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(71) Applicant: L'AIR LIQUIDE, SOCIÉTÉ ANONYME POUR L'ETUDE ET L'EXPLOITATION DES PRECÉDÉS GEORGES CLAUDE [FR/FR]; 75, quai d'Orsay, 75007 Paris (FR).

(72) Inventors: SPIEGL, Nicloas; Stevinstraat 43, 2587 EB Den Haag (DE). JUDAS, Frederic; Oberfeldstr. 13, 60439 Frankfurt am Main (DE).

(74) Agent: DROPSCH, Holger; AIR LIQUIDE FORSCHUNG UND ENTWICKLUNG GMBH, Gwinnerstrasse 27-33, 60388 Frankfurt am Main (DE).

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(54) Title: FINE COAL FEED FOR A FIXED-BED PRESSURE GASIFIER

(57) Abstract: A fine coal feed for a fixed-bed pressure gasifier and also a process and a plant for producing such a fine coal feed from a raw coal associated with accompanying rock, which fine coal feed forms, under gasification conditions, an ash or clinker layer which has very good support and gas passage properties, is proposed. According to the invention, the comminuted raw coal is for this purpose fed to two successive density separation stages and the second light material obtained is at least partly mixed with the heavy material from the first density separation stage. Especially when employed in combination with a fixed-bed pressure gasifier of the FBDB type, the fine coal feed obtained according to the invention produces, under gasification conditions as a result of the comminuting and mixing action of the rotary grating, an ash bed having support and gas passage properties which are improved compared to ash beds obtained from fine coal feeds according to the prior art.



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Fine coal feed for a fixed-bed pressure gasifier

Field of the invention

15 The invention relates to a fine coal feed for a fixed-bed pressure gasifier of the FBDB type, a process and a plant for producing such a fine coal feed from raw coal associated with accompanying rock as feed material for a fixed-bed pressure gasifier and the use of this fine coal feed for producing a synthesis gas comprising hydrogen and carbon oxides.

Prior art

The term synthesis gas is used to refer to gas mixtures which contain hydrogen and carbon oxides and are used in various synthesis reactions. Examples are the synthesis of methanol, the preparation of ammonia by the Haber-Bosch process or the Fischer-Tropsch synthesis.

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A customary process for producing synthesis gases is the gasification of coal by means of fixed-bed pressure gasification reactors using steam and oxygen or air as gasifying agent in a shaft reactor under superatmospheric pressure to form a synthesis gas containing carbon monoxide and hydrogen, with a solid ash or liquid slag being obtained
30 as by-products depending on the way in which the gasification process is carried out.

Since the coal introduced as feed material is continuously consumed during the gasification operation, as a result of which the fixed bed of coal continually drops downwards under the action of gravity while at the same time fresh feed material is added at the top, the process is rather, in respect of the bed of solid, a moving-bed process since
5 the bed of solid moves in countercurrent to the gaseous gasifying agents introduced at the bottom end of the gasification reactor.

In the case of moving-bed gasifiers, the gasifying medium accordingly moves through the bed of granular or lumpy fuel or feed material. This type of gasifier has excellent
10 thermal efficiencies since discharged ash heats the incoming gases and the product gas flowing out heats the solid feed material introduced. The long residence times of solid particles which move through the bed (typically from 1 to 2 hours) together with the typical temperature profile of the countercurrent system make a high carbon conversion efficiency possible.

15 In countercurrent moving-bed gasifiers, the feed material travels through four not strictly separated zones having various temperatures and gas compositions, in which, with increasing temperature of the solid, the following chemical reactions can occur:

20 Drying and pyrolysis zone. Raw feed material comes into contact with hot product gases and moisture is driven off. Pyrolysis of the carbon-containing material to form gaseous products subsequently occurs.

Gasification zone. Pyrolyzed feed material from the pyrolysis zone comes into contact
25 with hot combustion products and steam from the zone immediately underneath. Reactions of the coal occur predominantly with steam, carbon dioxide and to a lesser extent hydrogen, so that the overall reaction is endothermic.

Combustion zone. The combustion zone supplies the heat energy for the gasification
30 zone arranged directly above it. The key reaction is the reaction of the carbon in the coal remaining after gasification with oxygen, producing heat and carbon oxides. Here,

the temperature rises to a maximum and in the case of non-slagging gasification with a dry ash bed, therefore has to be kept below the melting point of the ash, which is effected by introduction of excess steam, the amount of which goes beyond the stoichiometrically required amount.

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Ash zone. In the case of non-slagging gasification processes having a dry ash bed, the ash bed located on the underside of the reaction chamber, which ash bed rests on a grating or rotary grating, heats the inflowing gasifying medium by direct heat exchange and additionally acts as gas distributor and as support for the fuel or feed material bed located above it.

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A widespread version of the moving-bed gasifier is the Lurgi pressure gasifier with dry ash bed (Lurgi FBDB (fixed bed dry bottom) gasifier) which has been used commercially since the 1930s. The gasifier is surrounded by a water jacket for cooling, in which process steam is generated. Stock containers and a lock system for introducing the coal serving as feed material (typically particles having a size of from 3 to 50 mm) are installed at the top of the gasifier. A motor-driven distributor is used in order to distribute the coal entering the reaction chamber uniformly over the bed of coal. In some embodiments, a mechanical stirrer is present in order to allow the use of coals which cake. A motor-driven rotary grating at the bottom of the gasifier is used in order to take off the ash formed, with the ash being discharged via an appropriate lock system and fed to a stock container. Steam and oxygen or air are introduced as gasifying agents at the bottom of the gasifier and distributed into the bed of coal via the rotary grating. The grating supports the bed of coal and is rotated continually in order to ensure constant, uniform discharge of the ash. Crude synthesis gas as product gas is discharged with a typical temperature in the range from 400 to 600 °C at the upper end of the gasifier and flows through a scrub-cooler where it is cooled and scrubbed. Further cooling, purification and conditioning of the gas is carried out as a function of the desired use.

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Many types of coal which are provided for use in gasification processes such as the FBDB process contain a more or less high proportion of minerals as accompanying rock or, in

mining terminology, gangue. Before such types of coal can be used in the FBDB gasification process, the proportion of ash is normally reduced by a washing process, known as coal washing. Main advantages of a reduced proportion of ash are reduced transport costs and, associated therewith, reduced emissions caused by the transport, and also reduced wear on the equipment and, associated therewith, lower maintenance costs and a greater thermal efficiency of the process. The reduction in the proportion of ash is achieved by density separation methods such as coal washing, in which the raw coal is separated into a fraction having a high proportion of ash and a high relative density and a fraction having a low proportion of ash and a relatively low density.

Stable operation of an FBDB coal gasifier also requires an ash bed which is firstly stable enough to support the weight of the bed of coal and secondly makes uniform and homogeneous distribution of the gas flow through the fixed bed possible. In order to achieve this, it is necessary to optimize the ratio of liquid slag and solid minerals in the hottest zone of the gasification reactor by setting the steam-to-oxygen ratio in the gasifying agent appropriately.

In addition, it is desirable to increase the ash melting point of the coal introduced into the FBDB reactor. This allows a stable ash bed to be achieved at a relatively low steam-to-oxygen ratio in the gasifying agent and therefore leads to an overall better gas distribution and gasification performance and also to a reduced steam consumption. In order to increase the ash melting point, it is proposed that either the coal be separated into various fractions having a different ash content, which then also have different ash melting properties, or that additives which influence the general ash melting properties and in particular increase the ash melting point be introduced.

A reduction in the ash content of the coal is also of interest in order to reduce the wear and maintenance costs for the gasification reactor. This can be achieved by a density separation known per se before gasification, which is also referred to as coal wash.

The US patent document US 8906122 B2 teaches a process for producing a coal feed for coal gasification, in which the raw coal used is subjected to a coal wash to give coal fractions having different densities and mineral contents. The light fraction obtained is fed to entrained flow gasification, and the heavy fraction is fed to fixed-bed pressure gasification. A disadvantage here is that two different gasification technologies have to be used.

A further disadvantage is that those mineral constituents of the coal which form an at least partially liquid slag or soften on their surface under the conditions in the gasification reactor are undesirably removed in the coal wash. This partially liquefied or softened material acts as binder or adhesive when it solidifies again at lower temperatures in the lower region of the gasification reactor. Larger ash particles or clinker particles are thus formed by joining of solid, smaller ash particles by means of the (partially) liquid slag. The ratio of liquid slag to solid ash particles for a specific coal depends on the maximum temperature, which can be influenced by adjusting the steam-to-oxygen ratio in the gasifying agent.

The ratio of liquid slag to solid particles defines not only the size of the clinker particles which are formed but also the stability thereof. In general, a higher proportion of liquid slag leads to the formation of not only larger but also stronger clinker particles. The clinker particles have to be stable enough to be able to bear the weight of the coal bed resting on them and at the same time the particle size distribution of these particles has to be such that it ensures a homogeneous and uniform distribution of the gasifying agent over the cross section of the gasification reactor.

Description of the invention

It is therefore an object of the present invention to propose a fine coal feed for a fixed-bed pressure gasifier and a process and also a plant for the production thereof, which does not have the abovementioned disadvantages of the processes known from the prior art.

This object is achieved by a process having the features of Claim 1. Further embodiments of the process of the invention can be derived from dependent claims 2 to 9.

5 The invention also provides a plant for carrying out the process of the invention according to Claim 12, and also further embodiments of the plant of the invention according to Claims 13 to 15.

10 The invention further provides a fine coal feed for a fixed-bed pressure gasifier of the FBDB type according to Claim 10 and the use of this fine coal feed for producing a synthesis gas comprising hydrogen and carbon oxides according to Claim 11.

Process of the invention:

Process for producing a fine coal feed from raw coal associated with accompanying rock as feed material for a fixed-bed pressure gasifier, comprising the following steps:

- 15 (a) provision of the comminuted raw coal,
(b) introduction of the comminuted raw coal into a first density separation stage suitable for separating solid particles into fractions having densities which are less than and greater than a first fixed delimiting density,
(c) discharge of a solid fraction having a density less than the first fixed delimiting density
20 as first light material enriched in carbon and a solid fraction having a density greater than the first fixed delimiting density as heavy material enriched in accompanying rock,
(d) introduction of the first light material into a second density separation stage suitable for separating solid particles into fractions having densities which are less than and greater than a second fixed delimiting density,
25 (e) discharge of a solid fraction having a density less than the second fixed delimiting density as second light material which is further enriched in carbon and a solid fraction having a density greater than the second fixed delimiting density as intermediate material,
(f) introduction of the heavy material into a heavy material work-up comprising at least one
30 treatment step selected from the group: temporary storage, comminution, homogenization, classification; discharge of a treated heavy material from the heavy material work-up,

(g) mixing of at least part of the treated heavy material with the second light material to give the fine coal feed.

Plant of the invention:

- 5 Plant for producing a fine coal feed from mineral-containing raw coal as feed material for a fixed-bed pressure gasifier, comprising the following subassemblies and plant constituents:
- (a) means for providing the comminuted mineral-containing raw coal,
- (b) a first density separation stage suitable for separating solid particles into fractions hav-
- 10 ing densities which are less than and greater than a first fixed delimiting density, means for introducing the comminuted mineral-containing raw coal into the first density separation stage,
- (c) means for discharging a solid fraction having a density less than the first fixed delimiting density as first light material and means for discharging a solid fraction having a den-
- 15 sity greater than the first fixed delimiting density as heavy material,
- (d) a second density separation stage suitable for separating solid particles into fractions having densities which are less than and greater than a second fixed delimiting density, means for introducing the first light material into the second density separation stage,
- (e) means for discharging a solid fraction having a density less than the second fixed
- 20 delimiting density as second light material and means for discharging a solid fraction having a density greater than the second fixed delimiting density as intermediate material,
- (f) a heavy material work-up stage comprising at least one apparatus selected from the group: temporary store, comminution apparatus, homogenization apparatus, classification apparatus; means for introducing the heavy material into the heavy material work-up
- 25 stage, means for discharging a treated heavy material from the heavy material work-up stage,
- (g) a mixing apparatus for mixing at least part of the treated heavy material with the second light material to give the fine coal feed.
- 30 For the purposes of the present invention, the reaction conditions of the fixed-bed pressure gasification are the reaction and process conditions which are known per se to a

person skilled in the art, in particular temperature, pressure and residence time, as are set forth in detail in the relevant literature and at which at least partial conversion, but preferably industrially relevant conversions, of the fine coal feed into synthesis gas products such as CO and hydrogen occurs by reaction with the gasifying agents.

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The invention proposes a modified coal washing and coal mixing process and a plant suitable for this purpose, which firstly reduces the accompanying rock or ash content of the coal and secondly ensures that the required ratio of liquid slag to solid minerals can be attained so as to achieve the desired binding action by means of which relatively small ash or clinker particles are joined to form larger and stable particles. In this way, favourable gas passage properties and support properties of the ash bed on the gasifier grating are obtained and the mechanical wear on the gasification reactor is reduced.

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It is therefore proposed according to the invention that two density separation stages be combined with one another in such a way that the raw coal is separated into three different fractions according to the relative density in order to obtain a coal feed which has a lower proportion of ash than the raw coal but at the same time has sufficient and the correct minerals to serve as binders. A fine coal fraction as light material having a high carbon content, a low proportion of accompanying rock and a relatively low density is obtained as lightest fraction, a heavy material having a low carbon content, a high proportion of accompanying rock and a relatively high density is obtained as heaviest fraction which can be treated further by homogenization and classification. In mining terminology, the latter is also referred to as gangue or the gangue fraction. The fine coal fraction is then mixed with the homogenized gangue fraction. The invention is now based on the recognition that the heavy material or gangue fraction obtained has a comparatively high proportion of minerals which under the reaction conditions of the fixed-bed pressure gasification at least partially melt or, at least on their surface, soften. This fraction is therefore very suitable as binder by means of which smaller ash or clinker particles can be joined to form larger and stable particles.

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The liquid material acts as binder or adhesive if it resolidifies at lower temperatures at the lower end of the reactor. Larger ash particles or clinker particles are formed when solid ash particles are joined to one another by means of the liquid slag. The ratio of liquid slag to solid ash particles for a specific coal depends on the maximum temperature, which can be influenced by adjusting the steam-to-oxygen ratio in the gasifying agent.

The ratio of liquid slag to solid particles defines not only the size of the clinker particles which are formed but also the stability thereof. In general, a higher proportion of liquid slag leads to formation of stronger and larger clinker particles. The clinker particles have to be stable enough to be able to bear the weight of the bed of coal resting on them and at the same time the particle size distribution of the clinker particles has to be such that it ensures a homogeneous and uniform distribution of the gasifying agent over the cross section of the gasification reactor.

A significant proportion of the coals which are available at present and even more in the future for use in an FBDB gasification reactor have a high content of clay minerals. Part of the clay minerals is present separately from the coal matrix, while most of them are present as an intensive mixture or association of the clay minerals with the coal matrix.

As a result of the density separation of such raw coals, a light fraction which has a low ash content and a low relative density and contains particles which consist of a coal matrix which is intimately mixed with clay mineral particles is obtained. Particles which consist of a pure mineral fraction (known as accompanying rock or gangue) and particles having a very high proportion of minerals and only a very small proportion of coal are separated into a waste fraction which has a high ash content and a high relative density. An intermediate material fraction which has an intermediate ash content and an intermediate specific density may additionally be obtained.

The majority of the minerals in the light fraction consists of clay minerals, especially kaolinite. At high temperatures, kaolinite is converted into mullite which has a melting point of

1840 °C and therefore remains solid under the reaction conditions in the gasification reactor.

When the proportion of kaolinite is very high compared to the other remaining minerals, the light fraction can be such that there is not sufficient material that can serve as adhesive, i.e. can form liquid slag, and can act as binder between the kaolinite or mullite particles available. A stable clinker bed therefore cannot be formed. As a result of the addition according to the invention of the gangue fraction to the fine coal fraction, the proportion of minerals which can be converted into liquid slag and thus serve as adhesive or binder is increased. In addition, the removal of the ash-rich intermediate material significantly reduces the ash content of the fine coal feed for the fixed-bed pressure gasifier compared to the raw coal, as a result of which the mechanical wear on the gasifier during operation using the fine coal feed produced according to the invention is also reduced.

The invention not only makes it possible to operate the gasification reactor in a stable manner using the washed coal, but it also provides the process with two degrees of freedom which can be used for optimizing the process further:

1. The gangue fraction is recirculated in its entirety or in part to the fine coal fraction. This value can be optimized in order to set the lowest possible ash content in the feed to the gasification reactor and thus the smallest possible steam-to-oxygen ratio, with a stable ash bed being ensured at the same time.

2. As a result of setting of the particles sizes of the gangue fraction which is recirculated to the fine coal fraction, the ash melting behaviour is influenced and the process is thus optimized further.

The fine coal feed obtained according to the invention has the following novel and advantageous properties compared to the fine coal feed known from the prior art:

- As a result of the addition according to the invention of the gangue fraction to the fine coal fraction, the proportion of minerals which can be converted into liquid slag and thus serve as adhesive or binder is increased. A stable ash or clinker bed can therefore be formed.

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- In addition, removal of the ash-rich intermediate material significantly reduces the ash content of the fine coal feed for the fixed-bed pressure gasifier compared to the raw coal, as a result of which the mechanical wear on the gasifier during operation using the fine coal feed produced according to the invention is also reduced.

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Particularly when used in combination with a fixed-bed pressure gasifier of the FBDB type, the comminuting and mixing action of the rotary grating leads to the fine coal feed obtained according to the invention producing, under gasification conditions, an ash bed having support and gas passage properties which are improved compared to ash beds obtained from fine coal feeds according to the prior art.

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Preferred embodiments of the invention

In a preferred embodiment of the process of the invention, the raw coal is associated with accompanying rock which contains at least two different types of minerals, with the first type of mineral at least partially melting or softening under the reaction conditions of the fixed-bed pressure gasification and the second type of mineral remaining solid under the same reaction conditions and the second type of mineral adhering more strongly to the coal or being more intimately associated therewith. It is advantageous for separation or at least enrichment of the two types of minerals to be able to occur by means of mechanical treatment and separation processes, for example comminution and subsequent density separation. The first type of mineral becomes, as a result of its relatively higher density, concentrated in the heavy material, namely the gangue fraction; the second type of mineral remains in the light fraction because of its intimate association with the coal.

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The density separation of such raw coals therefore gives a light fraction which has a low ash content and a low relative density and contains particles which consist of a coal matrix

which is intimately mixed with clay mineral particles, especially kaolinite. At high temperatures, kaolinite is converted into mullite which has a melting point of 1840°C and therefore remains solid under the reaction conditions in the gasification reactor.

5 When the proportion of kaolinite is very high compared to the other remaining minerals, the light fraction can be such that there is not sufficient material that can serve as adhesive, i.e. can form liquid slag, and can act as binder between the kaolinite or mullite particles available. A stable clinker bed therefore cannot be formed. As a result of the addition according to the invention of the gangue fraction to the fine coal fraction, the proportion of
10 minerals which can be converted into liquid slag and thus serve as adhesive or binder is increased. In addition, the removal of the ash-rich intermediate material significantly reduces the ash content of the fine coal feed for the fixed-bed pressure gasifier compared to the raw coal, as a result of which the mechanical wear on the gasifier during operation using the fine coal feed produced according to the invention is also reduced.

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Correspondingly, the second type of mineral is therefore formed by clay minerals, in particular kaolinite, in a particularly preferred embodiment of the process of the invention.

In the process of the invention, the first fixed delimiting density is preferably in the range
20 from 1.8 to 2.1 g/cm³, preferably 1.9 g/cm³. Furthermore, the second fixed delimiting density in the process of the invention is preferably in the range from 1.4 to 1.8 g/cm³, preferably 1.6 g/cm³.

Especially when the two above-described embodiments are employed together, conven-
25 tional raw coal can be separated reliably by means of appropriate density separation steps into a carbon-enriched light material, a heavy material enriched in minerals of the first type and an intermediate material of intermediate density, with the latter being able, for example, to be discarded as waste fraction.

30 In a particularly preferred embodiment of the process of the invention, at least one density separation stage, preferably both density separation stages, is/are configured as heavy

liquid separation apparatus(es) and the respective heavy liquid density corresponds to the first and/or second fixed delimiting density. Corresponding apparatuses are commercially available. The setting of the respective heavy liquid density by use of suitable heavy materials is known from the prior art.

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Further comminution of the first light material is preferably carried out before it is fed to the second density separation stage. In this way, a larger proportion of the first light material can be transferred into the second light material and the proportion of the intermediate material is reduced.

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In a particular embodiment of the process of the invention, the heavy material work-up comprises temporary storage, homogenization and classification and the heavy material fines obtained is discharged from the heavy material work-up and at least partly mixed together with the second light material to give the fine coal feed. Fluctuations in the introduction of raw coal and in respect of the decrease resulting from the downstream process steps can be evened out by the temporary storage of the heavy material. The homogenization and classification makes it possible to obtain a fraction of the heavy material which, owing to its small particle size, ensures intimate mixing with the second light material.

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20 The fixed-bed pressure gasifier is particularly preferably a gasifier of the FBDB type, with the feed material and/or the ash resting on a rotary grating during operation of the gasifier. Stable operation of an FBDB coal gasifier requires an ash bed which is firstly stable enough to bear the weight of the coal bed and secondly to allow uniform and homogeneous distribution of the gas flow through the fixed bed. This is made possible by ash or
25 clinker particles which are formed from the fine coal feed according to the invention under gasification conditions.

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A further embodiment of the process of the invention is characterized in that the intermediate material obtained is comminuted further and recirculated at least partly to process
30 step 1 (a). In this way, amounts of the intermediate material can be transferred into the light material and/or the heavy material and the waste fraction is reduced.

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In a preferred embodiment of the plant of the invention, at least one density separation stage, preferably both density separation stages, is/are configured as heavy liquid separation apparatus(es) and the respective heavy liquid density corresponds to the first and/or
5 second fixed delimiting density. Corresponding apparatuses are commercially available. The setting of the respective heavy liquid density by use of suitable heavy materials is known from the prior art.

In a particular embodiment of the plant of the invention, the plant further comprises a
10 comminution apparatus which is spatially and/or in respect of the process flow connected to the first density separation stage and the second density separation stage and is suitable for comminuting the first light material further before introduction into the second density separation stage. In this way, a larger proportion of the first light material can be transferred into the second light material and the proportion of the intermediate material
15 is reduced.

In a further aspect of the invention, the plant of the invention is configured so that the heavy material work-up stage further comprises the following plant constituents: a temporary store, a homogenization apparatus, a classification apparatus, means for discharging
20 the heavy material fines obtained from the heavy material work-up stage, means for at least partly mixing the heavy material fines with the second light material to give the fine coal feed. Fluctuations in the introduction of raw coal and in respect of the decrease resulting from the downstream process steps can be evened out by the temporary storage of the heavy material. The homogenization and classification makes it possible to obtain
25 a fraction of the heavy material which, owing to its small particle size, ensures intimate mixing with the second light material.

Working example

Embodiments, advantages and possible uses of the invention can also be derived from
30 the following description of working examples and the drawing. Here, all features described and/or depicted form the invention, either on their own or in any combination,

regardless of the way in which they are summarized in the claims or the back-references thereof.

The single figure shows:

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Fig. 1 a preferred embodiment of the process of the invention or the plant of the invention.

10 In the working example according to Fig. 1 explained in the following, the term “conduit” should be interpreted in general terms and encompasses not only pipes in the narrower sense but also all other transport methods and transport apparatuses known per se to a person skilled in mechanical process technology, e.g. conveyor belts, transport screws, trough chain conveyors, pneumatic transport units, etc.; they are not described further and depicted in detail here. A person skilled in the art will be able to select the appropriate
15 transport method in each case depending on the nature of the material to be transported.

In the preferred embodiment of the process of the invention or of the plant of the invention shown schematically in Fig. 1, comminuted raw coal is introduced via conduit 2 into the plant 1 for producing the fine coal feed for a fixed-bed pressure gasifier of the FBDB type
20 having a rotary grating. The raw coal used here is associated with accompanying rock which comprises different types of minerals. These include kaolinite which is particularly intimately associated with the coal present and permeates the latter as fine veins or strands.

25 The raw coal goes via conduit 2 into the first density separation stage 3 which is configured as a heavy liquid separation apparatus. In this, the heavy liquid density is set to a first fixed delimiting density in the range from 1.8 to 2.1 g/cm³, preferably 1.9 g/cm³. In this first density separation stage, the gangue or the heavy material enriched in associated rock, i.e. the mineral or associated rock fraction, which contains only a small proportion of coal,
30 is separated from the remaining raw coal and discharged via conduit 11 from the first density separation stage.

The solids fraction having a density less than the first fixed delimiting density is discharged from the first density separation stage via conduit 4 as carbon-enriched first light material and supplied to the second density separation stage 5. In the latter, the heavy liquid density is set to a second fixed delimiting density in the range from 1.4 to 1.8 g/cm³, preferably 1.6 g/cm³. In this second density separation stage, which is again configured as heavy liquid separation apparatus, a solids fraction having a density less than the second fixed delimiting density is discharged via conduit 6 as second light material which is further enriched in carbon and a solids fraction having a density greater than the second fixed delimiting density is discharged from the process via conduit 7 as intermediate material and is discarded as waste.

The second light material is conveyed via conduit 6 to a stock container 8 and subjected to temporary storage in this.

The heavy material discharged via conduit 11 from the first density separation stage is introduced into a homogenization and temporary storage apparatus 12. From this, it is discharged via conduit 13 and fed to a classification apparatus 14 equipped with a set of screens of differing mesh opening. The coarse fraction obtained in the classification operation is discharged from the classification apparatus via conduit 16 and discarded as waste. The heavy material fines obtained in the classification operation is discharged via conduit 15, fed to a homogenization apparatus 10 and in this at least partly mixed with the second light material, which is discharged from the stock container 8 via conduit 9 and likewise fed into the homogenization apparatus, to form the fine coal feed which is discharged from the plant 1 via conduit 17 and can now be fed to a fixed-bed pressure gasification reactor.

Industrial applicability

The invention proposes a fine coal feed for a fixed-bed pressure gasifier and also a process and a plant for producing such a fine coal feed from raw coal which is associated with accompanying rock and under gasification conditions forms an ash or clinker layer

which has very good support and gas passage properties. Removal of the ash-rich intermediate material from the coal feed significantly reduces the ash content of the fine coal feed for the fixed-bed pressure gasifier compared to the raw coal, as a result of which the mechanical wear on the gasifier during operation using the fine coal feed produced according to the invention is also reduced. Especially when employed in combination with a fixed-bed pressure gasifier of the FBDB type, the fine coal feed obtained according to the invention produces, under gasification conditions, as a result of the comminuting and mixing action of the rotary grating, an ash bed having support and gas passage properties which are improved compared to ash beds obtained from fine coal feeds according to the prior art.

List of reference numerals

	[1]	Plant
5	[2]	Conduit
	[3]	First density separation stage
	[4]	Conduit
	[5]	Second density separation stage
	[6]	Conduit
10	[7]	Conduit
	[8]	Stock container
	[9]	Conduit
	[10]	Homogenization apparatus
	[11]	Conduit
15	[12]	Homogenization and temporary storage apparatus
	[13]	Conduit
	[14]	Classification apparatus
	[15]	Conduit
	[16]	Conduit
20	[17]	Conduit

Claims:

1. Process for producing a fine coal feed from raw coal associated with accompanying
5 rock as feed material for a fixed-bed pressure gasifier, comprising the following steps:
(a) provision of the comminuted raw coal,
(b) introduction of the comminuted raw coal into a first density separation stage suitable
for separating solid particles into fractions having densities which are less than and greater
than a first fixed delimiting density,
10 (c) discharge of a solid fraction having a density less than the first fixed delimiting density
as first light material enriched in carbon and a solid fraction having a density greater than
the first fixed delimiting density as heavy material enriched in accompanying rock,
(d) introduction of the first light material into a second density separation stage suitable
for separating solid particles into fractions having densities which are less than and greater
15 than a second fixed delimiting density,
(e) discharge of a solid fraction having a density less than the second fixed delimiting
density as second light material which is further enriched in carbon and a solid fraction
having a density greater than the second fixed delimiting density as intermediate material,
(f) introduction of the heavy material into a heavy material work-up comprising at least one
20 treatment step selected from the group: temporary storage, comminution, homogeniza-
tion, classification; discharge of a treated heavy material from the heavy material work-
up,
(g) mixing of at least part of the treated heavy material with the second light material to
give the fine coal feed.
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2. Process according to Claim 1, characterized in that the raw coal is associated with
accompanying rock which contains at least two different types of minerals, where the first
type of mineral at least partially melts or softens under the reaction conditions of the fixed-
bed pressure gasification and the second type of mineral remains solid under the same
30 reaction conditions and the second type of mineral adheres more strongly to the coal or
is more intimately associated with the latter.

3. Process according to Claim 2, characterized in that the second type of mineral is formed by clay minerals, in particular kaolinite.

4. Process according to any of the preceding claims, characterized in that the first fixed delimiting density is in the range from 1.8 to 2.1 g/cm³, preferably 1.9 g/cm³.

5. Process according to any of the preceding claims, characterized in that the second fixed delimiting density is in the range from 1.4 to 1.8 g/cm³, preferably 1.6 g/cm³.

6. Process according to any of the preceding claims, characterized in that at least one density separation stage, preferably both density separation stages, is/are configured as heavy liquid separation apparatus(es) and the respective heavy liquid density corresponds to the first and/or second fixed delimiting density.

7. Process according to any of the preceding claims, characterized in that the first light material is comminuted further before introduction into the second density separation stage.

8. Process according to any of the preceding claims, characterized in that the heavy material work-up comprises temporary storage, homogenization and classification and in that the heavy material fines obtained are discharged from the heavy material work-up and at least partly mixed with the second light material to form the fine coal feed.

9. Process according to any of the preceding claims, characterized in that the fixed-bed pressure gasifier is a gasifier of the FBDB type and in that the feed material and/or the ash rest on a rotary grating during operation of the gasifier.

10. Fine coal feed obtained by a process according to any of Claims 1 to 9.

11. Use of the fine coal feed produced according to any of Claims 1 to 9 for producing a synthesis gas comprising hydrogen and carbon oxides.

12. Plant for producing a fine coal feed from mineral-containing raw coal as feed material for a fixed-bed pressure gasifier, comprising the following subassemblies and plant constituents:

(a) means for providing the comminuted mineral-containing raw coal,

(b) a first density separation stage suitable for separating solid particles into fractions having densities which are less than and greater than a first fixed delimiting density, means

for introducing the comminuted mineral-containing raw coal into the first density separation stage,

(c) means for discharging a solid fraction having a density less than the first fixed delimiting density as first light material and means for discharging a solid fraction having a density greater than the first fixed delimiting density as heavy material,

(d) a second density separation stage suitable for separating solid particles into fractions having densities which are less than and greater than a second fixed delimiting density, means for introducing the first light material into the second density separation stage,

(e) means for discharging a solid fraction having a density less than the second fixed delimiting density as second light material and means for discharging a solid fraction having a density greater than the second fixed delimiting density as intermediate material,

(f) a heavy material work-up stage comprising at least one apparatus selected from the group: temporary store, comminution apparatus, homogenization apparatus, classification apparatus; means for introducing the heavy material into the heavy material work-up stage, means for discharging a treated heavy material from the heavy material work-up stage,

(g) a mixing apparatus for mixing at least part of the treated heavy material with the second light material to give the fine coal feed.

13. Plant according to Claim 12, characterized in that at least one density separation stage, preferably both density separation stages, is/are configured as heavy liquid separation apparatus(es) and the respective heavy liquid density corresponds to the first and/or second fixed delimiting density.

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14. Plant according to either of the preceding claims, characterized in that it further comprises a comminution apparatus which is connected to the first density separation stage and the second density separation stage and is suitable for comminuting the first light material further before it is introduced into the second density separation stage.

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15. Plant according to any of the preceding claims, characterized in that the heavy material work-up stage further comprises the following plant constituents: a temporary store, a homogenization apparatus, a classification apparatus, means for discharging the heavy material fines obtained from the heavy material work-up stage, means for at least partly mixing the heavy material fines with the second light material to give the fine coal feed.

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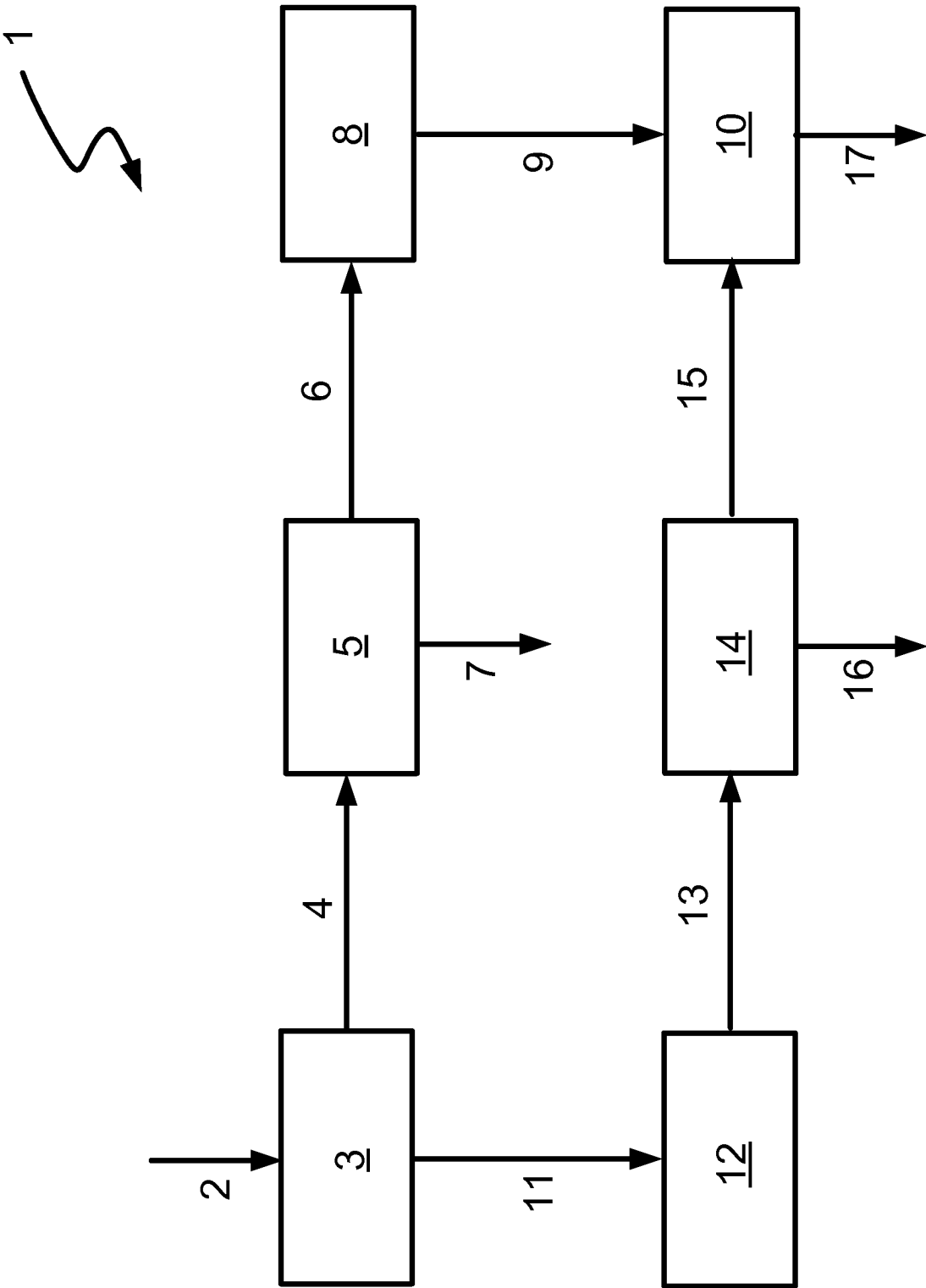


Fig. 1

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/025142

A. CLASSIFICATION OF SUBJECT MATTER
INV. C10L9/00 C10L5/04 B03B9/00
ADD.

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)
C10L B03B

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 practicable, search terms used)

EPO-Internal, COMPENDEX, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X A	DE 38 13 927 A1 (TATABANYAI BANYAK VALLALAT [HU]) 27 April 1989 (1989-04-27) page 2, line 3 - line 10 page 2, line 55 - page 3, line 2 claims; example -----	10,11 1-9, 12-15
X A	DE 27 36 801 A1 (DOW CHEMICAL CO) 23 February 1978 (1978-02-23) claims page 3 - page 5 figures 2-4; examples 5-7 -----	10,11 1-9, 12-15
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Further documents are listed in the continuation of Box C.



See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search

28 June 2018

Date of mailing of the international search report

11/07/2018

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Keipert, Olaf

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2018/025142

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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A	GB 2 108 012 A (PROMINCO SRL) 11 May 1983 (1983-05-11) page 1, line 6 - line 48 page 1, line 71 - page 2, line 63 figure 1 -----	1-15

INTERNATIONAL SEARCH REPORT

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