(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 689 854 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
29.01.2014 Bulletin 2014/05

(21) Application number: **12460055.2**

(22) Date of filing: **28.08.2012**

(51) Int Cl.:
B02C 13/00 *(2006.01)* ***B02C 23/14*** *(2006.01)*
B02C 13/286 *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **26.07.2012 PL 40015012**

(71) Applicant: **Innowacyjne Przedsiebiorstwo Wielobranzowe**
Wielobranzowe POLIN sp. z.o.o.
40-028 Katowice (PL)

(72) Inventor: **Bis, Zbigniew**
42-215 Czestochowa (PL)

(74) Representative: **Szczepanska, Krystyna**
Kancelaria Rzecznika Patentowego
Szczepanska Krystyna
Ul. Orzegowska 20/16 m. 15
41-907 Bytom (PL)

(54) **Method of obtaining protected against caking ultrafine fractions of rain raw materials such as chalk, gypsum, limestone, and system for this method execution**

(57) Method of obtaining protected against caking, ultrafine particle fractions of raw materials such as chalk, gypsum and limestone in which the initial raw material is introduced to the impact mill (2), favourably a beater mill, where it is subject to crushing with simultaneous mechanical activation of particles, it is further delivered to the dynamic separator (4), it is subject to generation of fraction of particle sizes not exceeding 90 μm which is sent to the separating cyclone (5) where it is separated from the circulating gas and sent to the bunker (26), is according to the invention characterized by the fact that the obtained ultrafine loose material is, prior to further transport and storage, subject to customizing, i.e. mechanical decaking and activation and discharge of electrostatic charges from the surface of particles in mechanical disintegrator (11) with simultaneous mixing, preliminary aeration in the chute cone of mechanical disintegrator (11), and then it is subject to intense process of aeration in pneumatic pressure pump (13) and transported to storage vessel (14). According to the invention version, additional loose material, favourably a halloysite is delivered to mechanical disintegrator (11) from additional vessel or set of vessels (21).

The subject of the invention is also a system of this method execution.

In systems of equipment according to the invention, by the method according to the invention, very fine particle fractions are obtained which are protected against undesired caking during their processing, storage, customizing, transportation and intended use.

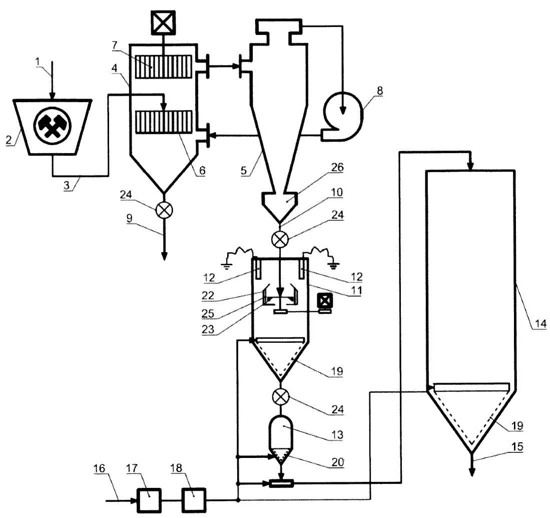

Fig. 1

EP 2 689 854 A1

Description

[0001] The subject of the invention is the method of obtaining protected against caking ultrafine fractions of particle raw materials such as chalk, gypsum and limestone, mechanically activated, of high reactivity, deprived of electrostatic charges and protected against undesired caking for the period of internal transport, storage, customizing and further distribution to the recipient and intended use. The subject of the invention is also a system for this method execution.

[0002] Materials having the characteristics reached according to the invention are intended for wide range of applications in different sectors of industry, in particular as sorbents for removal of toxic gases in power plants, as mixtures for road foundations mechanically stabilized, as agricultural limestone, as fillers for plastics and construction chemistry, as ground powdered chalk and limestone powder of reduced dust content, as fillers at obtaining different kinds of composites used as construction materials in different branches of technology, among others in building industry, aviation technology and astronautics, in the industry of road and rail means of transport, in manufacturing of machines, equipment and sports products.

[0003] Loose materials of very fine particle, below 90 μm, commonly referred to as powder or dust, find more and more applications in different branches of industry. It is due to their unique properties resulting from highly extended surface area and high reactivity in hetero- (gas/ liquid - solid) and homogenous (solid - solid) reactions.

[0004] Mineral fillers such as calcium carbonate are widely used in plastics industry, in production of paper, rubber, paints and in other branches of industry too. Power industry has an important place among the latest applications of fine ground calcium carbonate as it uses this raw material as an effective sorbent for removal of toxic gases. In this case, beside the size of ground calcium carbonate particles, a significant role is played by its reactivity whose improvement may be reached as an effect of increase of network defects concentration on the particles surface, improvement of internal porosity structure in particles and increase of separation surface between them, as a result of strictly controlled size reduction and classification processes of products grinding.

[0005] The loose materials of limestone, chalk, gypsum obtained in such a way and having the form of powders with particles smaller than 30-40 μm are still a serious problem for industry during their processing, storage, customizing and transport. Such type of powders have limited capacity for free flowing. These problems are manifested through considerable, even negative value of natural angle of repose resulting from high value of cohesion force, caused inter alia by Van der Waals attractive forces, electrostatic forces and adhesion forces, caused e.g. by material humidity or aeration gas. In numerous production and powder treatment processes, the appearance of electrostatic charges is an effect of repeated contacts between particles and between particles and pipeline walls, vessels and other structural elements with whom the particles of loose materials are in contact while they are lifted by the transporting agent.

[0006] In the known solutions, vibrations and air aeration applied in such cases frequently do not bring the expected effect and additionally they may contribute to enhancement of another, equally adverse process, i.e. compacting of particles. De-compacting of powders is one of the key and most difficult issues in production, customizing, transportation, storage and use of powders in different sectors of industry, in particular, where they are used as one of reagents. The probability of undesired powder caking occurrence increases when the forces of interaction between the particles much exceed the gravitation and aerodynamic forces, acting on individual particles of powder.

[0007] It is confirmed that particles in polydispersed mixtures of loose materials have both positive and negative (bipolar) electric charges, whereas distribution of charge in the function of particle sizes or quotient of particle charge value and its mass play an important role in its behaviour in different applications of loose materials in industry. These properties are of special importance during transportation and long-term storage in vessels for fine particle loose materials - dusts. In such a case, the presence of bipolarly charged particles contributes to enhancement of inclination to congestions on outlets of vessels and pneumatic transport hoses, it also increases the risk of electrostatic discharge and ignition. Bipolarity of charges in polydispersed mixture of particles may also be an essential obstacle in separation of such materials into particle fractions, and especially in separation of very fine sizes, below 40 μm.

[0008] The Polish patent no 159116 contains a description of a storage pressure vessel for powder materials of difficult fluidization, in its upper part equipped with filtration chamber and fabric filters and inlets of loading and dust removing pipes, having the bottom part of cylinder ended with reversed truncated cone, equipped from the bottom part with an air chamber with micro-pore partition in the shape of reversed cone whose base diameter is at least 0.4 of the internal diameter of the vessel, having an inlet to the unloading pipe located above the micro-pore partition. This vessel is equipped with three stage system of compressed air separation from the powder material loaded - this system consists of cyclone, fabric filters and filtration chamber playing the role of sedimentation chamber.

[0009] The Polish patent no 182596 contains a description of powder pumping by means of compressed air and a description of powder vessel pump where the powder is aerated in a tightly closed vessel until the it gets saturated with the air so that the compressed air pressure in the vessel in this moment does not overcome the flow resistance of the air and powder mixture in the transporting pipe, and after reaching this state of aeration the transporting pipeline opens. The vessel powder pump is composed of a tight vessel equipped in the upper part with powder inlet unit with a valve, air pipeline supplying compressed air to the vessel with the outlet inside the vessel near its bottom and a transporting pipeline with a valve and manometer removing the mixture of powder and air with the outlet in the area of air hose outlet and it has a venting pipeline connecting the pump tank with dust vessel or hopper of electrostatic precipitator, or bag filter, by-pass pipeline connecting the collector of compressed air with the pump vessel, additional compressed air pipeline connecting the transporting compressed air collector with transporting pipeline and decompressing pipeline connecting the pump tank with the powder storage vessel or hopper of electrostatic precipitator, or bag filter. The vessel dust pump has a vessel conically converging downwards where the vertex of a cone is cut off by an exchangeable aeration disk tightened with the bolts between the upper and lower pump flange, composed of perforated upper metal plate, aeration fabric and perforated lower metal plate. The outlet of transporting compressed air is located in the space between the pump bottom and aeration disk. The compressed air penetrates through the aeration disk causing its mixing with powder mass tightly closed in the pump tank. After reaching the state of dust saturation with the air, the valve on transporting pipeline opens and dense mixture of compressed air and powder is pressed to the transporting pipeline outlet located in the bottom part of the vessel above the aeration disk.

[0010] The Polish patent no 197004 contains a description of storage vessel for fine particle materials such as ashes from power industry, limestone dust, products of desulfurization, ground or fine crushed slag, in the form of a cylinder placed on foundations with a cone inside, having aeration cartridges in the lowest part of the interior, central drainage of fine particle material and circulation of process air containing a contraction inclined at the 10 - 20° angle to the outer casing of the vessel where the D_1 diameter of the bottom edge of this contraction is 0.75-0.85 of the internal vessel D diameter, and the D_2 diameter of the cone base is 0.5-0.6 of the internal vessel D diameter. The vessel bottom has an inclination on which aeration chutes are placed through which section aeration of the vessel bottom is executed. The supporting cone space is filled with fine particle material stored, and in the cone, above the material, there is a space where process air for aeration is collected.

[0011] Solutions known in the currently applied technologies are related to individual equipment used for collecting and storage and further transportation of loose materials which, however, do not eliminate the risk of undesired caking occurrence.

[0012] The purpose of this invention is development of an effective method of obtaining ultrafine, mechanically activated particle fractions of such raw materials as chalk, gypsum and limestone which are at the same time deprived of electrostatic charges and protected against undesired caking during their processing, storage, customising and transportation, and intended use, as well as development of a system for this method execution.

[0013] The method of obtaining protected against caking, ultrafine particle fractions of raw materials such as chalk, gypsum and limestone in which the raw material is initially inserted to the impact mill, most favourably beater mill, where it is crushed with simultaneous mechanical activation of particles, the product obtained being a polydispersed mixture of particles in a wide range of particle sizes is sent through the pneumatic transport line to a dynamic separator where thick fraction of particle sizes exceeding 90 μm is separated and discharged through the unloading system outwards of the dynamic separator, whereas from the factions of particle sizes below 90 μm lifted by the stream of circulating gas to the upper part of dynamic separator a desired size is separated, most favourably below 40 μm and it is sent to the separating cyclone where it is separated from the circulating gas and sent to the bunker - is according to the invention characterized by the fact that the obtained ultrafine loose material collected in the bunker under separating cyclone is subject to customizing prior to further transport and storage. Customizing means that the fine ground loose material mechanically activated in the impact mill is gravitationally delivered through the unloading system, most favourably through a chamber dispenser to the mechanical disintegrator in which the particles are subject to mechanical de-caking and activation and discharge of electrostatic charges from the electrified particle surfaces through their free collisions and elements of permanent palisade of impact bars and elements collecting electrostatic charges - rod shape metal electrodes or favourably freely hanging metal tapes - located on the whole rim of mechanical disintegrator. Further, after leaving the working chamber of mechanical disintegrator, the material is sent to the chute cone of mechanical disintegrator where by means of aeration elements it is subject to preliminary aeration, and subsequently, the pre-aerated loose material from mechanical disintegrator is transported to pneumatic pressure pump equipped with aeration inserts where it is subject to further intense aeration process and then pneumatically transported by means of high and homogenous concentration stream to the storage vessel.

[0014] According to the invention option, the method of obtaining protected against caking, ultrafine particle fractions of raw materials such as chalk, gypsum and limestone in which the raw material is initially inserted to the impact mill, most favourably beater mill, where it is crushed with simultaneous mechanical activation of particles, the product obtained being a polydispersed mixtures of particles in a wide range of particle sizes is sent through the pneumatic transport line to a dynamic separator where thick fraction of particle sizes exceeding 90 μm is separated and discharged through the unloading system outwards of the dynamic separator, whereas from the factions of particle sizes below 90 μm lifted by the stream of circulating gas to the upper part of dynamic separator a desired size is separated, most favourably below 40 μm and it is sent to the separating cyclone where it is separated from the circulating gas and sent to the bunker - is characterized by the fact that the obtained ultrafine loose material collected in the bunker under separating cyclone is subject to customizing prior to further transport and storage. Customizing means that the fine ground, mechanically activated in the impact mill loose material is gravitationally delivered through the unloading system, most favourably through chamber dispenser to the mechanical disintegrator to which simultaneously an additional loose material is delivered from additional vessel or set of vessels equipped with aeration elements, favourably through chamber dispenser - the loose material is favourably a halloysite in the quantity not exceeding 15% weight, the introduced constituents are thoroughly mixed in the mechanical disintegrator and particles are subject to mechanical de-caking and activation and discharge of electrostatic charges from the electrified particle surfaces through their free collisions and elements of permanent palisade of impact bars and elements collecting electrostatic charges - rod shape metal electrodes or favourably freely hanging metal tapes - located on the whole rim of mechanical disintegrator. Further, after leaving the working chamber of mechanical disintegrator, the material is sent to the chute cone of mechanical disintegrator where by means of aeration elements it is subject to preliminary aeration, and subsequently, the pre-aerated loose material from mechanical disintegrator is transported to pneumatic pressure pump equipped with aeration inserts where it is subject to further intense aeration process and then pneumatically transported by means of high and homogenous concentration stream to the storage vessel.

[0015] During unloading of the storage vessel, in order to preserve the reached desired properties of ultrafine loose material, it is subject to favourably further aeration with the air under pressure from 0.03 to 0.12 MPa, favourably 0.04 MPa by means of aeration elements built in the lower conical part of the storage vessel, favourably in the shape of hoses made of unwoven cloth permeable from one side inwards the chute cone of the storage vessel.

[0016] Favourably, on each stage of the loose material aeration process, the stream of air is introduced which was previously subject to filtration process.

[0017] Favourably, on each stage of the loose material aeration process, the stream of air is introduced which was previously subject to drying process.

[0018] Favourably, on each stage of the loose material aeration process, the stream of air of humidity not exceeding -5° of dew-point is introduced.

[0019] In the chute cone of mechanical disintegrator, in the preliminary aeration process, the air under pressure from 0.03 to 0.12 MPa, favourably 0.04 MPa is introduced by means of aeration elements, by the stream directed to the chute opening.

[0020] In the outlet hoppers of pneumatic pressure pump, in further aeration process, the air under pressure from 0.03 to 0.12 MPa, favourably 0.05 MPa is sent through aeration inserts.

[0021] In the lower, conical part of the vessel or additional vessels present in the system, according to the invention option, the air under pressure from 0.03 to 0.12 MPa, favourably 0.04 MPa is introduced by means of aeration elements.

[0022] In the working chamber of mechanical disintegrator, the loose material delivered from bunker under separation cyclone, or in the invention option, loose material delivered from the bunker under separation cyclone and loose material delivered from additional vessel or vessels is subject to intense mixing and the particles are given centrifugal acceleration by means of an agitator.

[0023] The essence of the invention is also a system for obtaining protected against caking, ultrafine particle fractions of raw materials such as chalk, gypsum and limestone, including an impact mill, favourably beater mill, crushing the excavated chalk, gypsum and limestone into fine fractions and a dynamic separator connected to the mill by means of pneumatic transport line, separating previously crushed material into desired sizes, separation cyclone and a bunker built below it whose characteristic feature is that behind the separation cyclone there is a mechanical disintegrator connected through the unloading system, favourably by means of chamber dispenser, to the bunker under separation cyclone, having a working chamber located inside the cylindrical tank where between the internal wall of the tank and external wall of the working chamber elements collecting electric charges are placed in the form of rod shape metal electrodes or favourably, freely hanging metal tapes, with aeration elements mounted on the wall of chute cone convergent towards the inlet opening of the vessel outlet pipe. The mechanical disintegrator is further connected by means of chamber dispenser to the pneumatic pressure pump equipped with aeration inserts of very high porosity and of shapes adjusted to the bottom, conical part of the pressure pump, and the further mechanical disintegrator is connected to the storage vessel in which the aeration elements are built on the walls convergent towards the outlet opening.

[0024] According to the invention option, the system for obtaining protected against caking, ultrafine particle fractions of raw materials such as chalk, gypsum and limestone, including an impact mill, favourably beater mill, crushing the excavated chalk, gypsum and limestone into fine fractions and a dynamic separator connected to the mill by means of pneumatic transport line, separating previously crushed material into desired sizes, separation cyclone and a bunker built below it whose characteristic feature is that behind the separation cyclone there is a mechanical disintegrator connected through the unloading system, favourably by means of chamber dispenser, to the bunker under separation cyclone, having a working chamber located inside the cylindrical tank where between the internal wall of the tank and external wall of the working chamber elements collecting electric charges are placed in the form of rod shape metal electrodes or favourably, freely hanging metal tapes, with aeration elements mounted on the wall of chute cone convergent towards the inlet opening of the vessel outlet pipe. The mechanical disintegrator is further connected by means of chamber dispenser to the pneumatic pressure pump equipped with aeration inserts of very high porosity and of shapes adjusted to the bottom, conical part of the pressure pump, and the further mechanical disintegrator is connected to the storage vessel in which the aeration elements are built on the walls convergent towards the outlet opening. Moreover, the system contains at least one additional vessel for loose materials, favourably connected by means of chamber dispenser to the mechanical disintegrator, having on the walls of the chute cone the aeration elements built convergent towards the inlet opening of the vessel outlet pipe.

[0025] The aeration elements built on the walls of chute cone of mechanical disintegrator and on the walls of chute cone of storage vessel are favourably in the shape of hoses made of unwoven cloth permeable from one side inwards the chute cone.

[0026] In the system, according to the invention option, the aeration elements built on walls of chute cone of the vessel or set of additional vessels are favourably in the shape of hoses made of unwoven cloth permeable from one side inwards the chute cone.

[0027] In the mechanical disintegrator with rod shaped metal electrodes mounted and collecting electrostatic charges, favourably an additional system of hammers to flick the loose material gathered on these electrodes is installed.

[0028] In the mechanical disintegrator with tape shaped metal electrodes mounted and collecting electrostatic charges, the tapes are favourably made of material having good elastic properties.

[0029] In the mechanical disintegrator, the elements collecting electrostatic charges in the form of metal rods and tapes are favourably hung on supports around the whole rim of working chamber.

[0030] In the working chamber of mechanical disintegrator an agitator is built, favourably in the form of a rotor composed of back plate with set of blades mounted to it, radially placed and with beaters on their ends.

[0031] The aeration inserts built in the pneumatic pressure pump are favourably made of micro-pore plastic.

[0032] The system according to invention contains air hoses supplied through filters and driers to the lower conical parts of the mechanical disintegrator vessels, pressure pump and storage vessel.

[0033] The system according to invention option contains air hoses supplied through filters and driers to the lower conical parts of the vessel or set of additional vessels.

[0034] In the method according to the invention the storage vessel is filled with the ultrafine loose material, mechanically activated, intensely and homogenously aerated, non-caked, of extensively spread active surface, whose particles are effectively deprived of electrostatic charges. Ultrafine fractions of chalk, gypsum and limestone obtained in this way may for a long time be stored in the storage vessel without the risk of lumping or secondary caking occurrence.

[0035] In the equipment system according to the invention, by method according to the invention, ultrafine particle fractions are obtained and they are protected against undesired caking during their processing, storage, customizing and transportation.

[0036] The subject of the invention is presented on the drawing on which fig.1 shows a diagram of the system (set of equipment) to obtain ultrafine, mechanically activated, deprived of electrostatic charges, protected against caking, fractions of raw materials such as chalk, gypsum and limestone in the basic version, fig.2 - a diagram (set of equipment) to obtain ultrafine, mechanically activated, deprived of electrostatic charges, protected against caking, fractions of raw materials such as chalk, gypsum and limestone in the version with additional vessel for loose materials.

[0037] The system to obtain protected against caking, ultrafine particle fractions of raw materials such as chalk, gypsum and limestone, according to the example presented on fig.1 consists of impact mill, beater mill 2 and a dynamic separator 4 connected to the mill through the pneumatic transport line 3, separation cyclone 5 with fan 8 and a bunker 26 built under the separation cyclone 5 which by means of unloading system 10 is connected to mechanical disintegrator 11 through the chamber dispenser 24 and further, by means of chamber dispenser 24, to the pneumatic pressure pump 13 equipped with aeration inserts 20 of very high porosity and shapes adjusted to the lower, conical part of the pressure pump 13, and further to the storage vessel 14, in whose lower conical part aeration elements 19 are built convergent towards the outlet opening, the elements are in the shape of hoses made of unwoven cloth permeable from one side inwards the chute cone of the storage vessel 14.

[0038] The mechanical disintegrator 11 has a working chamber 22 located inside the cylindrical vessel closed from above with the cover equipped with inlet pipe and from the bottom with chute cone with outlet pipe. The working chamber 22 is equipped with agitator 23 in the form of rotor composed of back plate with set of blades mounted to it, radially placed and with beaters on their ends. Between the internal wall of the vessel and external wall of the working chamber 22, freely hanging metal tapes 12 are installed on supports, around the whole rim, to collect electrostatic charges from electrified particles. On the walls of chute cone of mechanical disintegrator 11, aeration elements 19 are mounted convergent towards the inlet opening of the vessel outlet pipe in the shape of hoses made of unwoven cloth permeable from one side inwards the chute cone. The air hoses 16 are delivered to the chute cones of mechanical disintegrator

11, storage vessel 14 and chute hopper 20, pressure pump 13 through air filters 17 and driers 18.

[0039] The method of obtaining protected against caking, ultrafine particle fractions of raw materials such as chalk, gypsum and limestone, according to the example presented on fig.1 is that the excavated chalk, gypsum and limestone from a quarry is delivered by the supply system 1 to the impact mill, beater mill 2, where it is subject to crushing with simultaneous mechanical activation of particles occurring as a result of the particles being hit by beaters (hammers) and their exposure to instantaneous impulse of short-lasting force but of high amplitude value. The product which is a polydispersed mixture of particles in a wide range of particle sizes is delivered from the impact mill beater mill 2 through the pneumatic transport line 3 to the central part of dynamic separator 4 just above the stationary palisade of radially distributed plates 6 where as a result of centrifugal force, the thick fraction of particle sizes exceeding 90 μm is separated from the product and through the unloading system 9 discharged outside the dynamic separator 4, whereas from factions of particle sizes not exceeding 90 μm lifted by the stream of circulating gas to the upper part of dynamic separator 4, by means of a rotational palisade of adjustable speed 7 of radially placed blades the desired fine fraction of particle size below 40 μm is separated and sent to the separation cyclone 5 where it is separated from the circulating gas and sent to the bunker 26 under separation cyclone 5. The flow of circulating gas is forced by fan 8. The ultrafine loose material, mechanically activated in the impact mill 2, is sent through unloading system 10 by the inlet pipe to the central part of axisymmetric working chamber 22 of mechanical disintegrator 11, just above the agitator 23 in which the particles are subject to intense mixing, mechanical de-caking and activation and discharge of electrostatic charges from the surface of electrified particles through their mutual free collisions and their collisions with elements of permanent palisade of impact bars 25 and metal tapes 12 too.

To eliminate secondary caking process of particles depositing after leaving the working chamber 22 and delivering the loose material to the chute cone of mechanical disintegrator 11, it is subject to pre-aeration by means of aeration elements 19, the aeration is effected through introduction of preliminarily filtered air of humidity below -5°C of dew-point under 0.04 PMa pressure, with the stream directed to the chute opening. Preliminary aeration in the chute cone of mechanical disintegrator 11 improves free-flowing of material and facilitates gravitational leaving the disintegrator ensuring even and uniform outflow of material in the stream of high concentration.

[0040] The preliminary aerated loose material is transported from the mechanical disintegrator 11 through chamber dispenser 24 to the pneumatic pressure pump 13 where it is intensely aerated with the air under pressure not exceeding 0.05 MPa through the aeration insert 20 to prepare material for pneumatic transport by the stream of high and homogenous concentration to the storage vessel 14 located even in a long distance from the mechanical disintegrator 11. In this way the storage vessel 14 is filled with ultrafine loose material, mechanically activated, aerated, dry, non-caked, of highly spread active surface. Elimination of caking risk is reached as a result of prior discharge of electrostatic charges from the particles in the mechanical disintegrator 11 and intense and homogenous aeration of loose material charge, causing even occlusion of particles with molecules of air. The loose material prepared in such a way may be stored in the storage vessel 14 for a long time without a risk of lumping or secondary caking.

[0041] To preserve favourable properties of ultrafine loose material obtained in such a way during unloading of storage vessel 14 through the outlet pipe 15 it is subject to further aeration by means of preliminary filtered air of humidity below -5° of dew-point, introduced under 0.04 MPa pressure through the aeration elements 19.

[0042] In the invention version presented in the diagram on fig.2, the system contains an additional vessel 21 for loose materials connected by means of chamber dispenser 24 to mechanical disintegrator 11, having on chute cone walls the aeration elements 19 convergent towards the inlet opening of the outlet pipe of the vessel 21 to which the air hoses 16 are supplied through air filters 17 and dries 18.

[0043] In the method according to the invention version to the working chamber 22 of mechanical disintegrator 11, beside the ultrafine, mechanically activated in the impact mill 2 and separated in dynamic separator 4 loose material obtained from limestone, additional loose material, halloysite in the quantity of 12% weight, is simultaneously added from vessel 21, this materials is subject to prior aeration in vessel 21 by means of preliminarily filtered air of humidity below -5°C of dew-point, introduced through aeration elements 19 under 0.04 PMa pressure, and then the mixture of loose materials is subject to intense mixing, mechanical de-caking and activation of constituents. On further stage, this method is effected identically to the method presented on fig.1.

Claims

1. The method of obtaining protected against caking, ultrafine particle fractions of raw materials such as chalk, gypsum and limestone in which the raw material is preliminarily introduced to the impact mill, most favourably beater mill, where it is subject to crushing with simultaneous mechanical activation of particles; product obtained in such a way which is a polydispersed mixture of particles in a wide range of particle sizes is delivered to the dynamic separator through pneumatic transport line where the thick fraction of particle sizes exceeding 90 μm is separated and discharged through the unloading system outside the separator; whereas from the factions of particle sizes below 90 μm lifted to the upper part of

separator by the stream of circulating gas a desired fine fraction is separated, favourably below 40 μm, and sent to the separating cyclone where it is separated from the circulating gas and sent to the bunker, **features that** the obtained ultrafine loose material collected in the bunker (26) under separation cyclone (5) prior to further transportation and storage is subject to customization, i.e. fine, mechanically activated loose material separated from gas in the impact mill (2), is gravitationally delivered through the unloading system (10), most favourably through chamber dispenser (24) to mechanical disintegrator (11), in which the particles are subject to mechanical decaking and activation and discharge of electrostatic charges from electrified surfaces of particles through their mutual free collisions and collisions with elements of permanent palisade of impact rods (25) and elements collecting the electrostatic charges located around the whole rim of mechanical disintegrator (11) in the form of rod shape metal electrodes or freely hanging metal tapes (12), and further after leaving the working chamber (22) the material is sent to the chute cone of mechanical disintegrator (11) where by means of aeration elements (19) it is subject to preliminary aeration, then the preliminary aerated loose material from mechanical disintegrator (11) is transported to the pneumatic pressure pump (13) equipped with aeration inserts (20) where it is subject to further, intense aeration process, and then it is transported pneumatically by the stream of high and homogenous concentration to the storage vessel (14).

2. The method of obtaining protected against caking, ultrafine particle fractions of raw materials such as chalk, gypsum and limestone in which the raw material is preliminarily introduced to the impact mill, most favourably beater mill, where it is subject to crushing with simultaneous mechanical activation of particles; product obtained in such a way which is a polydispersed mixture of particles in a wide range of particle sizes is delivered to the dynamic separator through pneumatic transport line where the thick fraction of particle sizes exceeding 90 μm is separated and discharged through the unloading system outside the separator, whereas from the factions of particle sizes below 90 μm lifted to the upper part of separator by the stream of circulating gas a desired fine fraction is separated, favourably below 40 μm, and sent to the separating cyclone where it is separated from the circulating gas and sent to the bunker, **features that** the obtained ultrafine loose material collected in the bunker (26) under separation cyclone (5) prior to further transportation and storage is subject to customization, i.e. fine, mechanically activated loose material separated from gas in the impact mill (2), is gravitationally delivered through the unloading system (10), most favourably through chamber dispenser (24) to mechanical disintegrator (11), to which simultaneously additional loose material is delivered from additional vessel or set of vessels (21) equipped with aeration elements (19), favourably by means of chamber dispenser (24), the additional material being favourably a halloysite in the quantity not exceeding 15% weight, the introduced constituents are thoroughly mixed in the mechanical disintegrator (11) and particles are subject to mechanical de-caking and activation and discharge of electrostatic charges from the electrified particle surfaces through their free collisions and elements of permanent palisade of impact bars (25) and elements collecting electrostatic charges - rod shape metal electrodes or favourably freely hanging metal tapes (12) - located on the whole rim of mechanical disintegrator (11), further, after leaving the working chamber (22), the material is sent to the chute cone of mechanical disintegrator (11) where by means of aeration elements (19) it is subject to preliminary aeration, and subsequently, favourably the pre-aerated loose material from mechanical disintegrator (11) is transported through the chamber dispenser (24) to pneumatic pressure pump (13) equipped with aeration inserts (20) where it is subject to further intense aeration process and then it is pneumatically transported by means of high and homogenous concentration stream to the storage vessel (14).

3. The method according to claim 1 or 2 **features that** during unloading of storage vessel (14) to preserve the reached favourable properties of ultrafine loose material, it is subject to further aeration by air under pressure from 0.03 to 0.12 MPa, favourably 0.04 MPa by means of aeration elements (19) built in the lower conical part of the vessel (14), favourably in the shape of hoses made of unwoven cloth permeable from one side inwards the chute cone of the storage vessel (14).

4. The method according to claim 1 or 2 **features that** on each stage of the loose material aeration process, a stream of air is introduced which was previously subject to filtration process.

5. The method according to claim 1 or 2 **features that** on each stage of the loose material aeration process, a stream of air is introduced which was previously subject to drying process.

6. The method according to claim 1 or 2 **features that** on each stage of the loose material aeration process, a stream of air is introduced whose humidity is below -5°C of dew-point.

7. The method according to claim 1 or 2 **features that** in the chute cone of mechanical disintegrator (11) in the preliminary aeration process, the air is introduced

under pressure from 0.03 to 0.12 MPa, favourably 0.04 MPa, by means of aeration elements (19) with the stream directed to chute opening.

8. The method according to claim 1 or 2 **features that** in outlet hoppers of pneumatic pressure pump (13) in the further aeration process, the air is introduced under pressure from 0.03 to 0.12 MPa, favourably 0.05 MPa, through aeration inserts (20).

9. The method according to claim 2 **features that** in lower conical part of the vessel or vessels (21), the air is introduced under pressure from 0.03 to 0.12 MPa, favourably 0.04 MPa, by means of aeration elements (19).

10. The method according to claim 1 **features that** in the working chamber (22) of mechanical disintegrator (11) the loose material introduced from the bunker (26) under separation cyclone (5) is subject to intense mixing and giving the particles a centrifugal acceleration by means of an agitator (23).

11. The method according to claim 2 **features that** in the working chamber (22) of mechanical disintegrator (11) the loose materials introduced from the bunker (26) under separation cyclone (5) and additional vessel or vessels (21) is subject to intense mixing and giving the particles a centrifugal acceleration by means of an agitator (23).

12. System for obtaining protected against caking, ultrafine particle fractions of raw materials such as chalk, gypsum and limestone, including an impact mill, favourably beater mill, crushing the excavated chalk, gypsum and limestone into fine fractions and a dynamic separator connected to the mill by means of pneumatic transport line, separating previously crushed material into desired sizes, separation cyclone and a bunker built below it **features that** behind the separation cyclone (5) there is a mechanical disintegrator (11) connected through the unloading system (10), favourably by means of chamber dispenser (24), to the bunker (26) under separation cyclone (5), having a working chamber (22) located inside the cylindrical vessel where between the internal wall of the vessel and external wall of the working chamber (22) elements collecting electric charges are placed in the form of rod shape metal electrodes or favourably, freely hanging metal tapes (12), with aeration elements (19) mounted on the wall of chute cone convergent towards the inlet opening of the vessel outlet pipe; the mechanical disintegrator (11) is further connected by means of chamber dispenser (24) to the pneumatic pressure pump (13) equipped with aeration inserts (20) of very high porosity and in the shapes adjusted to bottom, conical part of the pressure pump (13), and further to the storage vessel (14) in which the aeration elements (19) are built on the walls convergent towards the outlet opening.

13. System for obtaining protected against caking, ultrafine particle fractions of raw materials such as chalk, gypsum and limestone, including an impact mill, favourably beater mill, crushing the excavated chalk, gypsum and limestone into fine fractions and a dynamic separator connected to the mill by means of pneumatic transport line, separating previously crushed material into desired sizes, separation cyclone and a bunker built below it **features that** behind the separation cyclone (5) there is a mechanical disintegrator (11) connected through the unloading system (10), favourably by means of chamber dispenser (24), to the bunker (26) under separation cyclone (5), having a working chamber (22) located inside the cylindrical vessel where between-the internal wall of the vessel and external wall of the working chamber (22) elements collecting electric charges are placed in the form of rod shape metal electrodes or favourably, freely hanging metal tapes (12), with aeration elements (19) mounted on the wall of chute cone convergent towards the inlet opening of the vessel outlet pipe; the mechanical disintegrator (11) is further connected by means of chamber dispenser (24) to the pneumatic pressure pump (13) equipped with aeration inserts (20) of very high porosity and in the shapes adjusted to bottom, conical part of the pressure pump (13), and further to the storage vessel (14) in which the aeration elements (19) are built on the walls convergent towards the outlet opening, moreover the system contains at least one additional vessel (21) for loose materials, connected favourably by means of chamber dispenser (24) to the mechanical disintegrator (11), having on the walls of the chute cone the aeration elements (19) built convergent towards the inlet opening of the vessel (21) outlet pipe.

14. The system according to claim 12 or 13 **features that** aeration elements (19) built on the walls of chute cone of mechanical disintegrator (11) and on the walls of chute cone of storage vessel (14) are made in the shape of hoses of unwoven cloth permeable from one side inwards the chute cone.

15. The system according to claim 13 **features that** aeration elements (19) built on the walls of chute cone of the vessel or set of vessels (21) are made in the shape of hoses of unwoven cloth permeable from one side inwards the chute cone.

16. The system according to claim 12 or 13 **features that** in the mechanical disintegrator (11) with rod shaped metal electrodes mounted and collecting electrostatic charges, favourably an additional system of hammers to flick the loose material gathered on these electrodes is installed.

17. The system according to claim 12 or 13 **features that** in the mechanical disintegrator (11) with metal tape shaped metal electrodes (12) mounted and collecting electrostatic charges, the tapes are made of material having good elastic properties.

18. The system according to claim 12 or 13 **features that** in the mechanical disintegrator (11) the elements collecting electrostatic charges in the form of rods or metal tapes (12) are hung on supports around the whole rim of working chamber (22).

19. The system according to claim 12 or 13 **features that** in the working chamber (22) of mechanical disintegrator (11) an agitator (23) is built, favourably in the form of a rotor composed of back plate with set of blades mounted to it, radially placed and with beaters on their ends.

20. The system according to claim 12 or 13 **features that** aeration inserts (20) are made of micro-porous plastic.

21. The system according to claim 12 or 13 **features that** it contains air hoses (16) supplied through filters (17) and driers (18) to the lower conical parts of the mechanical disintegrator (11) vessels, pressure pump (13) and storage vessel (14).

22. The system according to claim 13 **features that** it contains air hoses (16) supplied through filters (17) and driers (18) to the lower conical parts of the vessel or set of additional vessels (21).

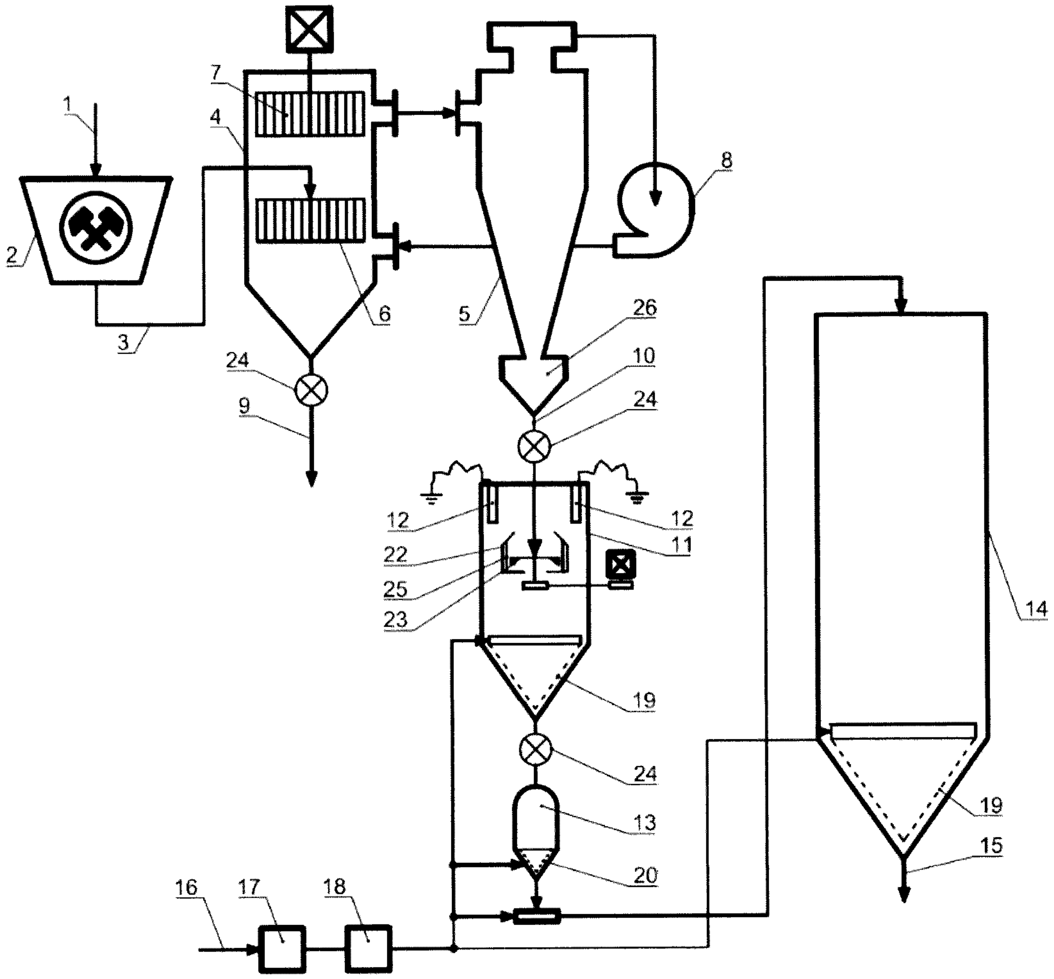

Fig. 1

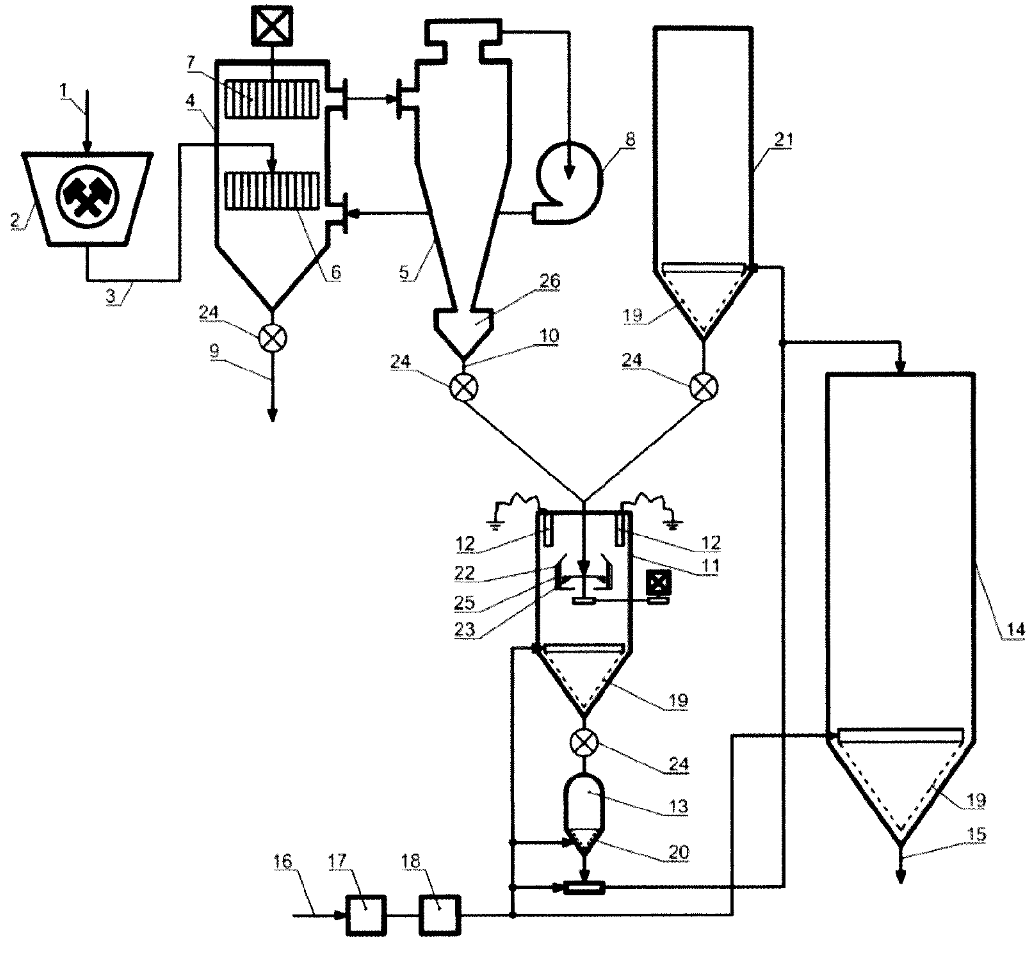
1
2
3
4
7
6
9
24
5
26
10
8
21
19
24
24
14
12
12
11
22
25
23
19
24
13
20
19
15
16
17
18

Fig. 2

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 12 46 0055

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 5 695 130 A (CSENDES ERNEST [US]) 9 December 1997 (1997-12-09) * the whole document * -----	1-22	INV. B02C13/00 B02C23/14 B02C13/286
A	US 4 269 363 A (ENTZMANN KARL) 26 May 1981 (1981-05-26) * the whole document * -----	1-22	
A	DE 12 00 657 B (ONODA CEMENT CO LTD) 9 September 1965 (1965-09-09) * the whole document * -----	1-22	
A	DE 560 412 C (KRUPP FRIED GRUSONWERK AG) 1 October 1932 (1932-10-01) * the whole document * -----	1-22	
A	US 3 580 519 A (KLEIN KURT ET AL) 25 May 1971 (1971-05-25) * the whole document * -----	1-22	

TECHNICAL FIELDS SEARCHED (IPC)
B02C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	21 October 2013	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

1

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 46 0055

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.

21-10-2013

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5695130 A	09-12-1997	AU 697510 B1	08-10-1998
		BR 9704465 A	06-06-2000
		CA 2211513 A1	25-01-1999
		CN 1208671 A	24-02-1999
		CZ 9702318 A3	17-02-1999
		EP 0891812 A1	20-01-1999
		HU 9701345 A2	28-07-1999
		JP H1157520 A	02-03-1999
		NO 974162 A	10-03-1999
		NZ 328374 A	25-11-1998
		RU 2140823 C1	10-11-1999
		TW 425306 B	11-03-2001
		US 5695130 A	09-12-1997
		ZA 9706657 A	25-11-1998
US 4269363 A	26-05-1981	AT 362290 B	27-04-1981
		AU 4789079 A	03-01-1980
		DE 2829272 A1	03-01-1980
		ES 480806 A1	16-01-1980
		FR 2429758 A1	25-01-1980
		GB 2025259 A	23-01-1980
		US 4269363 A	26-05-1981
		ZA 7902974 A	30-07-1980
DE 1200657 B	09-09-1965	NONE	
DE 560412 C	01-10-1932	NONE	
US 3580519 A	25-05-1971	CH 500001 A	15-12-1970
		DE 1642998 A1	13-04-1972
		ES 351408 A1	01-12-1969
		FR 1555348 A	24-01-1969
		GB 1213494 A	25-11-1970
		JP S5411277 B1	14-05-1979
		NL 6803231 A	24-09-1968
		SE 339458 B	11-10-1971
		US 3580519 A	25-05-1971

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- PL 159116 **[0008]**
- PL 182596 **[0009]**
- PL 197004 **[0010]**