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(54) Titre: PROCEDE ET DISPOSITIF POUR LA CENTRIFUGATION LIBRE DE FIBRES MINERALES

(57) Abstract

A method for forming mineral fibres by pouring a molten material onto the circumference of centrifuging wheels having substantially horizontal axes, whereby the fibres are centrifugally formed then thrown in a direction substantially parallel to the axis by a main gas flow over at least part of the wheel circumference. An auxiliary gas flow is generated in substantially the same direction as the main gas flow, a liquid binder is sprayed onto the fibres, and the auxiliary gas flow consists of individual streams of which some, in particular, are rotating. Part of the liquid binder may be fed into the rotating streams. In the device for carrying out the method, secondary blowing nozzles around the fiberising machine comprise rotary guides, particularly helical rods or worms. An enhanced distribution of the binder throughout the fibres may be achieved.

(57) Abrégé

L'invention concerne un procédé de formation de fibres minérales dans lequel un matériau fondu est versé sur la périphérie de roues de centrifugation à axes sensiblement horizontaux où les fibres sont formées par centrifugation puis projetées dans une direction sensiblement parallèle à l'axe par un courant gazeux principal sur au moins une partie de la périphérie des roues, dans lequel un courant gazeux auxiliaire est créé avec sensiblement la même direction que le courant gazeux principal et dans lequel un liant liquide est projeté sur les fibres et dans lequel le courant gazeux auxiliaire est constitué de courants individuels dont notamment certains sont des courants tournants. Une partie du liant liquide peut être introduite à l'intérieur de ces courants tournants. L'invention propose également un dispositif pour mettre en oeuvre le procédé dans lequel des buses de soufflage secondaire situées autour de la machine de fibrage comportent des guides rotatifs, notamment des tiges hélicoïdales ou des vis d'Archimède. L'invention permet une meilleure répartition du liant parmi les fibres.

PATENT

PROCESS AND DEVICE FOR THE FREE CENTRIFUGING OF MINERAL FIBRES

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ABSTRACT

The invention relates to a process for the formation of mineral fibres, in which a molten material is poured onto the periphery of centrifuging wheels having substantially horizontal axes, where the fibres are formed by centrifuging and are then shot out in a direction substantially parallel to the axis by a main gas flow over at least part of the periphery of the wheels, in which an auxiliary gas flow is created with substantially the same direction as the main gas flow and in which a liquid binder is shot out onto the fibres and in which the auxiliary gas flow consists of individual flows, especially some of which are rotating flows.

Part of the liquid binder may be introduced into the interior of these rotating flows.

The invention also proposes a device for implementing the process, in which secondary-blowing nozzles lying around the fiberizing machine include rotary guides, especially helical rods or Archimedean screws.

The invention allows better distribution of the binder among the fibres.

Figure 3.

PROCESS AND DEVICE FOR THE FREE CENTRIFUGING OF MINERAL FIBRES

The invention relates to so-called external centrifuging or free centrifuging techniques for manufacturing mineral fibres, it relates [sic] more particularly to the blowing intended to entrain the fibres and to the supply of the binder which combines them with each other.

The invention relates to the techniques for producing rock wool intended, for example, to serve as the basic material for thermal and/or acoustic insulation products. More specifically, the invention relates to an improvement to the technique of fiberizing a drawable material having a high melting point, for example of the type comprising basalt glass and blast-furnace slags or other equivalent materials, in which the material to be fiberized is poured in the molten state onto the peripheral band of centrifuging wheels driven in rotation, is accelerated by these wheels, is detached therefrom and is partly converted into fibres due to the effect of the centrifugal force, a gas flow emitted tangentially to the peripheral band of the wheels separating, from the unfiberized material, the fibres thus formed and driving them towards a receiving unit.

The above fiberizing technique briefly mentioned, known for example from European Patent Applications 59 152 and 195 725, is called exclusively a free-centrifuging technique, recalling both that the molten glass is neither divided into a series of elementary strands (internal centrifuging) nor subjected to gas-induced drawing by a flow of high-temperature high-velocity gas. This fiberizing technique is very useful, in particular as it is to all intents and purposes the only one able to be used under conditions of interest from an economic standpoint with materials such as basalt slags which are characterized by melting temperatures appreciably higher than the usual soda-lime glasses.

In this fiberizing process, the fibres are conveyed from the immediate vicinity of the fiberizing machine by a tangential gas stream emitted at the periphery of the centrifuging wheels in a direction essentially parallel to the axes of the wheels; the acceleration by the centrifuging wheels [sic] gives the still unfiberized particles present among the fibres a velocity sufficient for the peripheral gas stream to have no significant effect on the path of these particles, which leads to sorting from the fibres which are, on the other hand, deflected because of their lower relative density and lower velocity.

The invention relates to a device in accordance with the one described in European Patent EP-B 439 385. This device comprises a series of centrifuging wheels arranged in an assembly bringing their peripheral surfaces into proximity with one another, these wheels being rapidly rotated by motors which are arranged on one side, outside the assembly formed by the series of centrifuging wheels, and which drive the said wheels by means of mechanical transmission members arranged so as to be clear of the region in the middle of the series of centrifuging wheels. Two consecutive wheels on the path of the material to be fiberized rotate in opposite directions and a molten-material feed unit is mounted so as to allow the said material to be poured onto the external surface of the first centrifuging wheel, a first blowing member generating a gas flow around the series of centrifuging wheels, parallel to the axes of rotation of the said centrifuging wheels, and a second blowing member generating an auxiliary gas flow some distance from the centrifuging wheels and substantially in the same direction as the main gas flow.

The devices of the above type are equipped with systems for feeding a liquid binder intended, after drying and/or polymerization, for mechanically combining the fibres with each other in order to constitute a fibrous mat.

A tricky problem is that of distributing the binder within the mat. Several techniques have been proposed for delivering the binder and distributing it uniformly among the fibres. European Patent EP-B-59 152 thus proposes to introduce the liquid binder at the centre of the centrifuging wheels and to allow it to be expelled by the centrifugal force from an annular slot at some distance from the periphery of the wheel. The drops of binder thus radially expelled encounter the fibres which are themselves shot out parallel to the axis of the wheel. This system is very effective, but it has its limitations. On the one hand, the yield is not a maximum, that is to say the percentage of binder actually used is substantially less than 100. This is because the fibres are not created and extracted over the entire periphery of the centrifuging wheels - in general, they occupy only at most three quarters of the periphery. Over the remaining quarter, binder is expelled which has only a slight chance of encountering fibres. Another limitation of this technique is in the very short duration for which a drop of binder has a probability of encountering one or more fibres. Since the two sheet-like flows, that of the drops of binder and that of the fibres, are orthogonal and thin, the region where they intersect occupies a very small volume. The invention has the task of improving the technique of Patent EP-B-59 152.

European Patent EP-B-439 385 describes a free centrifuging technique in which an auxiliary gas flow, especially emanating from a ring of nozzles, is added to the main gas flow emanating from circular slots, these partially surrounding the circumference of the centrifuging wheels. This technique is very useful for very precisely controlling the conditions for conveying the fibres to the receiving member, this having the consequence of improving the quality of the mats of insulating materials obtained from two standpoints: a decrease in the amount of unfiberized particles and an increase in the thermal impedance. However, in this document no study was presented on the distribution of binder emanating, due to centrifuging, from an annular slot on the front side face of the centrifuging wheel. The objective of the invention is to improve this distribution.

Techniques have been proposed for controlling the distribution of binder in the various layers making up the mat of fibres. European Patent Application EP-A-374 112 proposes adding conduits to the source of binder at the centre of the rotors, these conduits being placed at certain specific points so that certain regions of "the suspension of fibres in the process of being formed", which correspond to particular strata in the mat, receive specific quantities or specific types of binder, making it possible to obtain a non-uniform distribution of the binder in the mat, certain strata, especially the outer faces of the mat, being, for example, coated with a great deal of binder while others, such as the central part, are provided with less binder. The objective which the invention seeks to achieve is the opposite of that of EP-A-374 112 since here, on the contrary, it relates to seeking the most uniform distribution of binder possible through the entire thickness of the mat.

In a general manner, when the distribution of binder is not uniform in a mat of so-called rock or glass mineral fibres, this leads to degradation in the quality from two standpoints - the visual quality and the mechanical quality.

The resins used as binders are generally coloured, giving a specific colour to each manufacturer's product and, moreover, making it possible to observe in production what the distribution of binder among the fibres is.

When the distribution is not satisfactory, lighter regions corresponding to groups of non-bonded fibres may be seen in the finished mat. This represents an appearance defect which, in certain cases, however, could have technical consequences: at points where the lack of binder is greatest the cohesion of the fibres is insufficient and the mat runs the risk of being more easily delaminated. The objective of the invention is to improve the uniform distribution of the binder in the mat.

According to the present invention there is provided a process for the formation of mineral fibres, including pouring a molten material onto the periphery of centrifuging wheels having substantially horizontal axes, forming the fibres by centrifuging and propelling the fibres in a direction substantially parallel to the axes of the centrifuging wheels by a main gas flow over at least part of the periphery of the wheels, creating an auxiliary gas flow in substantially the same direction as the direction of the main gas flow and projecting a liquid binder onto the fibres, wherein the binder is supplied into the auxiliary gas flow.

These rotating flows substantially improve the distribution of the binder emanating from the wall of the centrifuging wheels on the mat and through its thickness, as well as the actual structure of the mat.

Preferably, the rotating auxiliary gas flows are oriented in a convergent manner with respect to the axes of the rotors.

In order to obtain an even better distribution, the invention additionally provides for liquid binder to be introduced especially into some of the rotating auxiliary gas flows. However, preferably the major part of the liquid binder is introduced at the centre of the centrifuging wheels and distributed by centrifugal force, while about 30% of the liquid binder is introduced via the interior of the auxiliary gas flows and the rest via the centre of the centrifuging wheels.

According to another aspect of the present invention there is provided a device for forming mineral fibres including centrifuging wheels having a substantially horizontal axis, onto the periphery of which a molten material is poured, a slot on the periphery of the wheels being fed, at least locally, by a gas source and nozzles, also fed by a gas source, which lie around the slot, and a system for feeding binder into the centre of the centrifuging wheels by projecting the binder radially, wherein some of the nozzles include liquid-binder supply tubes.

Three examples of guides are given, these either being Archimedean screws or being made from a helical rod or else including a rotationally driven moving blade.

Provision is also made for a binder feed tube to be incorporated into the rotary guides.

The invention also proposes a process for the formation of mineral fibres, in which a molten material is poured onto the periphery of centrifuging wheels having substantially horizontal axes, where the fibres are formed by centrifuging and are then shot out in a direction substantially parallel to the axis by a main gas flow over at least part of the periphery of the wheels, in which an auxiliary gas flow is created with substantially the same direction as the main gas flow and in which a liquid binder is shot out onto the fibres, and where binder is supplied into the auxiliary gas flow. Preferably, the supply of binder into the auxiliary gas flow takes place mainly beneath the fibre-forming centrifuging wheels. However, advantageously the major part of the binder is introduced at the centre of the centrifuging wheels and distributed by centrifugal force. Moreover, especially about 30% of the liquid binder is introduced via the interior of the auxiliary gas flows and the rest via the centre of the centrifuging wheels.

The description and the figures will enable the invention to be understood and its advantages to be appreciated:

- Figure 1 represents an external centrifuging machine according to the invention,
- Figure 2 shows a binder delivery device, and
- Figure 3 shows the same with, in addition, a blowing device according to the invention.

A plant for the manufacture of mineral fibres by free centrifuging generally includes the following elements: a reactor for melting the raw materials, which delivers one or more vertical strands of molten glassy materials, one or more fiberizing machines, each fed with a strand, the machines produce [sic] the fibres and spray [sic] them with a liquid binder. The fibres are received on a conveyor belt and pass, when the mat is formed, into an oven where the binder is cured.

The melting reactor is usually a cupola furnace fed with natural rocks and with industrial products such as blast-furnace slags. This cupola furnace produces a glass at a temperature of about 1500°C. The stream flows onto the fiberizing machine of Figure 1 and drops onto a first centrifuging wheel 1 from which the molten material is expelled towards the number 2 wheel. The first wheel, like the others, is surrounded on the machine itself by a slot 3 via which a gas is expelled. It serves to cool the wheel 1. Part of the molten material received by the wheel 2 is torn off its surface by the air flow emanating from the slot 4 and it forms fibres which are shot out in a direction substantially parallel to the axis of the centrifuging wheel 2. The non-fiberized remaining material is expelled towards the centrifuging wheel 5 and so on. Like the wheel 2, each of the wheels 5 and 6 possesses a slot, respectively 7 and 8, via which gas is expelled tangentially to the periphery of the wheel in order to draw and expel the fibres, the velocity of the gases is [sic] about 100 m/sec. These gases around the fibre-forming centrifuging wheels 2, 5, 6 make up the main gas flow which will convey the fibres to the conveyor belt, where they are gathered in order to form a bed of fibres. This bed of fibres makes up the final mat, or at least one of the elements of the latter.

In Figure 1 may be seen, at 9, nozzles from which gases are also blown in order to make up an auxiliary gas flow. These nozzles make up a ring and, as is explained in Patent EP-B-439 385, the auxiliary gas flow makes it possible to obtain a good distribution and a good orientation of the fibres on the receiving belt.

Conventionally, the binder intended - after it has cured - for mechanically combining the fibres with each other is expelled from the centrifuging wheels themselves via circular slots 10, 11, 12.

The device of the invention is employed in the nozzles 9. This device includes two elements which each contribute in turn to the result. These are the rotary guides and the supplies of binder.

Let us consider the latter first of all. These are tubes which are substantially concentric with some of the nozzles 9 of the ring of the auxiliary gas flow. Figure 2 shows such a nozzle equipped with the binder supply tube. The nozzle 13 is mounted via its end 14 on the fiberizing machine, this being a tubular conduit with a diameter of, for example, 40 mm from which the gases are expelled at velocities of about 70 m/sec. A tube 16, preferably on the axis of the outlet 15 of the nozzle, makes it possible to supply the binder in the middle of the gas flow which flows through the nozzle 13.

Trials have been carried out in order to supply the binder at various points in the ring of the auxiliary gas flow of Figure 1. It has been observed that the distribution of binder in the mat of fibres is markedly improved when the secondary supply of binder takes place below three fibre-forming rotors 2, 5 and 6, in particular the first one 2 and the second one 5. These supplies of binder, which are associated with some of the nozzles in the ring, do not serve to supply all the binder. It has been observed that the best conditions were those in which only 30% is delivered to the ring, the rest being, in the conventional manner, expelled from the centre of the wheels 10, 11, 12.

Figure 3 represents a nozzle equipped not only with its supply of binder but also with a rotary guide. These two devices are independent and each, by itself, is effective. The rotary guide is intended to rotate the auxiliary gas flow emanating from the nozzles such as 9 in Figure 1. The system shown Figure 3 [sic] is of the "corkscrew" type, that is to say that a metal rod 17 in the form of a helix has been placed inside the nozzle, concentric with the latter. When the gases channelled through the nozzle encounter the helical rod at high velocity (for example 70 m/s), they are rotated about the axis of the nozzle. Other equivalent devices have been tried, especially a fixed Archimedean screw, its axis coinciding with the axis of the nozzle, and even a system comprising a blade moving about the axis of the nozzle, the blade having a slightly helical shape which enables it to rotate when the gas flow rate is established. All these rotary devices make it possible to rotate at least some of the auxiliary gas flows.

In order to assess the efficacy of the above means, many comparative trials have been carried out. For each means, rotary guide on the one hand and central supply of binder on the other hand, as well as for the combination of both means, large quantities of rock wool were produced under the same conditions and the results compared.

The production parameters to be maintained the same in two trials intended to be compared were essentially: the degree of draw, the density of the final mat, the amount of binder and the characteristics, diameter and length, of the individual fibres.

The tests intended to evaluate the distribution of binder in the end product, that is to say to evaluate the results of the tests, are of two types, one being an optical observation and the other a tear test.

The optical appearance is evaluated by measuring the colour at the surface of the completed mat. The colour is measured using the trichromatic coordinates L^* a^* b^* [sic]. The colorimeter, which measures an 8 mm diameter circular surface in reflection, is the CR 100 type from the company MINOLTA. 30 uniformly spaced measurement points are selected over a 1 m x 1 m panel. Since the binder gives the product a yellow colour, only the L^* (luminance) and b^* (blue) coordinates were measured. The measurement consists in calculating the percentage of measurement points for which L^* is greater than 0.62 and b^* less than 0.20. These limits are those which separate a region in which the binder is missing (a "white sliver") and a region in which the binder is deposited normally. The calculated percentage provides the "white sliver content".

The tear test serves to determine the tensile strength of the end product perpendicularly to the faces of the mat, it [sic] is carried out in accordance with Standard CEN/TC 88. Taken over the width of the production line are 16 10 cm x 10 cm specimens uniformly distributed over the width. A 10 mm thick prefabricated plaster pad is adhesively bonded to each of the faces. Then, after the adhesive has cured, the specimens are put one by one into an INSTRON tensometer and the force at the moment of failure, when one face is pulled while the other remains fixed, is recorded.

The tear strength in kN/m^2, σ, is:

$$\sigma = 10^{-3} F/S$$

where F is the force measured in Newtons [sic] and S is the area ($0.01\ m^2$).

The "white sliver content" measurement was carried out on 3 different trials and on a reference production mat. The production [sic] was that with a density of 45.5 kg/m^3, the quantity of binder in the end-product was 3.1% and the white sliver content 22%.

The three trials according to the invention were performed under the following conditions:

1. Rotation alone

All the nozzles in the ring were equipped with the rotary guide consisting of the helical rod of Figure 3, the binder being supplied conventionally via the centre of the centrifuging wheels 10, 11 and 12.

2. Supply of binder into the nozzles

None of the nozzles 9 includes a rotary guide. Binder supply tubes are fitted on all the nozzles lying between the 8th and the 15th and between the 23rd and the 25th, the nozzles in Figure 1 being numbered in the positive direction, starting from the top left of the figure. 70% of the binder was supplied at the centre of the centrifuging wheels and 30% via the nozzles.

3. Rotation and supply of binder into the nozzles

This is the combination of the two above means: all the nozzles are equipped with rotary guides and the nozzles 8 to 15 and 23 to 25 are equipped with binder supply tubes (the same proportion as above).

The results are depicted in the table:

	Density kg/m^3	% binder	White sliver content
Reference	45.5	3.1	22%
Rotation alone	47.9	2.7	15%
Binder alone	43.4	3.3	13%
Rotation + binder	46.3	3.2	3%

These results thus show that each of the two means proposed, rotation and external supply of binder, is effective when it is by itself (respectively an improvement of 32% and 41%) and that their combination provides a further improvement (virtual disappearance of the "white slivers").

Moreover, the excellent results obtained from the combination of the two systems were confirmed by carrying out a tear measurement during another trial run, in which the density was double that above.

The results are also summarized in a table:

	Density kg/m^3	Thickness mm	% binder	Tear kPa
Reference	84.3	80.1	4.20	6.7
Trials	82.4	80.2	4.55	7.8

A 16% improvement in the tear behaviour is observed.

Thus, both the visual appearance (white sliver content) and the mechanical performance (tearing) are markedly improved by virtue of the process of the invention.

This better distribution of binder, in addition to the mechanical behaviour of the finished mat, has another advantage: it gives the mat being formed better cohesion. This is particularly beneficial when the mats are manufactured in two steps, formation of a primary web, as thin as possible, and then deposition of several thicknesses of the primary web in a zigzag fashion perpendicularly to the axis of the final mat. The greater the number of primary webs, that is to say, all other things being equal, the smaller the individual thickness, the better the performance characteristics of the finished mat.

The trials have shown that, whereas a normal production mat was limited at the low end in the case of the surface density of the primary web (below this minimum value the web tears and holes appear), the invention makes it possible very easily, under the same production conditions, to go down to values which are at least 30% lower, that is to say the primary web is 30% thinner, enabling the quality of the finished mat to be substantially improved.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A process for the formation of mineral fibres, including pouring a molten material onto the periphery of centrifuging wheels having substantially horizontal axes, forming the fibres by centrifuging and propelling the fibres in a direction substantially parallel to the axes of the centrifuging wheels by a main gas flow over at least part of the periphery of the wheels, creating an auxiliary gas flow in substantially the same direction as the direction of the main gas flow and projecting a liquid binder onto the fibres, wherein the binder is supplied into the auxiliary gas flow.

2. A process according o Claim 1, in which the supply of binder into the auxiliary gas flow takes place mainly beneath each of the fibre-forming centrifuging wheels.

3. A process according to Claim 1 or Claim 2, in which the major part of the binder is introduced at the centre of the centrifuging wheels and distributed by centrifugal force.

4. A process according to Claim 3, in which about 30% of the liquid binder is introduced via the interior of the auxiliary gas flow and the rest via the centre of centrifuging wheels.

5. A process according to any one of the preceding claims, in which the auxiliary gas flow includes individual flows.

6. A process according to Claim 5, in which some of the auxiliary gas flows are rotating flows.

7. A device for forming mineral fibres including

\\melb_files\home$\Caroline\Keep\Speci\P22815.doc 17/01/00 centrifuging wheels having a substantially horizontal axis, onto the periphery of which a molten material is poured, a slot on the periphery of the wheels being fed, at least locally, by a gas source and nozzles, also fed by a gas source, which lie around the slot, and a system for feeding binder into the centre of the centrifuging wheels by projecting the binder radially, wherein some of the nozzles include liquid-binder supply tubes.

8. A device according to Claim 7 in which the nozzles including liquid-binder supply tubes are located around the slot.

9. A device according to Claim 7 or 8 in which some of the nozzles include rotary guides.

10. A device according to Claim 9, in which the rotary guides are made from a helical rod.

11. A device according to Claim 9, in which the rotary guides are Archimedean screws.

12. A device according to Claim 9, in which the rotary guides include a rotationally driven moving blade.

13. A process for the formation of mineral fibres substantially as herein before described with reference to any one of the accompanying drawings.

14. A device for forming mineral fibres substantially as herein before described with reference to any one of the accompanying drawings.

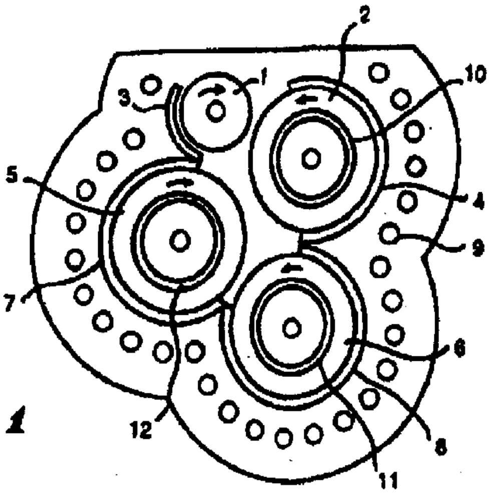

Fig. 1

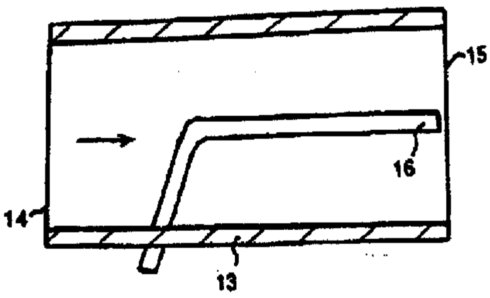

Fig. 2

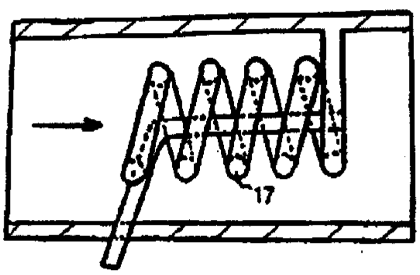

Fig. 3