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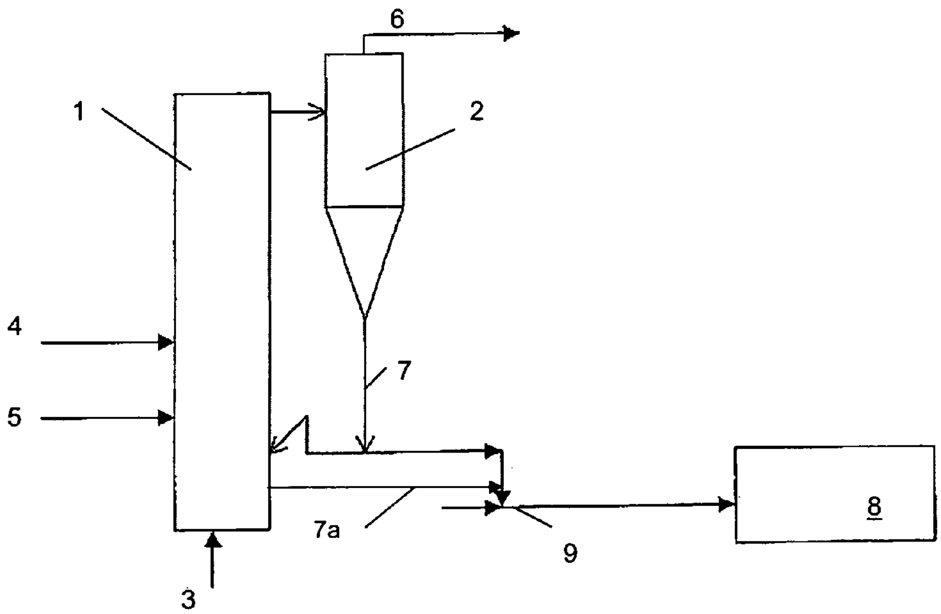
Fig. 1



(57) Abstract: The present invention relates to a process and a plant for producing char and fuel gas. In a fluidized bed reactor (1) carbonaceous material like coal is degasified with oxygen containing gasses in the presence of steam. More than 60 % of the fixed carbon in the carbonaceous material is recovered in the produced char.

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PROCESS AND PLANT FOR PRODUCING CHAR AND FUEL GAS

Technical Field

The present invention refers to a process for producing char and fuel gas in which carbonaceous material like coal is degasified with oxygen containing gases in a fluidized bed reactor with a circulating fluidized bed in the presence of steam at a temperature of more than about 1000°C and at a pressure of about 1 bar to about 40 bar, as well as to a corresponding plant.

From EP 0 062 363 A1 a process and a plant for producing fuel gas and process heat from carbonaceous materials is known. In this process coal or the like reacts with oxygen containing gases in the presence of steam in a fluidized bed reactor. The degasification is carried out at a pressure of up to 5 bar and at a temperature of 800°C to 1100°C. To maximize the amounts of fuel and heat which can be obtained from this process the parameters of the fluidized bed reactor are adjusted such that 40% to 80% of the carbon of the starting material is reacted in the fluidized bed reactor. A similar process is known from US 4,474,583 and JP 2003105351.

Many metallurgical processes like the smelting reduction of iron ores in a smelt reduction vessel (HIsmelt-SRV) or the reduction of ilmenite in a rotary kiln require carbonaceous material like coke breeze, char, anthracite or power station coal. However, the known processes in which a maximum amount of fuel and heat is produced are not appropriate to obtain enough char or the like for use in such metallurgical processes. Further, a low volatile content of the char is preferred as this leads to energy savings and to an increased production in the metallurgical processes.

Description of the invention

Therefore, it is an object of the present invention to provide a process and a plant for producing char and fuel gas optimizing the use of carbon for providing the necessary heat for the charring process and thus generating a maximum amount of char with the simultaneous generation of fuel gas.

In accordance with the present invention, this object is solved by a process which is characterized in that the supply of oxygen within the reactor is adjusted or regulated such that more than 60% of the fixed carbon in the carbonaceous material is recovered in the produced char. Thus, the invention combines the production of hot char and fuel gas in a way that only a minimal amount of carbon is used for providing the necessary heat for the charring process. Consequently, high caloric fuel gas is produced while simultaneously recovering most of the carbon in the solid product which may be used for further metallurgical processes. Char according to this invention is carbonaceous material, which is heat treated and contains mainly carbon and ash with some remaining low contents of mainly hydrogen and oxygen.

According to a preferred embodiment of the invention the supply of oxygen within the reactor is adjusted or regulated such that the oxygen availability in a lower or bottom region of the reactor is smaller compared with an upper region of the reactor. It is preferred that the supply of oxygen within the reactor is adjusted or regulated such that the oxygen availability in a lower or bottom region of the reactor is less than 50 %, preferably less than 80 %, of the oxygen availability in an upper region of the reactor. For example the oxygen availability in a lower or bottom region of the reactor may be less than 90 % of the oxygen availability in an upper region of the reactor. By doing this, the reactor is separated theoretically into two sections. The lower one is low in free oxygen supply and therefore less fixed carbon is combusted, resulting in a higher yield of carbon especially in the desired coarse particle product.

Most of the energy of the process is provided in the upper part of the reactor where volatiles and fine coal particles are combusted e.g. with injected oxygen in a zone with still high particle concentration and therefore good heat transfer, avoiding agglomeration of the particles, which occur quite easily in reactor systems where the combustion zone is diluted, like bubbling fluidized beds. In addition, the circulation of particles within the reactor ensures a good heat transfer, which is also critical in diluted free boards of conventional, stationary fluidized or fixed bed reactors.

As volatiles are not fixed carbon and fine particles would be lost with the offgas stream anyhow, the combusted carbon units do not effect the yield of fixed carbon significantly. However, by the means of separating the reactor and having a zone dedicated to the generation of energy, high yields of fixed carbon (>60%) can be achieved in a fluidized bed reactor even at high temperatures in the range of 1000°C and above, avoiding the generation of significant amounts of tars.

The yield of more than 60% of the fixed carbon, preferably more than 70 %, in the product may be achieved by using a circulating fluidized bed (CFB) reactor wherein gas or air with a content of oxygen of less than 5% is fed into a lower part and/or the bottom of the reactor as a fluidisation gas and wherein oxygen enriched gas or air with a content of oxygen of 50% to about 100%, preferably between 90% and 99%, especially with a content of oxygen of at least 95%, is fed into an upper part of the fluidized bed reactor as secondary gas.

According to a preferred embodiment of the invention the temperature of the reaction in the circulating fluidized bed of the fluidized bed reactor is between about 1000°C and about 1100°C. Although the temperature may be within a range of 950°C to 1150°C, in particular between 980°C and 1100°C, a temperature of the reaction of above 1000°C is preferred, preferably above 1050°C. The pressure of the reaction in the inventive process may be between 1 bar and 40 bar, preferably between 1,1 and 30 bar. However, it is preferred that the pressure in the fluidized bed reactor is above about 5 bar and below 20 bar.

In addition or as an alternative to the above, a mixture of steam and gas or air or mixtures of these gases are fed into the circulating fluidized bed of the fluidized bed reactor as primary fluidizing gas. Further, recycling gas may be used. The amount and ratio of feed gases and their contents of O_2 and other components may be adjusted.

The inventive process is adjusted such that in addition to char a high caloric fuel gas is produced. The fuel gas produced by degasification of carbonaceous material in the fluidized bed reactor has preferably a minimum heating value of 9 MJ/m^3 (STP). This fuel gas is preferably with low tar content.

To ensure the reuse of thermal energy and fuel gas within the inventive process a closed circuit gas flow system may be provided with the offgas of the fluidized bed reactor being fed to a waste heat boiler to produce steam and being introduced at least partially as fluidizing gas in the fluidized bed reactor. This amount may be controlled and adjusted. The gas leaving the waste heat boiler may be partly dedusted in a multiclone or any other type of dust removal system, e.g. a fabric or ceramic or metallic filter or an electrostatic precepitator, and fed to a process gas scrubber unit for further cleaning and cooling prior to reintroducing the fuel gas into the fluidized bed reactor. Furthermore, the contents of the circulation gas can be controlled by adding or removing components like H_2O, CO_2, O_2, pollutants and/or impurities. Prior to the use of fuel gas or recycle gas, it is also possible to reheat the gas, e. g. by heat transfer or partial combustion, and use energy of the process for reheating.

Advantageously, the solid produced in the fluidized bed reactor, i.e. hot char, is transferred into a plant like a smelting furnace or a rotary kiln at a temperature of more than about 750°C, preferably between 950°C and 1100°C. Thus, thermal energy of the hot char produced in the fluidized bed reactor may be reused in a further metallurgical process.

In a further preferred embodiment of the invention the produced hot char is transferred by a pneumatic injection and/or transport system to a plant for a metallurgical process like smelting reduction of iron or reduction of ilmenite. As an alternative, the hot char is not directly conveyed to the metallurgical plant but may be collected in an intermediate storage bin from where it is fed to smelting or reduction reactors or the like. Thus, the produced char may be stockpiled or filled into closed silo train bins for transport. It is also possible to use the char for any other convenient processes like as a supplement for sintering, pelletizing, electric winning of metals as well as for non metallurgical processes like power plants or the production of elemental phosphorus.

It is preferred that wet coal as carbonaceous feeding material is predried and crushed to a particle size of below 10 mm prior to feeding the coal into the fluidized bed reactor. The wet coal is fed from a stockpile with a transport system to a wet coal bin. This wet coal bin may have a storage capacity for 15 hours of operation. The received coal is crushed and simultaneously dried to remove surface moisture, preferably as far as possible. After that, the coal may be stored in a bin for dried coal and/or be transported continuously by a pneumatic conveying and dosing system in the fluidized bed reactor. As a carbonaceous feeding material anthracite and steaming coals having a moisture content reduced to lower than 5% and/or lignites and brown coals having a surface moisture content reduced below 17 % may be used. The water content of the pre-dried coal can be controlled according to the desired process needs. Effluent gas from the coal drying may be removed from the other gas and may be treated in a special plant, e.g. according to AU 2005 237 179, or reused in the process, e. g. as steam containing gas after heating for injection into the upper part of the reactor or as part of the fluidising gas and/or recycling gas. The pre-dried coal may be heated and a part of the volatile matter can be removed during this heating. This gas stream may be handled separately, too, e. g. as process gas or for combustion.

For the use in metallurgical processes a low volatile content of char is preferred as this leads to energy savings and to an increased production. Thus, according to a preferred embodiment of the invention the volatile content of the char produced in the fluidized bed reactor is below 10 wt.-%, preferably below 4 wt.-%.

A plant in accordance with the invention which is suited in particular for performing the above described process for producing char and fuel gas comprises a fluidized bed reactor, preferably with a circulating fluidized bed or an annular fluidised bed reactor like DE 102 60 734 with internal circulation, a further reactor for a further metallurgical process and a pneumatic injection and/or transportation system being provided between the fluidized bed reactor and the further reactor. The fluidized bed reactor is provided with an inlet for a primary fluidizing gas provided in a lower region of the reactor and connected to a supply of steam and gas or air or mixtures with these gases, an inlet for a secondary gas provided above said inlet for a primary fluidizing gas and connected to a supply of oxygen enriched gas or air or mixtures with these gases and an inlet for solids connected to a supply of dried and crushed coal or the like carbonaceous material. According to the present invention the inlet for a primary fluidizing gas is connected to the first supply of gas or air having an oxygen content which is smaller compared with the oxygen content of the second supply of oxygen enriched gas or air to which the inlet for a secondary gas is connected. This ensures that the lower region of the reactor is low in free oxygen and therefore less fixed carbon is combusted, resulting in a higher yield of carbon especially in the desired coarse particle product. In this case most of the energy of the process is provided in the upper part of the reactor where volatiles and fine coal particles are combusted e.g. with injected oxygen in a zone with still high particle concentration and therefore good heat transfer, avoiding agglomeration of the particles. It should be noted that according to the present invention the plant may be configured such that the char produced in the fluidized bed reactor may be stockpiled or filled into closed silo train bins for transport instead of or prior to transferring the hot char into a further reactor for a further metallurgical process.

In a preferred embodiment of the invention a cyclone and/or a multiclone are provided downstream of the fluidized bed reactor for separating char and dust from fuel gas with an outlet of the cyclone and/or the multiclone being connected to a conduit for feeding fuel gas as fluidizing gas into the fluidized bed reactor and/or into a fluidized bed cooler being provided downstream of the fluidized bed reactor. Alternatively any other dust removal system might be used, e.g. a fabric or ceramic filter or an electrostatic precipitator. Thus, a closed circuit gas flow system may be provided for recycling and reusing at least a part of the produced process gas for fluidization.

Advantageously the char is transferred into a further reactor for a further process, preferably a reactor for a metallurgical process, like a smelting furnace for a smelting reduction of iron or a rotary kiln for a reduction of ilmenite or an electric furnace for winning of metals. Prior to transferring the char into the further reactor, the char may be cooled down and/or mixed with dust in a fluidized bed reactor.

Another preferred option of cooling the char product is to combine the cooling of solids with a preheating of boiler feed water and the conveying to a desired plant height. For this preferably a process with an annular fluidized bed reactor system combined with a vertical pneumatic transport reactor like DE 102 60 738 is used. Preferably cooling bundles are inserted into the fluidized bed annual ring to transfer heat for an economizer of the waste heat boiler in the off gas train.

Developments, advantages and possibilities for applying the present invention may also be taken from the following description of embodiments and from the drawings. All described and/or illustrated features per se or in combination form the subject matter of the invention, independent of their inclusion in the claims or their back reference.

Brief description of the drawings

Fig. 1 shows a process diagram of a process and a plant in accordance with a first embodiment of the present invention and

Fig. 2 shows a process diagram of a process and a plant in accordance with a second embodiment of the present invention.

Detailed description of the preferred embodiments

The plant depicted in Fig. 1 comprises a fluidized bed reactor 1 having a circulating fluidized bed and a cyclone 2 which is provided downstream of the circulating fluidized bed reactor 1 (CFB reactor). A first inlet 3 for introducing a primary fluidizing gas, a second inlet 4 for introducing a secondary gas and a third inlet 5 for introducing solids are provided in the fluidized bed reactor 1. The first inlet 3 is connected to a supply of steam and gas or air or mixtures with these gases. The second inlet 4 is connected to a supply of oxygen enriched gas or air or mixtures with these gases. Thus, the oxygen availability is significantly higher in the upper region of the reactor 1 into which oxygen enriched gas or air is introduced via the second inlet 4 compared with the lower region of the reactor 1 in which the first inlet 3 is located. The third inlet 5 may be part of a pneumatic transportation system (not shown in Fig. 1) to feed dry coal or the like carbonaceous material into the fluidized bed reactor 1. Alternatively the coal could be introduced into the CFB reactor using a system of lock hopper and mechanical, volumetric conveying as e.g. rotary valves or screw conveyors.

Upstream of the fluidized bed reactor 1 there may be provided a stockpile from which coal is fed with a transport system to a wet coal bin which may have a storage capacity for 15 hours of operation. Further, a coal crushing and drying system may be provided in which the received coal is crushed to particle sizes below 10 mm and simultaneously dried to remove surface moisture as far as possible. The coal may be stored in a bin for dried coal prior to continuously introducing it via a pneumatic conveying and dosing system into the fluidized bed reactor 1.

To achieve uniform gas velocity along the entire height of the circulating fluidized bed reactor 1, the cross-section of the reactor is conically shaped at the bottom zone (not shown in Fig. 1). As depicted in Fig. 2, recycle gas may be introduced into the process as fluidization gas via a nozzle grid. Due to the high gas velocity the solids are entrained over the full height of the fluidized bed reactor 1 such that the suspended solids are in a constant motion. The solids either leave the reactor with the gas stream and are recycled via cyclone 2 (external circulation) or flow back on the reactor walls to be re-entrained in the fluidizing gas at the reactor bottom (internal circulation). This intense solids/gas mixing behaviour is characteristic for systems with a circulating fluidized bed and ensures excellent heat and mass transfer as well as an almost uniform temperature distribution over the fluidized bed reactor 1.

Fuel gas produced in the fluidized bed reactor 1 and solids entrained therewith are discharged into cyclone 2 for separating char and dust from the fuel gas which may be discharged via a conduit 6. A major part of the particles entrained in the gas leaving the fluidized bed reactor 1 are separated from the process gas in the recycle cyclone 2 and are returned via conduit 7 into the circulating fluidized bed via a seal pot forming the external circulation loop. Material from the seal pot as well as from the lower part of the fluidized bed reactor 1 via conduit 7a is discharged by means of water-cooled discharge devices at such a rate that a constant differential pressure is maintained over the reactor height, which is a measure for the reactor inventory.

Solids like char and dust discharged from cyclone 2 via conduit 7 or discharged from an outlet of the fluidized bed reactor 1 via conduit 7a may be fed into a further reactor 8 like a smelting furnace for smelting reduction of iron or a rotary kiln for reduction of ilmenite. Hot char and the like may be transferred from conduit 7 into reactor 8 via a pneumatic injection and transport system 9 indicated by arrows in Fig. 1.

Turning now to Fig. 2, the plant is provided with a fluidized bed reactor 1 and a cyclone 2 as described above.

Upstream of the fluidized bed reactor 1 there may be provided a wet coal storage bin, a coal crushing and drying system, a dried coal storage bin and/or a pneumatic transportation for dried coal (not shown in the drawings).

Hot char discharged from cyclone 2 via conduit 7 and/or from the fluidized bed reactor 1 is fed into a fluidized bed cooler 10. The char may then be introduced in a transmitting vessel 11 and/or transferred to a further reactor 8 via the injection and transport system 9 which is a hot conveying system.

The fluidized bed cooler 10 is moderately fluidized achieving low gas velocities, just enough to keep the solids in motion and to allow mixing of coarse and fine particles. By injection of water or control the temperature with other means (e. g. cooling bundles) the final temperature of the material is adjusted to cope with the maximum conveying temperature of 850°C. The offgas (fuel gas) leaving the fluidized bed cooler 10 may be injected into a process gas system prior to a process gas scrubber. A volatile content of lower than 3 wt.-% in the discharged char is assumed.

The fuel gas leaving cyclone 2 via conduit 6 is introduced at approximately 1000°C into a waste heat boiler 12 in which steam is produced by heating boiler feed water. After being cooled in the waste heat boiler 12 the fuel gas is at least partly dedusted in a multiclone 13 which is provided downstream of the waste heat boiler 12. The dust discharged from the multiclone 13 may be mixed with the char discharged from the circulating fluidized bed and transferred into the fluidized bed cooler 10 or into transmitting vessel 11.

The fuel gas leaving multiclone 13 at about 400°C may be subjected to further cleaning and/or cooling to approximately 30°C in a process gas scrubber unit (not shown). The energy of the produced fuel gas may be used e. g. to pre-dry and/or pre-heat the carbonaceous material and/or preheat other process materials. The process water from the scrubber is treated in a clarifier and a carbon rich sludge is produced. The clarifier overflow is recycled to the scrubber. The carbon rich sludge may be recycled to the coal crushing and drying plant or can be recycled directly into the process furnace, maybe after e. g. agglomeration or compaction.

In a closed circuit gas flow system the cleaned and cooled fuel gas may then be discharged via conduit 14 or at least partly reintroduced into the process via conduit 15. This amounts can be controlled and/or adjusted. As shown in Fig. 2, the fuel gas may be fed into fluidized bed cooler 10 as fluidizing gas and/or may be fed into fluidized bed reactor 1 as fluidizing gas. Prior to the use of the fuel gas or the recycle gas the contents of the gas may be controlled and/or adjusted by adding or removing components like steam, CO_2 or H_2S.

The plant may be operated under ambient pressure conditions or preferably at a pressure of above 5 bar. However, due to pressure losses and material load the resulting pressure will be higher. Thus, a recycle gas compressor recompressing the process gas flow may be provided to compensate for the pressure loss of the plant. The process water and machinery cooling water is cooled down in cooling towers and recycled back.

Example 1 (production of char and fuel gas)

In a plant as depicted in Fig. 2 char and fuel gas are produced using 385 t/h wet subbituminous coal as carbonaceous material which is crushed and dried to reduce the moisture content to 14 wt.-% and is then fed via inlet 5 into the circulating fluidized bed of fluidized bed reactor 1. The composition of the fed coal is as follows: 77 wt.-% (daf = dry and ash free) C; 4.1 wt.-% (daf) H; 16.91 wt.-% (daf) O; 0.65 wt.-% (daf) S; 1.34 wt.-% (daf) N and 9.1wt.-% ash. The volatile content is 35.3 wt.-% (d.b. = dry basis) and the fixed carbon contend is 55.6 wt.-% (d.b.).

The coal is partly combusted and gasified in the circulating fluidized bed using 62,000 Nm^3/h oxygen (95% O_2) and 5 t/h low pressure steam (900 kPag) which are fed into the reactor via inlets 4 as as secondary gas. The reactor is fluidized using 90,000 m^3/h (STP) of recycle gas with 39,3 % CO, 13,1 % CO_2, 37,6 % N_2, 1.4 % H_2O, 2.4 % CH_4, 0,4 % H_2S, 5.8 % N_2 which is introduced via inlets 3. The temperature in the circulating fluidized bed is greater than 1000°C and the pressure is 500 kPag.

The partial combustion and gasification of carbon is performed according to the following reaction:

$$2\,C + 1\ 1/2\ O_2 = CO + CO_2$$
$$C + H_2O = CO + H_2$$

A CO/CO_2 ratio of 2.90 is assumed for the process gas leaving the circulating fluidized bed reactor 1. 274,000 m³/h (STP) fuel gas with the following composition is produced: 12.7 vol.-% CO_2; 6.0 vol.-% N_2; 0 vol.-% O_2; 40.1 vol.-% CO; 38.6 vol.-% H_2 and 2.5 vol.-% CH_4; 0.1 vol.-% H_2O; 50 ppmv H_2S.

Further, 152 t/h of char with a carbon content of 80 wt.-% and 2 wt.-% volatiles (remaining ash) is produced. This solid product which consists of carbon and ash may be discharged either at the recycling line after the recycling cyclone 2 or from the bottom of the fluidized bed reactor 1. Generated dust which is too fine to be discharged in the recycling cyclone 2 is discharged in multiclone 13 with the char from the fluidized bed reactor 1 and the dust from the multiclone 13 being mixed in a fluidized bed reactor 10 which is also used to cool the products to a temperature of lower than 850°C. As an alternative, the multiclone dust stream may be combined with the cooled product from the fluidized bed cooler 10.

The fluidized bed reactor 10 uses cold recycling gas for fluidization and cooling. Further, water may be injected into fluidized bed reactor 10 for further cooling if appropriate. As an alternative, an indirect cooler may be used.

The product from the fluidized bed reactor 10 is transferred into an injection vessel 11 from where it is conveyed to a further reactor 8, for example a smelting reduction vessel using a hot conveying system. As an alternative, the product may be stockpiled or filled into closed silo train bins for transport.

The fuel gas leaving the cyclone 2 downstream of the fluidized bed reactor 1 is cooled in waste heat boiler 12 to a temperature below 450°C prior to entering the fuel gas into multiclone 13. Ultrafines, which have not been able to be discharged in the multiclone may be discharged as sludge from a venturi type scrubber (not shown). The sludge may then be transported to a clarifier. It is assumed that 10 wt.-% of the produced char is collected as sludge. In an integrated plant this sludge may be recycled via the coal drying and crushing unit (not shown) upstream of the fluidized bed reactor 1.

Further, the process gas (fuel gas) discharged from multiclone 13 may be further cooled down in a process gas cooler (not shown) and may then be delivered to a battery limit (not shown) for further use. A part of the process gas is recycled via conduit 15 and serves as fluidization gas for the circulating fluidized bed of fluidized bed reactor 1 and fluidized bed cooler 10. In addition, some amount of the process gas is used as fuel gas for the coal drying.

Reference numerals:

1	circulating fluidized bed reactor
2	cyclone
3	first inlet (gas)
4	second inlet (gas)
5	third inlet (solids)
6	conduit
7, 7a	conduits
8	further reactor
9	injection and transport system
10	fluidized bed cooler
11	vessel
12	waste heat boiler
13	multiclone
14	conduit
15	conduit

Claims:

1. A process for producing char and fuel gas in which carbonaceous material like coal is degasified with oxygen containing gases in a fluidized bed reactor (1) at a temperature of more than about 1000°C and at a pressure of about 1 bar to about 40 bar, **characterized in** that the supply of oxygen within the reactor is adjusted or regulated such that more than 60% of the fixed carbon in the carbonaceous material is recovered in the produced char.

2. The process as claimed in claim 1, **characterized in** that the supply of oxygen within the reactor is adjusted or regulated such that the oxygen availability in a lower or bottom region of the reactor (1) is smaller compared with an upper region of the reactor (1).

3. The process as claimed in claims 1 or 2, **characterized in** that the supply of oxygen within the reactor is adjusted or regulated such that the oxygen availability in a lower or bottom region of the reactor (1) is less than 50 %, preferably less than 80 %, of the oxygen availability in an upper region of the reactor (1).

4. The process as claimed in any of the preceding claims, **characterized in** that gas or air with a content of oxygen of less than 5% is fed into a lower part and/or the bottom of the reactor (1) as a fluidisation gas.

5. The process as claimed in any of the preceding claims, **characterized in** that oxygen enriched gas or air with a content of oxygen of 50% to about 100%, preferably between 90% and 99%, especially with a content of oxygen of at least 95%, is fed into an upper part of the fluidized bed reactor (1) as secondary gas.

6. The process as claimed in any of the preceding claims, **characterized in** that the temperature of the reaction in the fluidized bed reactor (1) is between about 1000°C and about 1100°C.

7. The process as claimed in any of the preceding claims, **characterized in** that the pressure of the reaction in the fluidized bed reactor (1) is above about 5 bar.

8. The process as claimed in any of the preceding claims, **characterized in** that a mixture of steam and gas or air is fed into the fluidized bed reactor (1) as primary fluidizing gas.

9. The process as claimed in any of the preceding claims, **characterized in** that fuel gas with a minimum heating value of 9 MJ/Nm^3 (STP) is produced by degasification of carbonaceous material in the fluidized bed reactor (1).

10. The process as claimed in any of the preceding claims, **characterized in** that at least a part of the produced fuel gas is recycled and reused as fluidizing gas in the fluidized bed reactor (1).

11. The process as claimed in any of the preceding claims, **characterized in** that the produced char is transferred into a plant (8) like a smelting furnace or a rotary kiln at a temperature of more than about 750°C, preferably between 950°C to 1100°C.

12. The process as claimed in any of the preceding claims, **characterized in** that the produced hot char is transferred by a pneumatic injection and/or transport system (9) into a plant (8) for a metallurgical process like smelting reduction of iron, electric winning of metals or reduction of ilmenite.

13. The process as claimed in any of the preceding claims, **characterized in** that the produced char is conveyed to a desired plant height and simultaneously cooled using the thermal energy to preheat boiler feed water.

14. The process as claimed in any of the preceding claims, **characterized in** that the volatile content of the char produced in the fluidized bed reactor (1) is below 10 wt.-%, preferably lower than 4 wt.-%.

15. A plant for performing a process for producing char and fuel gas as claimed in any of the preceding claims comprising:

- a fluidized bed reactor (1) with
    - an inlet (3) for a primary fluidizing gas provided in a lower region of the reactor,
    - an inlet (4) for a secondary gas provided above the inlet (3) for a primary fluidizing gas
    - and an inlet (5) for solids a supply of dried and crushed coal,
- a further reactor (8) for a further process and
- a pneumatic injection and/or transportation system (9) being provided between the fluidized bed reactor (1) and the further reactor (8),

wherein the inlet (3) for a primary fluidizing gas is connected to a first supply of gas or air having an oxygen content which is smaller compared with the oxygen content of a second supply of oxygen enriched gas or air to which the inlet (4) for a secondary gas is connected.

16. The plant as claimed in claim 15, **characterized in** that a cyclone (2) and/or a multiclone (13) are provided downstream of the fluidized bed reactor (1) for separating char and dust from fuel gas with an outlet of the cyclone (2) and/or the multiclone (13) being connected to a conduit (15) for feeding fuel gas

as fluidizing gas into the fluidized bed reactor (1) and/or into a fluidized bed cooler (10) being provided downstream of the fluidized bed reactor (1).

17. The plant as claimed in any of claims 15 to 16, **characterized in** that the further reactor (8) for a further process is a reactor for a metallurgical process.

18. The plant as claimed in any of claims 15 to 17, **characterized in** that the further reactor (8) for a further metallurgical process is a smelting furnace for smelting reduction of iron or a rotary kiln for reduction of ilmenite or an electric furnace for winning of metals.

19. The plant as claimed in any of claims 15 to 18, **characterized in** that the fluidized bed reactor is a circulation fluidized bed reactor or an annular fluidized bed reactor.

Fig. 1

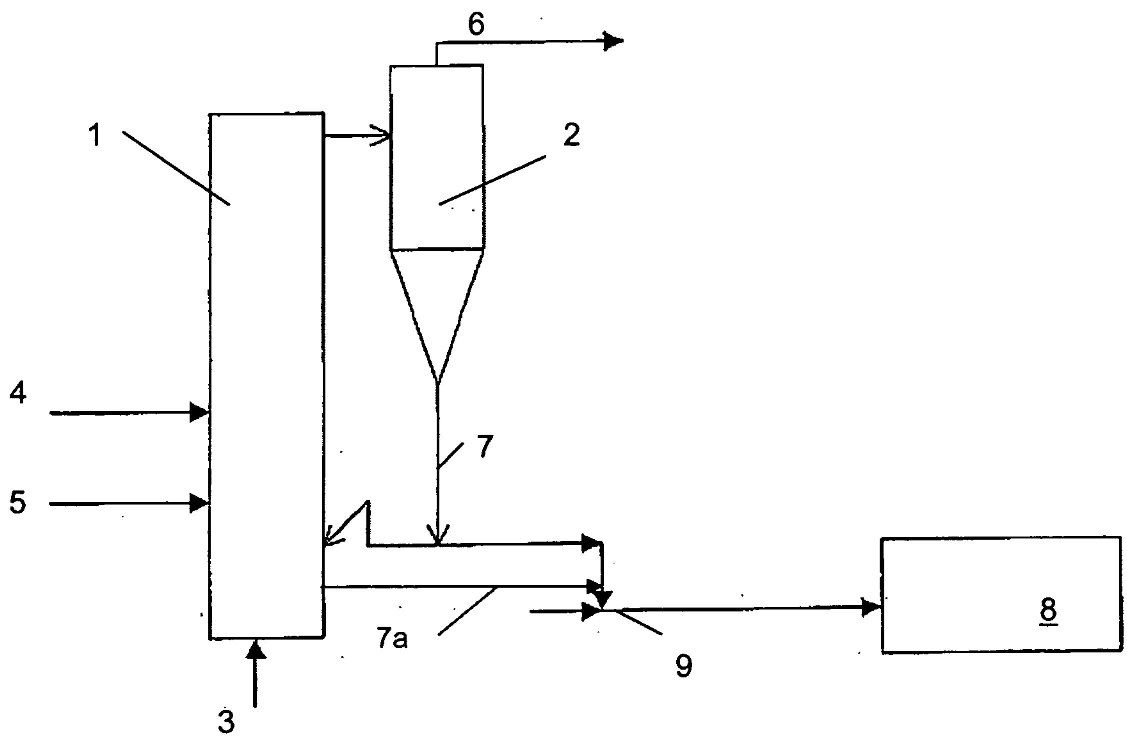
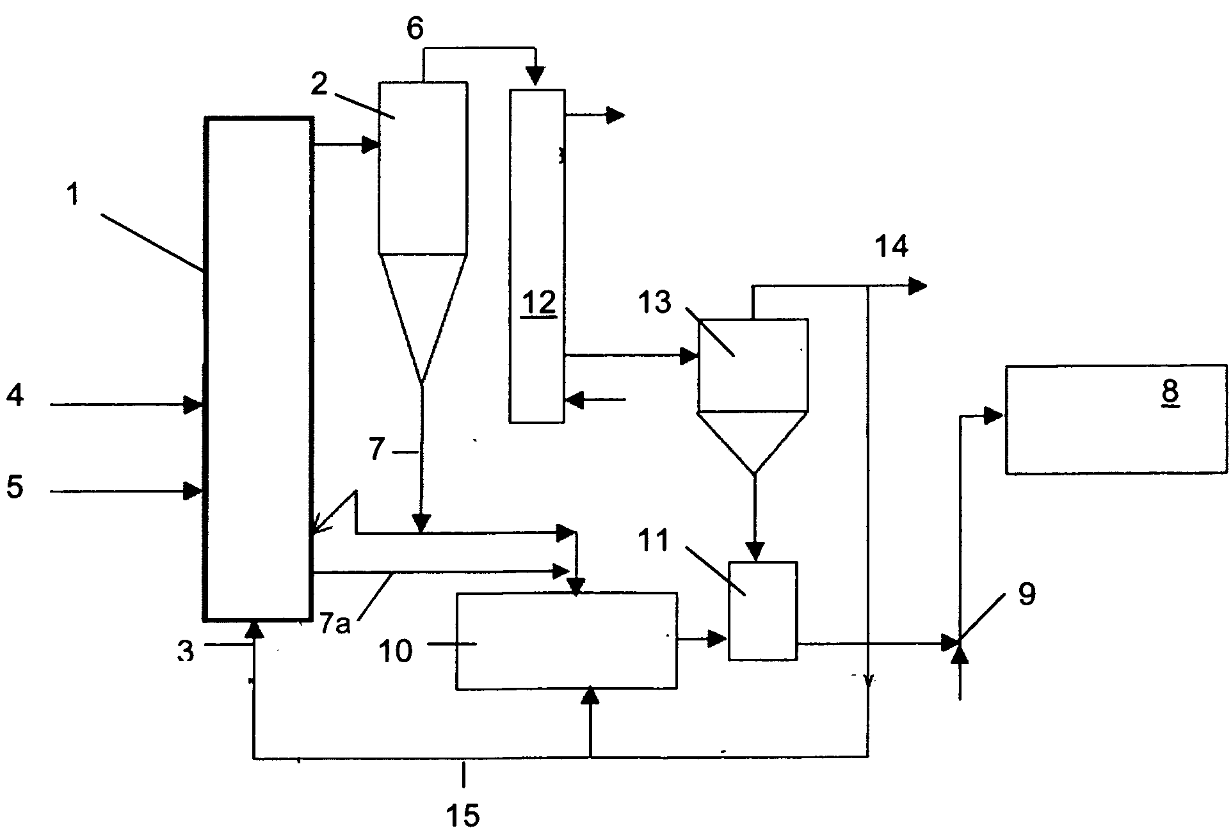


Fig. 2



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2007/010878

A. CLASSIFICATION OF SUBJECT MATTER
INV. C10J3/46 C10B49/10

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)
C10J C10B

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 December 2008	17/12/2008

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Lachmann, Richard

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2007/010878

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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A	WO 02/055744 A (MG TECHNOLOGIES AG [DE]; ORTH ANDREAS [DE]; HIRSCH MARTIN [DE]; WEBER) 18 July 2002 (2002-07-18) the whole document -----	1-19

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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