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

(11) EP 1 759 601 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
28.04.2010 Bulletin 2010/17

(51) Int Cl.:
A24B 3/04 *(2006.01)* ***A24B 3/12*** *(2006.01)*

(21) Application number: **06119168.0**

(22) Date of filing: **18.08.2006**

(54) **Method and device for thermal processing of loose materials, particulary organic plant materials**

Verfahren und Vorrichtung zur thermischen Behandlung von losen Materialen, insbesondere organischen Pflanzenmaterialen

Procédé et dispositf pour le traitement thermique de matières en vrac, en particulier matériaux végétaux organiques

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR

(30) Priority: **31.08.2005 PL 37684905**

(43) Date of publication of application:
07.03.2007 Bulletin 2007/10

(73) Proprietor: **International Tobacco Machinery Poland Sp. z o.o.**
26-600 Radom (PL)

(72) Inventors:
- **Druzdzel, Arkadiusz**
  26-600 Radom (PL)
- **Sieredzinski, Marek**
  26-600 Radom (PL)

(74) Representative: **Misztak, Irena et al**
Patpol
Nowoursynowska 162 J
02-776 Warszawa (PL)

(56) References cited:
EP-A1- 0 273 596
EP-A2- 0 917 828
WO-A-97/27766
DE-A1- 19 945 892
US-A- 4 572 218

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The invention relates to a method and a device for thermal processing of loose materials, particularly organic plant materials, for obtaining desired organoleptic properties of these materials, the desired final humidity and/or obtaining an increase of the specific volume. This invention is particularly useful for drying tobacco material, such as leaves, veins and/or cut tobacco.

[0002] In state of the art systems the batch material for thermal processing of organic plant materials, particularly tobacco, are leaves, particularly tobacco leaves, in any of various forms, including whole leaves or parts thereof, veins of tobacco leaves, tobacco foils, fillings for cigars, cut filling for cigarettes, so called cut tobacco, wastes (shavings) and/or crumbs of tobacco, and also any combination of materials containing tobacco and/or any other organic plant material in any form and proportions.

[0003] It is recommended, before feeding the material to the thermal processing step, to carry out an initial processing step, the aim of which is to obtain a uniform humidity level throughout the fed material in the minimum range of 13-14 % by weight, suitably at least 16% by weight, preferably more than 19% by weight. Parameters of the above-mentioned processes for increasing the humidity level are known and commonly employed in this branch of engineering. The wetted tobacco material is then subject to further processing steps, including, e.g., supplementation of taste modifiers, and next it is comminuted using any method, most frequently a conventional method known in the art. An exemplary process of processing tobacco material has been described in US 5722431. One of the most important steps of the material processing is the thermal processing step, which typically follows the above mentioned steps and which particularly relates to material which has been already comminuted before. In order to obtain thermal processing results, which are proper, preferable and desired for a specific type/sort of the tobacco blend, known methods and devices are used, which enable thermal processing. However, all these known methods are only a part of a more complex process. Because of the origination and nature of a processed material (natural plant materials, particularly tobacco materials) and its physical-chemical properties, as well as employed initial processing steps and additives for improving mechanical and organoleptic properties of the product, and desired physical-chemical changes both in the material and the additives due to the thermal processing, the process requires such a kind of thermal processing, which allows obtaining many required parameters simultaneously. It concerns the increase of the specific volume (m^3/g) of the processed material as well as obtaining the proper range of the output humidity of the processed material (at the outlet/output of the machine) and also obtaining the proper output temperature of the material. Furthermore, this being potentially the main and particularly desired goal of the processing, the problem may concern obtaining proper, desired and preferable chemical reactions between compounds contained in the material and/or introduced therein as a result of previous processing steps, in order to produce desired chemical compounds, which determine organoleptic properties of the final product, i.e., after finishing the step of thermal processing. Document EP-A-0273596 discloses a device for thermal processing of tobacco, the device comprising one process section having form of a body of revolution of a constant section. This section is equipped with an inlet stub pipe and an outlet stub pipe for a process gas. An additional nozzle for the processing gas is located in the process section, and situated at an adjusted angle relative to a tangent to the cross-section of the process section and at a constant angle to the horizontal axis. The distance between the outlet of the nozzle and the axis of rotation is smaller than the radius of the section's cross-section.

[0004] The subject matter of the present invention is a method for thermal processing of loose materials, particularly organic plant materials, and still more particularly tobacco material, wherein loose material is exposed to a process gas in a continuous mode, the method being carried out in multiple steps.

[0005] In each of the steps independently proper, preferable, local conditions for thermal processing are established by feeding a process gas, for which a stream of transported energy, preferably including thermal energy, is adjusted independently for every step of the method. The temperature of the thermodynamic medium in form of a process gas, preferably pure air and/or air saturated with another gas, is in the range of 20 - 400°C. The process gas is injected into a near-wall layer of the processed material through a set of one or several nozzles, positioned and controlled separately in each of process sections, under a pressure from 0,2 hPa to 1 MPa. The processed material is put into rotary motion, preferably in each of the steps, with a speed adjusted separately for each of the steps and a layer of the processed material is formed at the inner surface of the section. The rotary motion of the material is generated around axes, inclination angle of which relative to the horizontal direction is adjusted separately for every section, depending on desired quality parameters of the final product, the process gas being fed concurrently and/or backwardly relative to the rotating processed material, at an angle of adjusted magnitude, and fibers of the processed material stuck together are separated.

[0006] Preferably, the process gas is saturated steam or dry overheated steam.

[0007] The temperature of the process gas reaches 400°C, while the gas is injected under a pressure in the range from 0,1 MPa to 0,7 MPa.

[0008] The invention also relates to a device for thermal processing of loose materials, particularly organic plant materials, comprising several process sections, each of the sections of the device being equipped with an inlet stub pipe and an outlet stub pipe for a process gas and at least one additional nozzle for the process gas is located in each of the process sections, directed at an angle relative to the direction of rotation of the process section and situated at an adjusted angle relative to a tangent to the cross-section of the process section and at a angle relative to the horizontal axis measured in the plane of this cross-section, and the distance between the outlet of the nozzle and the axis of rotation of the process sections is smaller than the radius of the section's cross-section drawn in the plane of the location of the nozzle.

[0009] According to the invention, the process sections constitute the independently rotating, arranged in series bodies, having forms of bodies of revolution of variable and/or constant cross-section.

[0010] In a preferred embodiment at least one process section is located partially in the inner space of the next section, maintaining the distance from the inner surface of the section body, the distance enabling a free flow of the processed material, the axes of rotation of the both sections mutually intersecting at an adjusted angle, while the angle between generators of conical bodies of the both sections is in the range of 0 - 30°.

[0011] According to the invention, bodies of the process sections are preferably truncated cone, and the angles of inclination of the cone side surfaces in subsequent sections are diversified and are obtuse angles or acute angles.

[0012] The angles of inclination of axes of rotation relative to the horizontal direction are diversified for different sections and depend on proportions of their diameters, and the angle of inclination of cone generators relative to the horizontal direction is in the range of 0 - 30°.

[0013] The differences between the distance of the nozzle outlets from axes of rotation of the process sections and the radii of the process sections' cross-sections drawn in the planes of locations of the nozzles are in the range from 1 mm to 150 mm.

[0014] The inclination angle of the additional nozzle for the process gas relative to the horizontal direction, measured in the plane of this cross-section, is between 40° and 140°, preferably 50° and 100°.

[0015] The invention enables thermal processing of loose materials, particularly organic plant materials, for example leaves and/or cut tobacco, which are fed to the device and processed in a continuous mode. The device may comprise several sections, in which, separately, basic parameters of the thermal process are controlled, such as temperature of the dryer jacket, temperature and mass flow rate of the process gas, residence time of the processed material in subsequent thermal zones, etc.

[0016] By individual adjustment of a proper combination of thermal processing parameters in each of the sections, one obtains desired sequences of the kinetics of the thermal processing, this allowing for obtaining preferred mechanical and physical-chemical properties of the final product.

[0017] Employing several subsequent process sections allows, first of all, for significant intensification of the thermal process, and also allows for carrying out more complex versions of thermal processing of a material in a single, compact and modular device. A particular advantage of this design is also a possibility of obtaining such results of thermal processing, which require employing several separate devices in the state of the art systems. Furthermore, the method and device according to the invention enable obtaining proper quality parameters of the final product.

[0018] The term "quality parameters" is understood as:

- Obtaining final humidity of the product, at the outlet from the device, in a strictly defined range, typically of ±1 %, preferably ±0.5%;

- Obtaining a desired level of swelling of the product (the specific volume), in order to increase its volume per unit mass;

- Obtaining desired organoleptic properties of the product, particularly its taste and aroma properties, and also the color of the processed material, by carrying out controlled chemical reactions within the processed material and its components in different thermal zones.

[0019] The advantage of the adjustment of the inclination angle of the axis of rotation for each section is obtaining a preferred inclination of the lower edge of a rotating section, such that the duration of passing of the material through the section is important for the quality parameters, and, as a result, inter alia, the time of contact between the material and the casing of the process section is within a desired range.

[0020] Moreover, the invention allows for optimization of the angle of injection of the process gas jet relative to the inner surface of the process section by adjustment of the angle between the nozzle axis and the tangent to the inner surface of the process section. This enables obtaining optimal and preferred value of kinetic energy necessary to tear off a layer/stream of material adhering to the inner surface of the process section. At the same time, it also enables a more intensive exchange of thermal energy from process gas injected through a nozzle to the material, by generating conditions of hydrodynamic turbulent flow in the zone of contact between both streams, the material stream and the process gas stream, and a particularly beneficial for the processed material local hydrodynamic turbulent flow, thereby obtaining preferred increase and, as a result, relative difference of local speeds of relative slip of the both streams, thus obtaining a preferred uniform zone of intensive heat exchange to the material.

[0021] It is to be noticed that the proposed design of process sections according to the invention and the possibility of adjustment of their inclination angles advantageously affect proportions between different mechanisms of thermodynamic and chemical processes, particularly intensity of heat energy transfer to the material, particularly between the convection-type heat transfer (from the hot process gas) and the conduction-type heat transfer (from inner surfaces of the process sections).

[0022] The invention is further discussed and illustrated in embodiments referring to a drawing in which:

Fig. 1 shows schematically an arrangement of process sections in longitudinal section,

Fig. 2 shows schematically an arrangement of process sections in longitudinal section in another embodiment of the invention,

Fig.3 shows schematically an arrangement of process sections in longitudinal section in yet another embodiment of the invention,

Figs. 4 a-e show exemplary shapes of the process sections,

Fig. 5 shows schematically one of the process sections in longitudinal section with a properly angularly situated axis of rotation,

Fig. 6 shows a cross-section of a process section, and

Fig. 6a shows a detail from the cross-section of fig. 6, covering location of a gas nozzle.

[0023] As shown in figs. 1 and 2, a device for thermal processing of loose materials according to the invention comprises several rotating process sections 2, 4, 5 arranged in series, in which thermal processing of loose materials is carried out, the materials being fed to the first of the process sections by means of a feeding device 1. According to the invention a feeding device 1 may be for example a vibratory feeder or a belt feeder. Process sections 2, 4, 5 have bodies in form of cylinders or truncated cones, the longitudinal axes of which, as shown in figs. 1 and 2, are situated at different angles. The main stream of a process gas is delivered to each of these sections by means of devices, which are known in the art and are not shown in the illustration, the gas being sucked at the section's outlet. According to the invention an additional nozzle 3 is located in each of the process sections 2, 4, 5, delivering the process gas directly to a layer of the processed material adhering to walls of the process section, acting as a hydrodynamic scraper, for example a pneumatic scraper. The thermally processed material is received by a collecting device 6 mounted at the outlet from the last process section, for example in form a vibratory feeder or a belt feeder.

[0024] Fig. 3 shows another example of an arrangement of process sections, in which a portion of one section is located within the next section. In the lower zone, between the bodies of the sections there is a free space allowing for free flow of the material. Mutual inclination of the axes of the both sections is adjusted, this facilitating free flow of the material. The angle $\gamma 2$ between the generators of the conical bodies of these sections is within the range of 0 - 30°. In a preferred embodiment according to the invention, in order to increase the heat exchange by conduction between the jackets of both the sections, the angle $\gamma 2$ may be in the range of 0 - 20°.

[0025] Each section 2, 4, 5 may have differently shaped inner surface. Particularly, the inner surface may be smooth and/or may have specially formed bulges/recesses and/or blades.

[0026] Figs. 4 a-e show possible exemplary geometrical configurations of the process sections 2, 4, 5. Depending on the conditions of the thermal processing, the geometrical configuration of the sections' bodies may be selected in any sequence within a single device.

[0027] As shown in Fig. 5, the angle α of inclination of the rotation axis of every section relative to the horizontal direction is adjusted depending on the proportion D1/D2, i.e., the dimensions of the diameters of inlet and outlet of material of a process section. The angle α is adjusted within such a range that the lower edge of the section's body is inclined relative to the horizontal direction at the angle $\gamma 1$ of 30°.

[0028] Figs. 6 and 6a show angular orientation of an additional gas nozzle 3. According to fig. 6, the gas nozzle 3, delivering the process gas, is situated for delivering a stream of the process gas concurrently or backwardly relative to a layer of rotating processed material, at an adjusted angle β relative to the horizontal direction, in a plane perpendicular to the axis of rotation. The angle β may range from 40 to 140°, preferably from 50 to 100°. Furthermore, the nozzle is inclined at an adjusted angle δ relative to the tangent to the surface of the- cross-section of the section, the angle δ being adjusted in the range 10 - 170° relative to that tangent. The outlet of the nozzle 3 is located at a distance Rn from the rotation axis of the section, the distance being smaller than radius R of the cross-section in the plane of the position of the nozzle. In a preferred embodiment R - Rn = 1-150 mm.

[0029] According to a method of the invention, process parameters for each of the process sections 2, 4 and/or 5 are adjusted and controlled individually, separately and in independent ranges.

[0030] The functionality of each of the sections depends on selected parameters of the thermal processing. For example, the first process section 2 may be treated as a section in which intensive transfer of thermal energy to the material proceeds, through conduction from walls of the rotary section as well as through convection from the process gas, for example air. In this section, inter alia, free, not bound chemically with the material, liquid substances contained within the cellular structure of the material, particularly free water and its solutions undergo the phase transition to steam. As a result of the phase transition from liquid to gas, evaporation pressure within the cellular structure of the material increases significantly, and as a consequence thereof increases the volume of particles of the processed material. This process is called swelling and/or expanding of the material.

[0031] Next, at least one process section 4 has, for example, a function of drying and/or so-called roasting of the material simultaneously. By employing several, independently located and controlled gas nozzles 3, several thermal zones are created within one process section 4, in which different process parameters are maintained, thus obtaining a desired level of drying, desired kinetics of heat energy transfer to the material (and as a result also drying), and also, by selection of the material's transition time through the process sections, a proper kinetics of chemical reactions of the material and its components, all this resulting in obtaining desired organoleptic changes and avoiding changes which are not desired.

[0032] The rotational speed of each of the sections 2, 4, 5 is adjusted in various ranges, rotations of the section 2 being adjusted in the range of 0 - 300 rpm, while rotations of the section 4 being adjusted in the range of 0 - 100 rpm, preferably in the range of 0 - 50 rpm. High rotational speeds for the sections 2, 4 are advantageous since such speeds enable the centrifugal force to be in a range, which allows a layer of the material to be kept at the wall of the rotating section.

[0033] A process gas of high kinetic energy is delivered through the additional nozzle 3, and collision of two backward streams is caused, namely the stream of coming out gas and the stream of the material, which is kept within a near-wall zone by the centrifugal force of the rotating section 2. The impact of the gas stream with the material stream causes tearing off the material particles from the walls of the process section 2 and simultaneously causes particularly intensive transfer of the heat energy of the gas delivered through the nozzle 3 to the processed material adhering to the walls of the section 2. An additional, advantageous effect of such processing is separation of fibers of the processed material, which has been intentionally comminuted as a result of previous steps of the process.

[0034] The process gas is delivered through the nozzle 3 under pressure in the range from 0,2 hPa to 1 MPa, preferably in the range from 0,1 MPa to 0,7 MPa, and in the range of temperature which depends on expected results of the thermal processing. The temperature of the process gas is from 20°C to 400°C, preferably from 80°C to 300°C. According to the invention, pure air and/or air saturated with another gas is employed as the process gas, and also saturated and/or dry steam, or overheated steam may be used.

Claims

1. A method for thermal processing of loose materials, particularly organic plant materials, according to which loose material is exposed to a process gas in a continuous mode, the method being carried out in multiple steps, **characterized in that** in each of the steps independently, proper, preferred, local conditions for thermal processing of the loose material are established by feeding a process gas, for which a stream of transported energy, preferably including thermal energy, is adjusted independently for every step of the method, whereas the temperature of the thermodynamic medium in form of a process gas, preferably pure air and/or air saturated with another gas, is in the range of 20 - 400°C, the process gas is injected into a near-wall layer of the processed material through a set of one or several nozzles, positioned and controlled separately in each of the process sections, under a pressure from 0,2 hPa to 1 MPa, while the processed material is put into rotary motion, preferably in each of the steps, with a speed adjusted separately for each of the steps, and a layer of the processed material is formed at the inner surface of the section, while the rotary motion of the material is generated around axes, the inclination angle of which relative to the horizontal direction is adjusted separately for every section, depending on desired quality parameters of the final product, whereas the process gas is fed concurrently and/or backwardly relative to the rotating processed material, at an angle of adjusted value, and fibers/particles of the processed material being stuck together are separated.

2. A method according to claim 1, **characterized in that** the process gas is saturated steam.

3. A method according to claim 1, **characterized in that** the process gas is dry overheated steam.

4. A method according to claim 1, **characterized in that** the temperature of the process gas reaches 400°C.

5. A method according to claim 1, **characterized in that** the pressure of the process gas is in the range from 0,1 MPa to 0,7 MPa.

6. A device for thermal processing of loose materials, particularly organic plant materials, comprising several process sections, each of the sections of the device being equipped with an inlet stub pipe and an outlet stub pipe for a process gas and at least one additional nozzle for the process gas is located in each of the process sections, directed at an angle relative to the direction of rotation of the process section and situated at an adjusted angle relative to a tangent to the cross-section of the process section and at a angle relative to the horizontal axis measured in the plane of this cross-section, and the distance between the outlet of the nozzle and the axis of rotation of the process sections is smaller than the radius of the section's cross-section drawn in the

plane of the location of the nozzle, **characterized in that** the process sections (2,4,5) constitute the independently rotating, arranged in series bodies, having forms of bodies of revolution of a variable and/or constant cross-section.

7. A device according to claim 6, **characterized in that** at least one process section (4) is located partially in the inner space of the next section (5), maintaining the distance from the inner surface of the section body (5), the distance enabling a free flow of the processed material, the axes of rotation of the both sections mutually intersecting at an adjusted angle, while the angle ($\gamma 2$) between generators of conical bodies of the both sections (4, 5) is in the range of 0 - 30°.

8. A device according to claim 6, **characterized in that** bodies of the process sections (2, 4, 5) have form of truncated cones, and the angles of inclination of the cone side surfaces in subsequent sections are diversified and are obtuse angles or acute angles.

9. A device according to claim 6, **characterized in that** the angles α of inclination of the axes of rotation relative to the horizontal direction are diversified for different sections (2, 4, 5) and depend on proportions D1/D2 of their diameters, and the angle ($\gamma 1$) of inclination of cone generators relative to the horizontal direction is in the range of 0 - 30°.

10. A device according to claim 6, **characterized in that** the difference of dimensions: R - Rn is in the range from 1 to 150 mm.

11. A device according to claim 6, **characterized in that** the angle β is in the range between 40 and 140°.

12. A device according to claim 11, **characterized in that** the angle β is in the range between 50 and 100°.

Patentansprüche

1. Verfahren zur thermischen Behandlung von Schüttgütern, besonders von pflanzlicher Herkunft, bei dem das Schüttgut der dauerhaften Einwirkung eines Prozessgases unterworfen wird, wobei das Verfahren mehrstufig durchgeführt wird, **dadurch gekennzeichnet, dass** in jeder Stufe geeignete vorteilhafte lokale Bedingungen der thermischen Behandlung des Materials über die Zufuhr des Prozessgases unabhängig voneinander bestimmt werden, für das der Strom der transportierten Energie, darunter vorzugsweise Wärmeenergie, unabhängig für jede Verfahrensstufe reguliert wird, wobei die Temperatur des thermodynamischen Mediums in Form des Prozessgases, vorzugsweise der sauberen und/ oder mit einem anderen Gas gesättigten Luft, von 20 bis 400°C beträgt, und dieses Gas in die Wandschicht des behandelten Materials über eine Düsenanordnung oder über eine Anordnung von mehreren Düsen zugeführt wird, die in jeder Behandlungssektion unabhängig positioniert und gesteuert werden, unter absolutem Druck von 0,2 hPa bis 1 MPa, wobei das behandelte Material, vorzugsweise in jeder Stufe, in Rotation mit einer Geschwindigkeit versetzt wird, die für jede Stufe unabhängig gesteuert wird, und an der Oberfläche der inneren Sektion eine Schicht des behandelten Materials gebildet wird, und die Rotationsbewegung um diejenigen Achsen vollzogen wird, derer Neigungswinkel gegenüber der Horizontalebene im Zusammenhang mit erforderten Qualitätsparametern des Endprodukts, unabhängig für jede Sektion, gesteuert wird, wobei das Prozessgas in Gleichstrom und/oder Gegenstrom gegenüber des rotierenden Behandlungsmaterials unter einem steuerbaren Winkel zugeführt wird, und die zusammengeklebten Fasern/Teilchen des behandelten Produkts in Fasern zerlegt werden.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** das Prozessgas ein gesättigter Dampf ist.

3. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** das Prozessgas ein trockener überhitzter Dampf ist.

4. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** die Temperatur des Prozessgases 400°C beträgt.

5. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** der Druck des Prozessgases von 0,1 bis 0,7 MPa beträgt.

6. Vorrichtung zur thermischen Behandlung von Schüttgütern, besonders von pflanzlicher Herkunft, mit mehreren Sektionen, die mit Zufuhrstutzen und Abfuhrstutzen für das Prozessgas ausgestattet sind, und in jeder Behandlungssektion mindestens eine zusätzliche Düse für das Prozessgas angebracht ist, die unter einem Winkel zur Rotationsrichtung der Behandlungssektion gerichtet und unter einem steuerbaren Winkel zur Tangente zum Querschnitt der Behandlungssektion, sowie unter einem Winkel zur horizontalen Achse liegt, der in der Ebene dieses Querschnitts gemessen wird, wobei der Abstand zwischen dem Düsenabfluss und der Rotationsachse der Behandlungssektion kleiner als der Radius des Sektionsquerschnitts ist, der in der Anbringungsebene der Düse liegt,
dadurch gekennzeichnet, dass die Behandlungssektionen (2, 4, 5) reihenweise aufgestellte, unabhängig voneinander rotierende Rotationskörper mit

veränderlichem und/oder gleichbleibendem Querschnitt sind.

7. Vorrichtung nach Anspruch 6, **dadurch gekennzeichnet, dass** mindestens eine Behandlungssektion (4) teilweise im Innenraum der folgenden Sektion (5), unter Erhaltung eines eine freie Materialströmung erlaubenden Abstands von der Innenfläche des Sektionskörper, angebracht ist, wobei sich die Rotationsachsen der beiden Sektionen unter einem steuerbaren Winkel überschneiden, und der Winkel ($\gamma 2$) zwischen den Erzeugenden der konischen Körper der beiden Sektionen (4, 5) 0 bis 30° beträgt.

8. Vorrichtung nach Anspruch 6, **dadurch gekennzeichnet, dass** die Körper der Behandlungssektionen (2, 4, 5) vorteilhaft als abgestumpfte Kegel gestaltet sind, wobei die Neigungswinkel der Mantelflächen der Kegel in den aufeinander folgenden Sektionen unterschiedlich sind und die Werte von stumpfen oder spitzen Winkel annehmen.

9. Vorrichtung nach Anspruch 6, **dadurch gekennzeichnet, dass** der Neigungswinkel α der Rotationsachse der einzelnen Behandlungssektionen (2, 4, 5) zur Horizontalen für jede Sektion unterschiedlich und von der D1/D2-Proportion abhängig ist, wobei der Abweichungswinkel ($\gamma 1$) der Erzeugenden der Kegel von der Horizontalen 0 bis 30° beträgt.

10. Vorrichtung nach Anspruch 6, **dadurch gekennzeichnet, dass** die Differenz zwischen den Abmessungen: R - Rn von 1 bis 150 mm beträgt.

11. Vorrichtung nach Anspruch 6, **dadurch gekennzeichnet, dass** der Winkel β zwischen 40 und 140° beträgt.

12. Vorrichtung nach Anspruch 11, **dadurch gekennzeichnet, dass** der Winkel β zwischen 50 und 100° beträgt.

Revendications

1. Procédé de traitement thermique de matériaux pulvérulents, en particulier d'origine végétale, dans lequel le matériau pulvérulent est soumis à l'action continue du gaz de processus, le procédé se déroulant en plusieurs étapes, **caractérisé en ce qu'**à chaque étape on établit de manière mutuellement indépendante les conditions préférentielles, appropriées et locales de traitement thermique du matériau, en introduisant le gaz de processus, pour lequel le flux d'énergie transportée, y compris, de préférence, d'énergie thermique, est ajusté séparément pour chaque étape du procédé, la température de l'agent thermodynamique sous forme du gaz de processus, de préférence de l'air pur et/ou saturé par un autre gaz, allant de 20 à 400 °C, ce gaz étant introduit dans la couche du matériau traité située près de la paroi par l'ensemble d'une ou de plusieurs buses, positionnées et contrôlées de manière indépendante dans chaque section du processus, à la pression absolue allant de 0,2 hPa à 1 Mpa ; le matériau traité est cependant, de préférence à chaque étape, entraîné en mouvement de rotation à une vitesse ajustée indépendamment pour chaque étape et une couche de matériau traité se forme contre la surface interne de la section, tandis que le mouvement de rotation est réalisé autour des axes, l'angle d'inclinaison desquels par rapport au plan horizontal est ajusté séparément pour chaque section en fonction des paramètres qualitatifs exigés du produit final, le gaz de processus étant introduit sous un angle de valeur ajustée, en parallele et/ou à contre-courant par rapport au matériau traité et en rotation, et en démêlant les fibres/particules du produit traité, collées mutuellement entre elles.

2. Procédé selon la révendication 1, **caractérisé en ce que** le gaz de processus est constitué par la vapeur saturée.

3. Procédé selon la révendication 1, **caractérisé en ce que** le gaz de processus est constitué par la vapeur surchauffée sèche.

4. Procédé selon la révendication 1, **caractérisé en ce que** la température du gaz de processus atteint jusqu'à 400 °C.

5. Procédé selon la révendication 1, **caractérisé en ce que** la pression du gaz de processus est comprise entre 0,1 et 0,7 Mpa.

6. Equipement pour le traitement thermique de matériaux pulvérulents, en particulier d'origine végétale, muni de plusieurs sections, équipées de tubulures d'entrée et d'échappement du gaz de processus, dans chaque section du processus étant instalée au moins une buse supplémentaire du gaz de processus, orientée sous un angle par rapport au sens de rotation de la section du processus et située sous un angle ajusté par rapport à la tangente à la section transversale de la section du processus et sous un angle par rapport à l'axe horizontal, cet angle étant mesuré dans le plan de cette section transversale, la distance de l'échappement de la buse à l'axe de rotation de la section du processus étant inférieure au rayon de la section transversale de la section, tracée dans le plan d'installation de la buse, **caractérisé en ce que** les sections du processus (2, 4, 5) sont des solides de révolution alignés en rang, pivotant de manière indépendante, et ayant une section transversale constante et/ou variable.

7. Equipement selon la révendication 6, **caractérisé en ce qu'**au moins une section du processus (4) est localisée partiellement dans l'espace interne de la section suivante (5), en conservant la distance à la surface interne du corps de la section (5), ce qui permet un écoulement libre du matériau, les axes de rotation des deux sections se recoupant sous un angle de valeur ajustée, et l'angle ($\gamma 2$) compris entre les génératrices des corps côniques des deux sections (4, 5) s'élevant à 0 - 30°.

8. Equipement selon la révendication 6, **caractérisé en ce que** les corps des sections du processus (2, 4, 5) ont de préférence la forme de troncs de cône, les angles d'inclinaison des surfaces latérales des cônes de sections consécutives étant diversifiés et adoptant des valeurs d'angles obtus ou aigus.

9. Equipement selon la révendication 6, **caractérisé en ce que** l'angle α d'inclinaison des axes de rotation des sections particulières (2, 4, 5) du processus par rapport au plan horizontal est différencié pour chaque section et dépend de la proportion D1/D2, l'angle ($\gamma 1$) d'inclinaison des génératrices des cônes par rapport au plan horizontal s'élevant à 0 - 30°.

10. Equipement selon la révendication 6, **caractérisé en ce que** la valeur de la différence des dimensions : R - Rn vaut de 1 à 150 mm.

11. Equipement selon la révendication 6, **caractérisé en ce que** la valeur de l'angle β est comprise entre 40 et 140°.

12. Equipement selon la révendication 11, **caractérisé en ce que** la valeur de l'angle β est comprise entre 50 et 100°.

Fig. 1

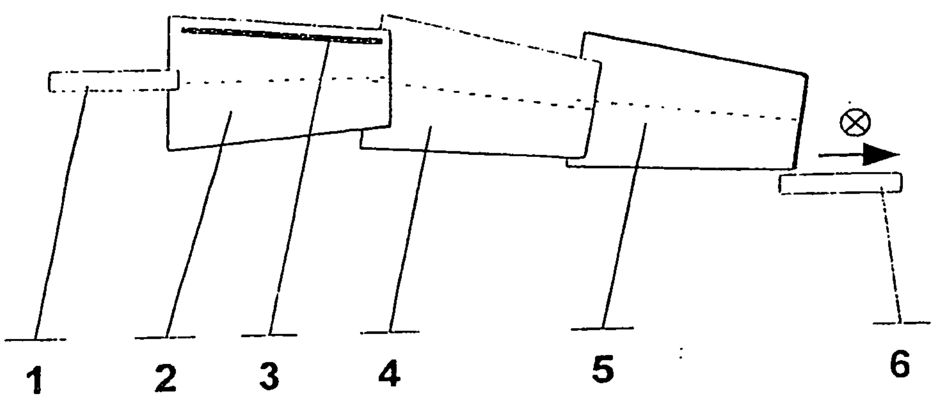


Fig. 2

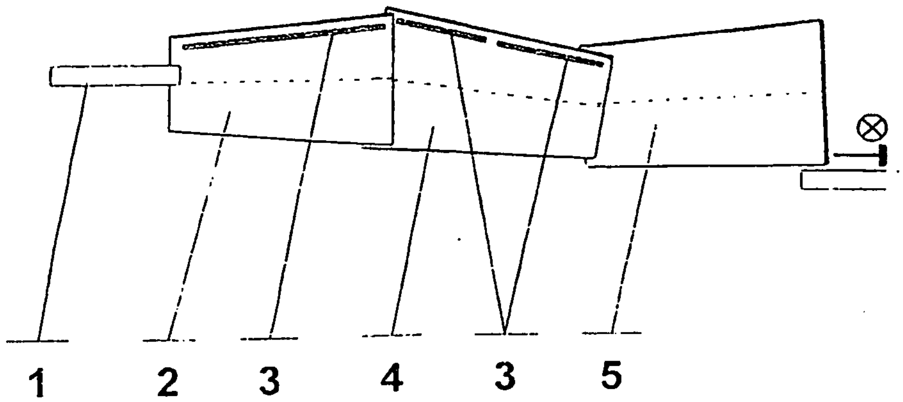


Fig. 3

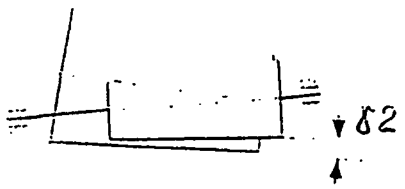


Fig.4a

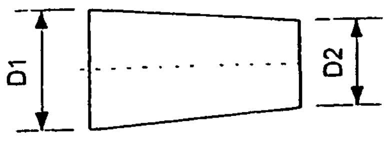


Fig.4b

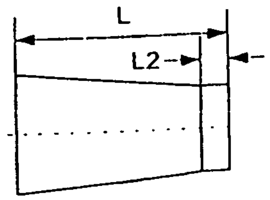


Fig.4c

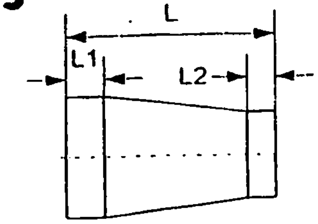


Fig 4.e

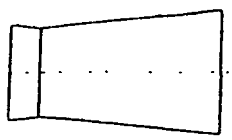


Fig.4d

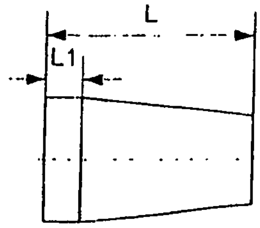


Fig. 5

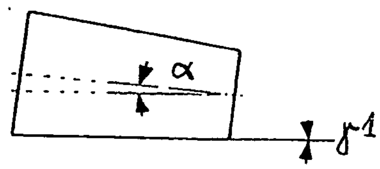


Fig. 6

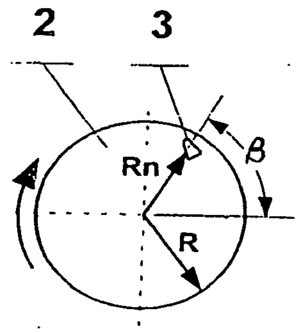
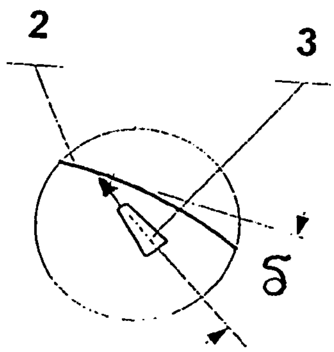


Fig. 6a



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

- US 5722431 A **[0003]**
- EP 0273596 A **[0003]**