for reprocessing the treatment gas which is arranged above the fluidized bed in the fluidized-bed chamber is arranged in the region of the splash zone of the fluidized bed, so that the finely particulate charge material which is present in the region of the splash zone can be heated or cooled by the device itself and/or by the at least partially reprocessed, in particular oxidized, treatment gas.

1/1

Fig. 1

