

GRINDING AND DRYING PLANT

Technical field

[0001] The present invention generally relates to grinding and drying plants used for producing comminuted dry materials useful for a number of applications.

Background Art

[0002] Grinding plants are used to comminute bulk material. Often such grinding plants also comprise drying equipment to simultaneously reduce the bulk material's moisture content. Typical examples of such grinding and drying plants are used to process granulated blast furnace slag for the production of cement or so-called coal grinding and drying plants to turn wet coarse raw coal into dry pulverized coal, to be injected into blast furnaces or fired in power plants.

[0003] In case the bulk material to be ground and dried is combustible, e.g. in the case of coal, the resulting product is explosive and special attention has to be paid to the design of the process and of the plant, in order either to prevent/avoid explosions, primarily by keeping the oxygen concentration in the gases in contact with the explosive material below the so-called lower explosion limit value (explosion preventing design) or to protect the equipment and the environment against the effects of such explosions (explosion protecting design).

[0004] In typical grinding and drying plants, comminution, normally grinding, and drying of the raw material is performed, largely in parallel, inside a comminuting equipment or mill. Coarse material is ground e.g. between rotating rollers, balls etc., and a rotating grinding table or bowl, and moisture is evaporated in contact with a hot drying gas. The drying gas conveys the ground material into a classifier, usually integrated into the top part of the mill. Coarse material is eliminated from the drying gas flow and returned onto the grinding table or bowl, the fine material is transported by the cooled-down waste drying gas with increased water vapor content into a downstream equipment for gas-solid-separation, usually a bag filter.

[0005] Although many improvements have been made so far in the conception and operation of such grinding and drying plants, it remains that the overall process is very cost intensive in terms of energy consumption.

Technical problem

[0006] It is therefore an object of the present invention to provide an enhanced method and plant for producing a comminuted dry material from a coarse material allowing for a more energy efficient operation.

General Description of the Invention

[0007] Hence, in a first aspect, the present invention proposes a method for producing a comminuted dry material from a coarse material, the method comprising the steps of:

- (a) providing a heated drying gas from a drying gas source;
- (b) providing the coarse material in a storage bin;
- (c) feeding said coarse material and said heated drying gas into a comminuting equipment;
- (d) comminuting and drying said coarse material within said comminuting equipment to obtain a comminuted dry material;
- (e) collecting a mixture of drying gas and comminuted dry material from the comminuting equipment and feeding the mixture to a separator to separate the comminuted dry material from the drying gas.

[0008] The method of the invention further comprises the step of (f) recycling at least part of the drying gas from step (e) as a preconditioning gas and feeding said preconditioning gas into a lower part of said storage bin to precondition the coarse material.

[0009] In a second aspect, the invention provides a grinding and drying plant arranged for implementing the method as described herein. In particular, the invention provides a grinding and drying plant for producing a comminuted dry material from a coarse material, the grinding and drying plant comprising: a source of heated drying gas for providing heated drying gas at a predefined temperature; a coarse material storage bin for temporarily storing said coarse material; a comminuting equipment for comminuting and drying said coarse material to obtain a comminuted dry material; a coarse material feeding equipment for feeding coarse material from said coarse material storage bin into the comminuting

equipment; conduits for feeding said heated drying gas into the comminuting equipment; a separator downstream the comminuting equipment for collecting and separating the comminuted dry material from the drying gas. The grinding and drying plant of the invention further comprises recycling conduits downstream the separator for recycling at least part of the drying gas as a preconditioning gas to a lower part of the coarse material storage bin to precondition the coarse material within the coarse material storage bin.

[0010] The present invention is based on two major findings providing two major advantages. A first important advantage of the invention is that by recycling at least part of the drying gas to precondition the coarse material upstream of comminuting equipment, the comminuting equipment or mill can be of significantly *lower* capacity without compromising on end product quality.

[0011] Indeed, factors conditioning the required capacity of the mill primarily include the requested nominal product (ground and dried material) output flow rate, the grindability (softness) and the moisture content of the raw material and the fineness (grain size distribution parameters) of the product. Now, in the usual case that the grain size (range) of the raw material is by far larger than the grain size (range) of the product, e.g. by several decimal powers (mm versus μm), the impact of the raw material grain size on the mill capacity is negligible.

[0012] Furthermore, factors determining the required drying capacity primarily include the requested nominal product (ground and dried material) output flow rate, the moisture content of the raw material and the residual moisture content of the product. In the case of coal for example, the residual moisture content asked for is usually in the order of magnitude of 1 % (while the value that can actually be achieved is conditioned by the actual moisture retention capacity of the coal brand considered, reflected by the sorption isotherms), whereas raw coal moisture may range up to about 15 % for black coal, even higher for lignite and brown coal.

[0013] Hence, the impact of raw material moisture content on the capacity of the mill can thus be significant. The example in Fig. 1 shows the decrease of the output capacity when producing pulverized coal of 1 % residual moisture content and $80\% < 90\ \mu\text{m}$ grain size distribution, the impacting parameters being the raw material moisture content (on an as received basis, i.e. ratio of water to wet

material) and the grindability, reflected by the Hardgrove index (HGI, Hardgrove Grindability Index).

[0014] Suppliers of mills usually offer their equipment in a series of units (mill sizes) with graded, increasing capacities or nominal product outputs for defined raw material and fine material (product) conditions. In parallel, the drying gas flow rate range acceptable in each unit or mill size is fixed, these ranges becoming larger and being shifted to higher value levels as the capacities or product outputs increase.

[0015] In other words, as the coarse starting material may be very variable in terms of moisture, the plant and especially the mill must be dimensioned so as to cope with all grades of starting materials, i.e. both relatively dry and very wet material. As an example, in the case of coal and the conditions of Fig. 1, reducing the moisture content of raw coal e.g. from 15 % to 7 % would reduce the required capacity by $[1/(\leq 0.8)] - 1 = (\geq 0.25)$, i.e. by 25 % and more as compared to the initial value, depending on the grindability. Significant savings would actually occur at mill level in case and provided the reduction of the required capacity would actually result in the installation of a mill size smaller than the size to be considered in the original conditions.

[0016] In addition, the mill inlet temperature range of the hot drying gas being fixed, the moisture content of the raw material being already reduced by the preconditioning upstream the mill result as well in a significant reduction of the required drying gas flow rate, and thus of the size of the gas-solid-separation equipment (bag filter) and the through-put of the drying gas main fan, provided the reduced drying gas flow rate fits into the acceptable drying gas flow rate range of the mill, which is of course likely in case the mill size could be reduced as well, as explained above.

[0017] A second major advantage of the invention is that it allows for an easier and steadier operation of the grinding and drying process. Indeed, the apparently inevitable variability of the starting material puts a significant burden on the operator of the plant and any uncontrolled variation puts at risk the continuous production of comminuted material. Indeed, if the material is not sufficiently dried,

it will agglomerate and not only produce unusable material, but also clog the downstream equipment especially the separators or filters.

[0018] This second major advantage is in fact due on the one hand to a reduced (and less fluctuating) temperature drop within the mill during material introduction and on the other hand to a more reliable drying with a reduced risk of clogging and unplanned plant shut-down. In other words, the invention provides a way to precondition the coarse material by preheating and/or predrying it or by reducing its variability both in terms of moisture and temperature, thereby facilitating operation and increasing reliability of the overall process.

[0019] In a further variant of the invention, step (f) comprises a sub-step (f1) of mixing the preconditioning gas with heated drying gas from the drying gas source before the feeding into the lower part of said storage bin. Hence, the grinding and drying plant preferably further comprises a mixing arrangement within the recycling conduits for mixing the preconditioning gas with heated drying gas from the drying gas source before the feeding into the lower part of said storage bin.

[0020] If necessary, step (f) comprises a sub-step (f2) of adjusting the pressure of the preconditioning gas before the feeding into the lower part of said storage bin. Adjusting the pressure may be required depending on the configuration of the storage bin and the coarse material to have an appropriate flow rate within the storage bin. In some embodiments, the pressure adjustment may be made with a fan installed in the conduits upstream (in the sense of the preconditioning gas flow) of the storage bin. Alternatively or additionally, a suction fan may be arranged within the conduit downstream of the storage bin or even downstream a further separator (see below).

[0021] Generally, the preconditioning gas is collected after the preconditioning at an upper part of said storage bin (sub-step (f3)). Hence, the coarse material storage bin preferably comprises a gas outlet arranged in an upper part thereof for collecting the preconditioning gas. As the preconditioning gas progresses through the coarse material, it becomes increasingly loaded with moisture and progressively cools down, the temperature of the preconditioning gas may fall below the dew point. It may therefore be advantageous to extract the preconditioning gas at a height below the top of the storage bin, i.e. at a point

where the preconditioning gas has not passed through the entire filling height of coarse material.

[0022] The preconditioning gas leaving the storage bin may still contain fine material and if this gas is to be released to the atmosphere it might thus be necessary to filter said gas. Hence, the method preferably comprises a sub-step (f4) of feeding the preconditioning gas collected in sub-step (f3) to a further separator to separate any residual fine material from the preconditioning gas. The plant thus preferably comprises such a further separator downstream the gas outlet of the storage bin for separating any residual fine material from the collected preconditioning gas.

[0023] For a similar reason as above, it may be advantageous to mix the preconditioning gas collected in sub-step (f3) with additional heated drying gas from the drying gas source before the feeding to the further separator of sub-step (f4) in order to avoid that the gas temperature drops below the dew point in the further separator. The plant thus preferably provides for appropriate conduits and mixing arrangement.

[0024] The drying gas source in the context of the invention may be any appropriate source of hot gases, such as a drying gas generator. In particular, if available, such a source of hot gases may use hot off-gases from other processes in vicinity of the grinding and drying plant, preferably a low calorific value gas with low hydrogen content, such as blast furnace gas.

[0025] If necessary or desired, the drying gas source comprises a burner equipment with sufficient heating capacity to heat the drying gas at temperatures useful for drying the comminuted material. If the drying gas comes from other processes and already is at a relatively high temperature, a low capacity burner may be used to adjust the temperature as necessary.

[0026] The separator for collecting and separating the comminuted dry material from the drying gas (step (e)) can be one or more of any appropriate type, such as a bag filter, a cartridge filter, a cyclone, etc.

[0027] In a particularly preferred embodiment, all the drying gas from step (e) is recycled, part of it being used for the preconditioning of the coarse material in the

storage bin and part of it being used to dry the comminuted material in the comminuting equipment or mill (step (d)). Preferably at least the part for use in step (d) is mixed with hot drying gas from the drying gas source. More preferably all of the drying gas is mixed with said hot drying gas. As all the drying gas is recycled the plant does not require an off-gas stack after the separator. A further advantage is that the separator therefor does not need to filter the drying gas to the same degree. Indeed, as all of the drying gas is recycled and not released to the atmosphere, it is acceptable to have a certain amount of residual fine material or dust in the gas. Hence, less demanding separators may be used, thereby reducing procurement and operating costs (less expensive, requiring less maintenance) and increasing reliability (being less prone to clogging). In particular preferred embodiments the separator is a cyclone type separator. Depending on the actual gas flows to be cleaned, the separator thus preferably comprises one or more cyclones, still more preferably two or more cyclones in parallel arrangement.

[0028] The method and grinding and drying plant described herein may in principle be used for any coarse material to be comminuted and dried. Particularly preferred uses are grinding and drying of slag, such as blast furnace slag, or of coal, such as black coal, lignite or brown coal.

Brief Description of the Drawings

[0029] Preferred embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings in which:

Fig. 1 is a diagram illustrating an example of relative mill output depending on grindability and moisture.

Fig. 2 is a schematic of a conventional grinding and drying plant for comminuting coarse material into comminuted dry material;

Fig. 3 is a schematic of a first embodiment of a grinding and drying plant of the present invention for comminuting coarse material into comminuted dry material; and

Fig. 4 is a schematic of a second embodiment of a grinding and drying plant of the present invention for comminuting coarse material into comminuted dry material.

[0030] Further details and advantages of the present invention will be apparent from the following detailed description of several not limiting embodiments with reference to the attached drawings.

Description of Preferred Embodiments

[0031] Fig. 1 shows a diagram illustrating an example of relative mill output depending on grindability and moisture. In fact, this example shows the decrease of the output capacity when producing pulverized coal with 1 % residual moisture content and 80 % < 90 µm grain size distribution. The impacting parameters are the raw material moisture content (on an as received basis, i.e. ratio of water to wet material) and the grindability, reflected by the Hardgrove Grindability Index (HGI). As can be clearly seen in Fig. 1 and further explained above, the impact of raw material moisture content on the capacity of the mill can be significant.

[0032] Fig. 2 shows a conventional (prior art) explosion preventing type design of a grinding and drying plant 100, especially of a coal grinding and drying plant.

[0033] Raw material, e.g. coarse slag or coal is stored in a raw material storage bin 110 upstream the mill 130. In order to be processed into dried pulverized material, e.g. pulverized slag or coal, raw material is preferably supplied into the mill 130 by means of a variable speed (variable capacity) conveyor 115, e.g. a variable speed drag chain conveyor and/or a rotary valve. The through-put of the conveyor conditions, within the grinding and drying capacity limits of the plant, the actual output of the grinding and drying plant.

[0034] In case the bulk material to be ground and dried is combustible, e.g. in the case of coal, the resulting product is explosive and special attention has to be paid to the design of the process and of the plant, in order either to prevent/avoid explosions, primarily by keeping the oxygen concentration in the gases in contact with the explosive material below the so-called lower explosion limit value (explosion preventing design) or to protect the equipment and the environment against the effects of such explosions (explosion protecting design).

[0035] Drying energy is supplied by a variable capacity drying gas generator 120, fired with a combustible gas. As far as available, the combustible gas is preferably a low calorific value gas with low hydrogen content, e.g. blast furnace gas. Low

hydrogen content limits the water vapor content of the drying gas produced, thus increasing the drying efficiency. The drying gas generator 120 generally also includes a combustion air fan and an additional low capacity burner for high calorific value combustion gas, e.g. natural gas or coke oven gas, required for heating up the plant and possibly for supporting the combustion of the low calorific value combustion gas. As the close to stoichiometric combustion - avoiding high oxygen concentration in the flue gas - even of a low calorific value combustion gas - results in hot flue gas temperature levels in the order of magnitude of 1,000 °C and above, i.e. several times higher than what is acceptable inside the mill and in contact with the wet raw material, especially coal, to be dried, the hot flue gas produced inside the drying gas generator 120 has to be mixed up with a large flow rate of recycled waste drying gas, of about 100 °C, from conduit 170 in order to get an appropriate drying gas temperature in front of the mill, in the range of about 200 to 350 °C in case of coal, the actual value required being primarily conditioned by the moisture content of the raw material.

[0036] When available, hot off-gases from other processes, of suitable temperature range and limited oxygen content, may be used to replace at least partly, in ideal conditions whole of the drying gas produced by burning combustion gas in the drying gas generator.

[0037] In typical grinding and drying plants 100, comminution, normally grinding, and drying of the raw material is performed, largely in parallel, inside the mill 130. Material is ground e.g. between rotating rollers, balls etc., and a rotating grinding table or bowl, and moisture is evaporated in contact with the hot drying gas. The drying gas conveys the ground material into a classifier, usually integrated into the top part of the mill 130. Coarse material is eliminated from the drying gas flow and returned onto the grinding table or bowl, the fine (comminuted) material is transported by the cooled-down waste drying gas with increased water vapor content through conduit 135 into a downstream filter equipment 140 for gas-solid-separation, usually a bag filter.

[0038] Pulverized material separated from the waste drying gas is transferred through conduit 145 into a downstream storage or conveying equipment 150, e.g.

a fine material/product (pulverized coal) storage bin, a conveying hopper, a powder pump etc.

[0039] The waste drying gas is aspirated by the drying gas main fan 171, part of it is released as off-gas through the stack 160 into atmosphere, equaling the input of hot flue gas, evaporated moisture, false air etc., the balance is returned to the drying gas generator 120 through conduit 170, to be mixed up with the hot flue gas produced in the burner(s) of said generator 120.

[0040] In coal grinding, before startup, the plant 100 is flushed by means of an inert gas, normally nitrogen, bringing the oxygen concentration below the lower explosion limit value. In operation, most of the gas input, flue gas, water vapor, have a limited oxygen concentration, which, in combination with the oxygen release in the waste drying off-gas through the stack 160, keeps the oxygen concentration low and thus the plant in inert, explosion preventing conditions.

[0041] While keeping the drying gas circuit in inert conditions, it may be useful to inject complementary air, frequently called dilution air, through conduit 172 into that circuit, up to the maximum allowable oxygen concentration. This input of cold air additionally (slightly) increases the required drying energy output of the drying gas generator 120, i.e. more flue gas is produced. The combined additional input of air and flue gas, balanced by an increased off-gas flow rate, reduces the water vapor content of the drying gas, the dew point in the drying gas is lowered and drying efficiency is increased. The dilution air is supplied by a dedicated fan 173, shown next to the drying gas generator 120 in Fig. 2.

[0042] In the embodiment of a grinding and drying plant 200 shown in Fig. 3, instead of releasing part of the waste drying gas through an off-gas stack 160 (see Fig. 2) downstream the drying gas main fan, whole of the waste drying gas is recycled through conduit 270 to the drying gas generator 220 and mixed with hot flue gas to produce hot drying gas with the appropriate mill inlet temperature level. A larger part of this hot drying gas is then generally supplied to the mill 230, the balance is supplied to the raw material storage bin 210 via conduit 275 and injected into the lower (conical) part of the bin 210 through inlets 276. The hot drying gas injected into the bin 210 flows through the raw material bed, heats the raw material up, evaporates part of the raw material moisture, is cooled down and

leaves the bin 210 at the top. The waste drying gas leaving the raw material storage bin 210 is cleaned in a downstream off-gas bag filter 280 and finally released into atmosphere through off-gas stack 290; the fine solid material separated from the off-gas is transferred into the fine material / product bin 250. The raw material of decreased moisture content is transferred from the raw material storage bin 210 into the mill 230, to be processed into dried fine material.

[0043] As compared to the conventional design of Fig. 2, the reduced raw material moisture content upstream the mill 230 results in a reduced drying gas flow rate to be supplied to the mill 230 (within the limits of the drying gas flow rate range fixed by the mill), (as conditioned by this drying gas flow rate) a reduced gas-solid-separation equipment 240 (bag filter) size, a reduced through-put of the drying gas main fan 271 and finally a reduced mill 230 size. The capacity of the drying gas generator 220, however, basically remains the same, additional drying energy being supplied into the raw material storage bin 210, respectively the total moisture amount to be eliminated (raw material to be heated up, water to be heated up and to be evaporated) remaining unchanged.

[0044] The pressure level in the circuit is controlled (via the control of the off-gas flow) in such a way as to have downstream the drying gas generator 220 and upstream the mill 230 and the raw material storage bin 210 an appropriate overpressure level for conveying the given drying gas flow rate through the raw material storage bin 210 and the downstream bag filter 280 and stack 290 (off-gas pipe) into atmosphere. Alternatively or additionally, the pressure level downstream the drying gas generator 220 and upstream the mill 230 and the raw material storage bin 210 can be fixed at a lower level, while the drying gas flow through the raw material storage bin 210 and the downstream bag filter 280 and stack 290 (off-gas pipe) into atmosphere is conveyed by an additional suction fan (not shown) installed downstream the bin 210 or the off-gas bag filter 280.

[0045] Depending on the filling level of the raw material storage bin 230 when starting the input of hot drying gas into that bin, the waste drying gas leaving the bin could have been cooled-down to a temperature level close to or below the dew point, which would strongly impair the operation of the downstream off-gas bag filter 280. In a preferred embodiment, an additional hot drying gas line may be

installed, by-passing the raw material storage bin 210 and allowing mixing cold waste drying gas with hot drying gas in order to reach an appropriate temperature level in front of the off-gas bag filter 280. In case of a large capacity raw material storage bin, it is also contemplated to have the drying gas to solid material heat exchange and water evaporation only take place in the lower part of the bin, and have the waste drying gas leave the bin 210 at a level lower than the top.

[0046] The design of the grinding and drying plant with a preconditioning step according to the invention avoids or reduces a significant disadvantage of a conventional design sized for a (potentially) high inlet moisture content, in case this conventional design has to be operated with raw material of an actual moisture content significantly lower than the design moisture content and/or at an output flow rate significantly lower than the design output flow rate, this disadvantage being the substantially increased specific electrical energy requirement of the mill, when this mill is operated at a capacity level or grinding energy input significantly lower than its nominal input.

[0047] The solution outlined above having aimed at reducing the size and capacity of the equipment to be installed in a new plant, in order to reach a given fine material capacity or product output, may in principle as well be used to increase the capacity of an existing plant, provided the limitation of the capacity is in the mill and caused by a high moisture content of the raw material. In this case, the capacity of the drying gas generator might have to be increased; respectively an additional drying gas generator might have to be installed, to heat up the gas to be supplied into the raw material storage bin. In case the existing raw material storage bin cannot accommodate the additional equipment required for the pre-drying of the raw material, it may be suitable as well to install an additional bin, specifically dedicated to and sized for the heat transfer from the drying gas to the raw material, upstream the existing raw material storage bin.

[0048] Further potential cost savings are possible with an embodiment as shown in Fig. 4. This embodiment of a grinding and drying plant 200a includes the installation of a multiple cyclone 240a instead of the bag filter downstream the mill 230, as whole of the waste drying gas is recycled to the mill 230 or supplied to the raw material storage bin 210, respectively no waste drying gas is released

downstream the initially considered bag filter into atmosphere. The residual solid material content in the waste drying gas is significantly higher downstream a multiple cyclone than downstream a bag filter, but the equipment costs are significantly lower. Conversely, the dust content to be expected in the waste drying off-gas downstream the raw material storage bin is low and the installation of a cartridge filter rather than of a conventional bag filter may reduce equipment costs in that area.

[0049] The raw material preconditioning concept described herein has been analyzed for the case of an existing 50 t/h coal grinding and drying plant, producing 80 % < 90 µm pulverized coal out of raw coal of nominal 12 % water content. It would be possible to replace the initially required mill by the next smaller size and reduce the capacity of the bag filter and the main drying gas fan. In nominal conditions, i.e. 50 t/h of 80 % < 90 µm pulverized coal out of raw coal of 50 HGI grindability and 12 % water as received, the reduction of the total electrical process energy requirement has been estimated to amount to about 22 %, primarily due to the lower requirement of the mill (lower moisture content) and of the drying gas main fan (lower waste drying gas flow rate).

Legend:

Ref. #	Designation	Alternative designation
Fig. 2 (Prior art)		
100	Grinding and drying plant	
110	Coarse material hopper	Coarse material storage bin
115	Coarse material conveyer	
120	Drying gas generator	
130	Comminuting equipment	Mill
135	Conduit	
140	Separator	Filter equipment
145	Conduit	
150	Comminuted material hopper	
160	Stack	Off-gas stack
170	Recycling line	
171	Recycling main fan	
172	Dilution air conduit	
173	Dilution air fan	
Fig. 3 and 4		
200, 200a	Grinding and drying plant	
210	Coarse material hopper	
215	Coarse material conveyer	
220	Drying gas generator	
230	Comminuting equipment	Mill
235	Conduit	
240, 240a	Separator	Filter equipment Specifically 240: bag filter Specifically 240a: cyclone
245	Conduit	
250	Comminuted material hopper	
270	Recycling line	
271	Recycling main fan	
272	Dilution air conduit	
273	Dilution air fan	
275	Conduit	
276	Inlets	Storage bin inlets
280	Further separator	Further bag filter
290	Stack	Off-gas stack

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Revendications

- 5 1. Procédé de production d'une matière sèche fragmentée à partir d'une matière grossière, le procédé comprenant les étapes de :
- (a) fourniture d'un gaz de séchage chauffé provenant d'une source de gaz de séchage ;
- (b) fourniture de la matière grossière dans un bac de stockage ;
- 10 (c) alimentation de ladite matière grossière et dudit gaz de séchage chauffé dans un équipement de fragmentation ;
- (d) fragmentation et séchage de ladite matière grossière à l'intérieur dudit équipement de fragmentation pour obtenir une matière sèche fragmentée ;
- 15 (e) collecte d'un mélange de gaz de séchage et de matière sèche fragmentée à partir de l'équipement de fragmentation et alimentation du mélange dans un séparateur pour séparer la matière sèche fragmentée du gaz de séchage ;
- caractérisé en ce qu'il comprend en outre l'étape de
- 20 (f) recyclage d'au moins une partie du gaz de séchage de l'étape (e) en tant que gaz de préconditionnement et alimentation dudit gaz de préconditionnement dans une partie inférieure dudit bac de stockage pour préconditionner la matière grossière.
- 25 2. Procédé selon la revendication 1, dans lequel l'étape (f) comprend une sous-étape (f1) de mélange du gaz de préconditionnement avec du gaz de séchage chauffé provenant de la source de gaz de séchage avant l'alimentation dans la partie inférieure dudit bac de stockage.
- 30 3. Procédé selon la revendication 1 ou 2, dans lequel l'étape (f) comprend une sous-étape (f2) d'ajustement de la pression du gaz de

préconditionnement avant l'alimentation dans la partie inférieure dudit bac de stockage.

- 5 4. Procédé selon l'une quelconque des revendications 1 à 3, dans lequel l'étape (f) comprend une sous-étape (f3) de collecte du gaz de preconditionnement au niveau d'une partie supérieure dudit bac de stockage.
- 10 5. Procédé selon la revendication 4, dans lequel l'étape (f) comprend une sous-étape (f4) d'alimentation du gaz de preconditionnement collecté à la sous-étape (f3) vers un autre séparateur pour séparer une quelconque matière fine résiduelle du gaz de preconditionnement.
- 15 6. Procédé selon la revendication 5, dans lequel le gaz de preconditionnement collecté à la sous-étape (f3) est mélangé avec du gaz de séchage chauffé provenant de la source de gaz de séchage avant l'alimentation vers l'autre séparateur de la sous-étape (f4).
- 20 7. Procédé selon l'une quelconque des revendications 1 à 6, dans lequel la source de gaz de séchage fournit des gaz de dégagement chauds provenant d'autres processus, préférablement un gaz à faible valeur calorifique avec une faible teneur en hydrogène, tel qu'un gaz de haut-fourneau.
- 25 8. Procédé selon l'une quelconque des revendications 1 à 7, dans lequel la source de gaz de séchage comprend un équipement de brûleur.
- 30 9. Procédé selon l'une quelconque des revendications 1 à 8, dans lequel le séparateur à l'étape (e) comprend un cyclone ou plus, préférablement deux cyclones ou plus dans un agencement parallèle.

10. Procédé selon l'une quelconque des revendications 1 à 8, dans lequel la matière grossière est un laitier, tel qu'un laitier de haut-fourneau, ou un charbon, tel que de l'anhracite, de la lignite ou de la houille brune.
- 5 11. Installation de broyage et de séchage pour produire une matière sèche fragmentée à partir d'une matière grossière, l'installation de broyage et de séchage comprenant :
- une source de gaz de séchage chauffé pour fournir un gaz de séchage chauffé à une température prédéfinie ;
 - 10 - un bac de stockage de matière grossière pour stocker temporairement ladite matière grossière ;
 - un équipement de fragmentation pour fragmenter et sécher ladite matière grossière pour obtenir une matière sèche fragmentée ;
 - un équipement d'alimentation de matière grossière pour
15 alimenter une matière grossière dudit bac de stockage de matière grossière dans l'équipement de fragmentation ;
 - des conduites pour alimenter ledit gaz de séchage chauffé dans l'équipement de fragmentation ;
 - un séparateur en aval de l'équipement de fragmentation pour
20 collecter et séparer la matière sèche fragmentée du gaz de séchage ;
- caractérisée en ce que l'installation de broyage et de séchage comprend des conduites de recyclage en aval du séparateur pour recycler au moins une partie du gaz de séchage en tant que gaz de préconditionnement
25 dans une partie inférieure dudit bac de stockage de matière grossière pour préconditionner la matière grossière à l'intérieur du bac de stockage de matière grossière.
- 30 12. Installation de broyage et de séchage selon la revendication 11 comprenant un agencement de mélange à l'intérieur des conduites de recyclage pour mélanger le gaz de préconditionnement avec du gaz de

séchage chauffé provenant de la source de gaz de séchage avant l'alimentation dans la partie inférieure dudit bac de stockage.

- 5 13. Installation de broyage et de séchage selon la revendication 11 ou 12, comprenant un moyen d'ajustement de pression pour ajuster la pression du gaz de préconditionnement avant l'alimentation dans la partie inférieure dudit bac de stockage.
- 10 14. Installation de broyage et de séchage selon l'une quelconque des revendications 11 à 13, dans laquelle le bac de stockage de matière grossière comprend une sortie de gaz agencée dans une partie supérieure de celui-ci pour collecter le gaz de préconditionnement.
- 15 15. Installation de broyage et de séchage selon la revendication 14, comprenant un autre séparateur en aval de la sortie de gaz pour séparer une quelconque matière fine du gaz de préconditionnement collecté.
- 20 16. Installation de broyage et de séchage selon l'une quelconque des revendications 11 à 15, dans laquelle la source de gaz de séchage est agencée pour fournir des gaz de dégagement chauds provenant d'autres processus, préférablement un gaz à faible valeur calorifique avec une faible teneur en hydrogène, tel qu'un gaz de haut-fourneau.
- 25 17. Installation de broyage et de séchage selon l'une quelconque des revendications 11 à 16, dans laquelle la source de gaz de séchage comprend un équipement de brûleur.
- 30 18. Installation de broyage et de séchage selon l'une quelconque des revendications 11 à 17, dans laquelle le séparateur pour collecter et séparer la matière sèche fragmentée du gaz de séchage comprend un cyclone ou plus, préférablement deux cyclones ou plus dans un agencement parallèle.

19. Installation de broyage et de séchage selon l'une quelconque des revendications 11 à 18, pour broyer et sécher un laitier, tel qu'un laitier de haut-fourneau, ou un charbon, tel que de l'anhracite, de la lignite ou de la houille brune.

Fig. 1

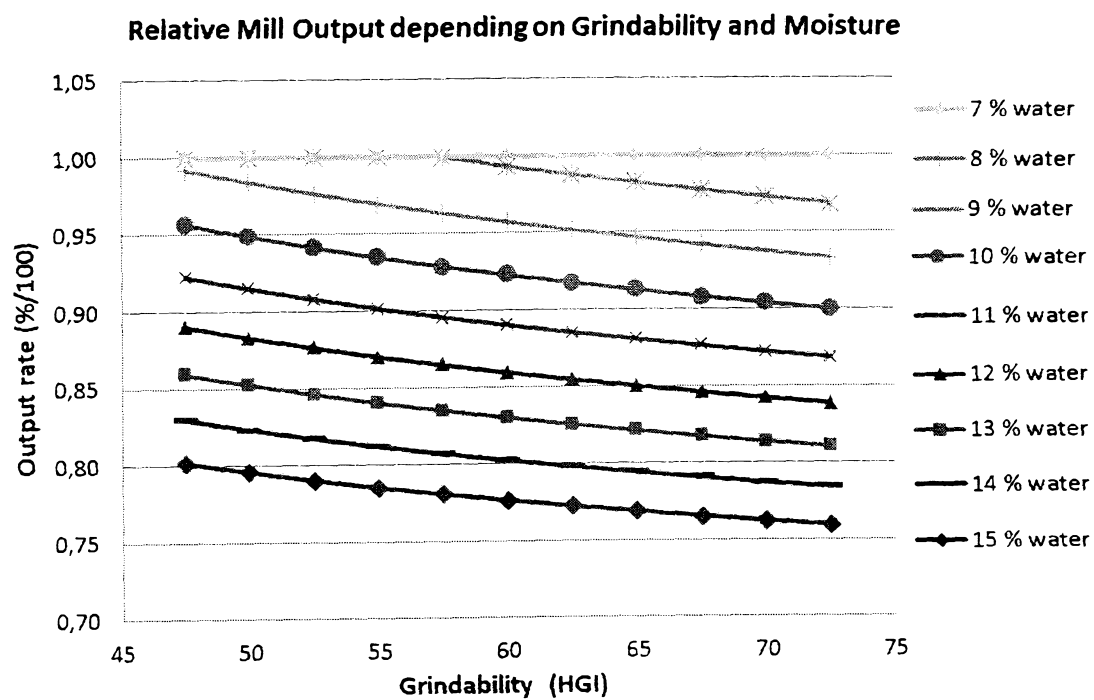


Fig. 2 (Prior art)

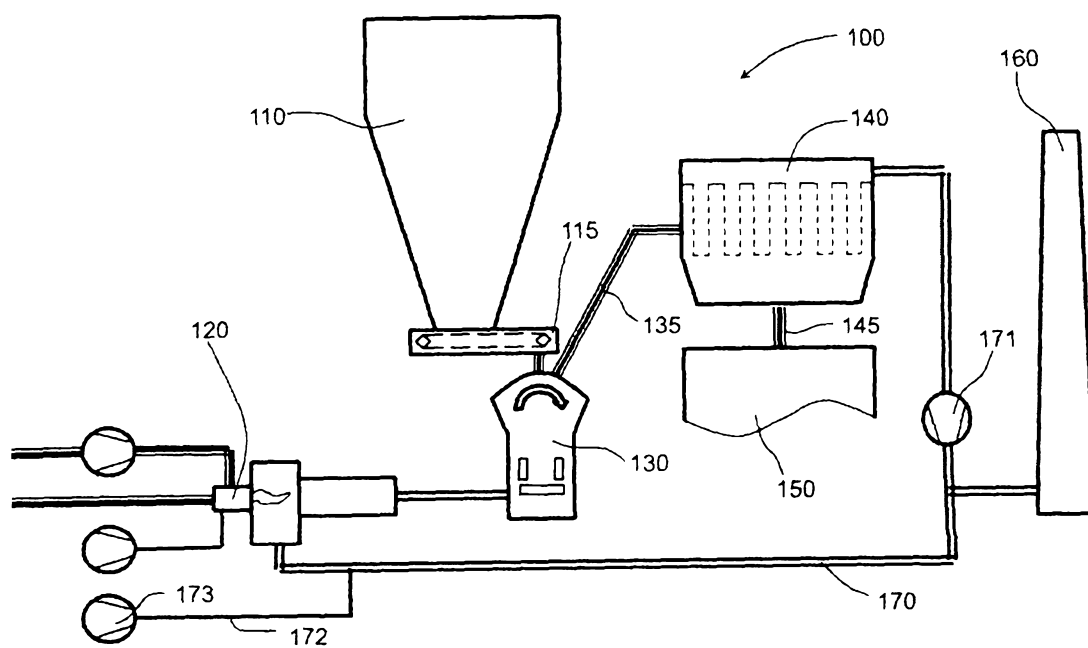


Fig. 3

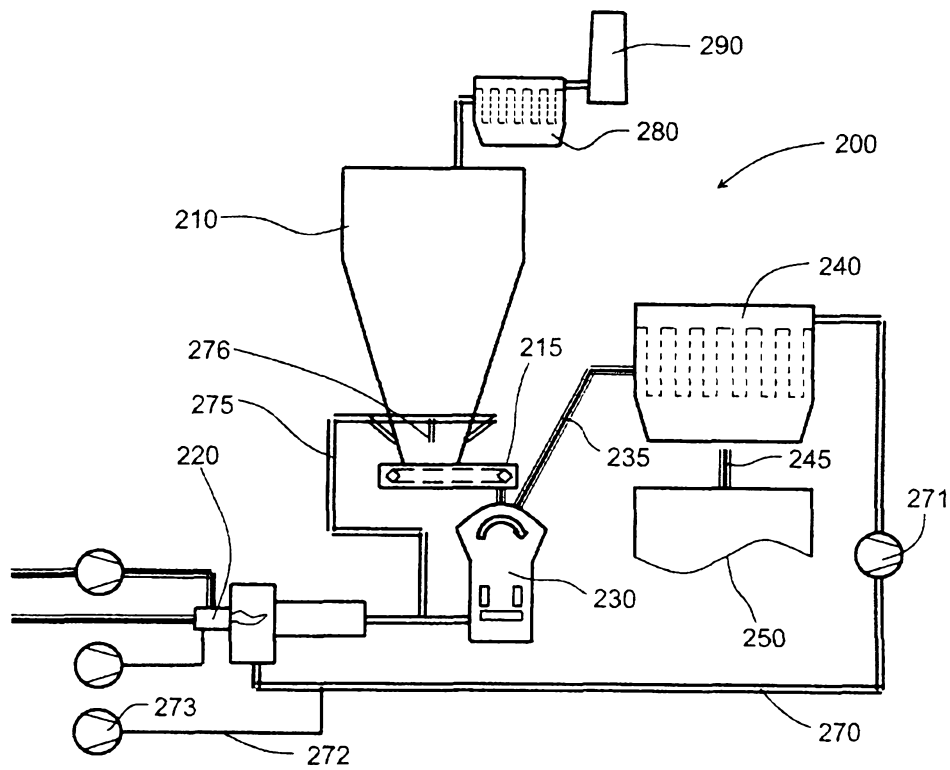
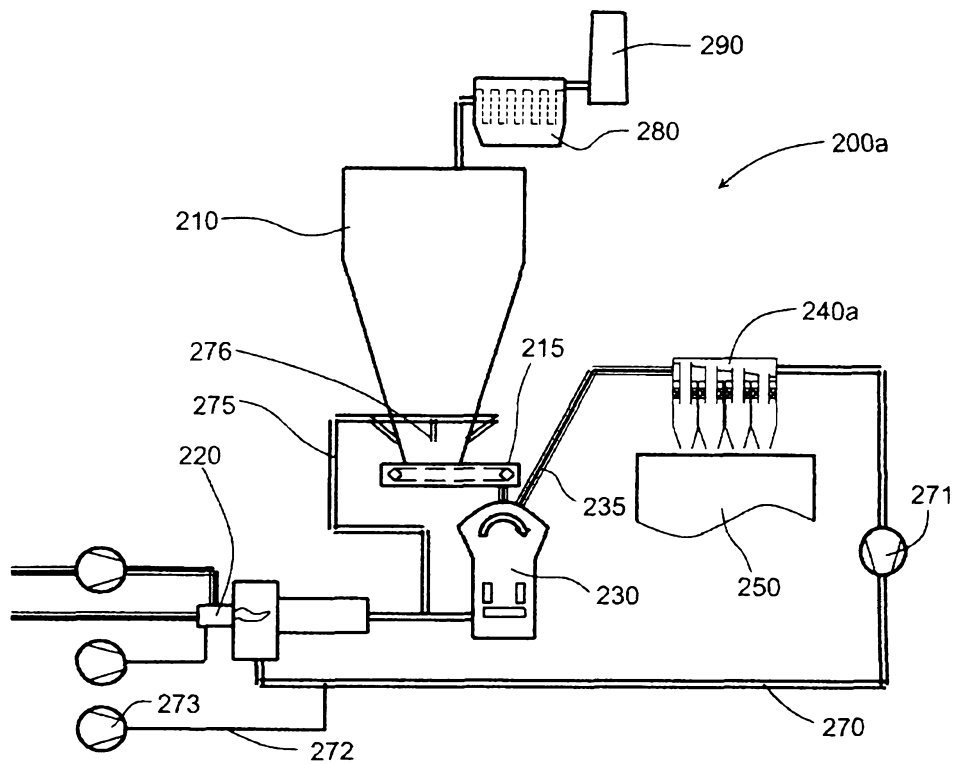


Fig. 4



Abstract

A method for producing a comminuted dry material from a coarse material, the method comprising the steps of: (a) providing a heated drying gas from a drying gas source; (b) providing the coarse material in a storage bin; (c) feeding said coarse material and said heated drying gas into a comminuting equipment; (d) comminuting and drying said coarse material within said comminuting equipment to obtain a comminuted dry material; (e) collecting a mixture of drying gas and comminuted dry material from the comminuting equipment and feeding the mixture to a separator to separate the comminuted dry material from the drying gas; wherein the method further comprises the step of (f) recycling at least part of the drying gas from step (e) as a preconditioning gas and feeding said preconditioning gas into a lower part of said storage bin to precondition the coarse material.

(Fig. 3)



SEARCH REPORT
in accordance with Article 35.1 a)
of the Luxembourg law on patents
dated 20 July 1992

LO 1242
LU 92916

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2002/023976 A1 (POESCHL FRANZ [DE]) 28 February 2002 (2002-02-28) * figures 1,3 *	1-19	INV. B02C23/02 B02C21/00
A	GB 2 129 707 A (ORENSTEIN & KOPPEL AG) 23 May 1984 (1984-05-23) * figures *	1-19	
A	US 5 353 997 A (KASSECK KLAUS [DE] ET AL) 11 October 1994 (1994-10-11) * figure 1 *	1-19	
A	DE 12 00 655 B (MIAG MUEHLENBAU & IND GMBH) 9 September 1965 (1965-09-09) * figures 1,2 *	1-19	
			TECHNICAL FIELDS SEARCHED (IPC)
			B02C
The present search report has been drawn up for all claims			
		Date of completion of the search 4 July 2016	Examiner Kopacz, Ireneusz
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

**ANNEX TO THE SEARCH REPORT
ON LUXEMBOURG PATENT APPLICATION NO.**

LO 1242
LU 92916

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

04-07-2016

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DE 1200655	B	09-09-1965	NONE



WRITTEN OPINION

File No. LO1242	Filing date (day/month/year) 17.12.2015	Priority date (day/month/year)	Application No. LU92916
International Patent Classification (IPC) INV. B02C23/02 B02C21/00			
Applicant PAUL WURTH S.A.			

This report contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the application
- ☐ Box No. VIII Certain observations on the application

Form LU237A (Cover Sheet) (January 2007)	Examiner Kopacz, Ireneusz
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WRITTEN OPINION

Application No.

LU92916

Box No. I Basis of the opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:
 - a. type of material:
 - ☐ a sequence listing
 - ☐ table(s) related to the sequence listing
 - b. format of material:
 - ☐ on paper
 - ☐ in electronic form
 - c. time of filing/furnishing:
 - ☐ contained in the application as filed.
 - ☐ filed together with the application in electronic form.
 - ☐ furnished subsequently.
3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes: Claims	1-19
	No: Claims	
Inventive step	Yes: Claims	1-19
	No: Claims	
Industrial applicability	Yes: Claims	1-19
	No: Claims	

2. Citations and explanations

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 Reference is made to the following documents:

D1: US2002023976

D2: GB2129707

D3: US5353997

D4: DE1200655

2 **Claims 1,11**

D1 discloses in fig.1 a milling and drying plant and a method for a mill drying process for clinker, metallurgical sand, coal and all other mineral and rock, the plant comprising:

- a source of heated drying gas for providing heated drying gas at a predefined temperature (see 3 and 6 in fig.1; par. 39);

- a coarse material storage bin for temporarily storing said coarse material (see 31 in fig.3 and par. 46);

- a comminuting equipment for comminuting and drying said coarse material to obtain a comminuted dry material (see 2 in fig.1);

- a coarse material feeding equipment for feeding coarse material from said coarse material storage bin into the comminuting equipment (see 30, 32, 25 in fig.3 and par. 4);

- conduits for feeding said heated drying gas into the comminuting equipment (see 6 in fig.1);

- a separator (see 8 in fig.1) downstream the comminuting equipment for collecting and separating the comminuted dry material from the drying gas.

The subject-matter of claims 1,11 differs from D1 in the characterizing features and is therefore new.

The distinguishing features lead to reducing the moisture of the raw material, which enable a number of savings, for example, use of a smaller mill, reduction of the required drying gas easier and steadier operation of the

grinding and drying process.

Accordingly the problem to be solved by the distinguishing features can be formulated to provide a an enhanced method and plant for production a comminuted dry material from a coarse material allowing for a more energy efficient operation.

The hitherto existing solutions to such the problem is to introduce hot gas into raw material ducts before the mill like in D2 (see entrance of the mill 12 through which hot gas 11 passes in counter current) or to include dryers prior the mill as disclosed in D3 (see 11 in fig.1) or D4 (see 3 in figs.1,2). Since none of the available documents suggests to include a storage bin for temporarily storing the coarse material with conduits for introducing heated gas recycled from the separator into the lower part of the storage bin for preconditioning the coarse material, the subject-matter of claims 1,11 appears to involve inventive step.

Claims 2-10, 12-19 are respectively dependent on claims 1,11 and as such also meet the requirements of novelty and inventive step.