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(54) **MINERAL FIBRE BATTS**

GLASFASERMATTEN

NAPPES DE FIBRES MIN RALES

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(73) Proprietor: **Rockwool International A/S
2640 Hedehusene (DK)**

(72) Inventors:
• **CLAUSEN, Anders, Ulf**
DK-4600 Koge (DK)
• **JACOBSEN, Bent**
DK-4000 Roskilde (DK)

(74) Representative: **Samuels, Lucy Alice et al**
Gill Jennings & Every LLP
Broadgate House
7 Eldon Street
London
EC2M 7LH (GB)

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EP 1 456 451 B1

Description

[0001] This invention relates to mineral fibre batts of the type which are conventionally known as "dual density" batts. These are bonded mineral fibre products comprising an upper layer intermeshed with a lower layer having a lower density than the upper layer, each layer being a bonded non-woven mineral fibre network.

[0002] The usual way of making dual density products is by providing a continuous mineral fibre web which contains binder, separating this web depthwise into upper and lower sub-webs, subjecting the upper sub-web to thickness compression so as to increase density, rejoining the sub-webs to form an uncured batt and then curing the binder to form the cured batt. The upper sub-web thus provides the higher density upper layer intermeshed with the lower density lower layer.

[0003] Typical disclosures of conventional dual density processes are given in, for instance, WO88/00265 and US-A-4,917,750. In each instance the web which is separated into sub-webs is a web as formed initially on a conveyor. As shown in WO88/00265, the web may be formed by cross lapping. As shown in both of those specifications the web is passed under some rollers as it approaches a device for separating the web into upper and lower sub-webs.

[0004] If no lengthwise compression is applied to the web before the separation, the fibres in the web will be substantially oriented parallel to the conveyor, because this is the predominant orientation during normal fibre lay-down processes. However in EP-A-1,111,113 the web is subjected to longitudinal compression before it is separated with the result that the fibres no longer have an orientation substantially parallel to the conveyor but instead have an orientation which has either a macro vertical component (so as to give significant visible pleats as shown in Figure 2 of EP-A-1,111,113) or a micro configuration (in which the vertical reconfiguration of the fibres has occurred but is not so visible to the naked eye, for instance as described in EP-A-0,889,981).

[0005] In conventional dual density processes the upper sub-web is subjected merely to thickness compression. However applying thickness compression necessarily results in minor elongation of the web and it is known to compensate for this by applying a longitudinal compression stage subsequent to the thickness compression stage. This is described in EP-A-1,111,113 (paragraph 59). Since the thickness compression will only give minor elongation, the subsequent compensatory longitudinal compression will also be minor.

[0006] Unpublished research by us has demonstrated that the upper layer and the lower layer serve different but interrelated functions in providing the overall properties of the dual density batt, and that the properties of each layer are influenced significantly by the macro and micro fibre arrangements within each layer in the final batt. Since the initial fibre orientation of the upper sub-web and the lower sub-web is the same this restricts the

ability to obtain optimum properties. Thus a fibre arrangement in the initial web which is optimum for the lower layer may not be optimum for the upper layer, and vice versa.

[0007] This invention relies in part on the realisation that starting with sub-webs which have the same fibre orientation and then merely subjecting the upper web to simple thickness compression (optionally with minor compensatory subsequent length compression) may not optimise the fibre orientation within each layer, having regard to the different functions that each layer is to serve. Naturally the difference in density will impose very different properties on the two layers but the present invention utilises the realisation that the benefits of the upper layer can be optimised if it is subjected to more than mere thickness compression in conventional manner (optionally with subsequent minor longitudinal compression). Since the upper and lower sub-webs have the same velocity when they are formed and when they are rejoined to form an uncured batt, it is necessary to compensate for the extra lengthwise compression in the upper sub-layer.

[0008] A process is described in WO94/16162 in which upper and lower sub-webs are derived by separating an initial web and are subjected to independent treatments before they are rejoined. Thus in Figure 1 one sub-web is subjected to pleating by longitudinal compression, optionally followed by thickness compression, or length compression while the other sub-web is subjected to cross lapping and then length compression and then thickness compression and/or more length compression. This process does allow for independent configuration of the two sub-webs and the attainment of a dual density product, but suffers from the inherent disadvantage that the major processing steps conducted separately on the two sub-webs necessitate extremely complex and lengthy apparatus.

[0009] Simpler processes, in which the lower sub-web has the same fibre configuration as the initial web, are also shown in WO94/16162 but these suffer from the traditional disadvantage that the properties of the primary web may not be optimum for both the upper and lower sub-webs.

[0010] We now find that it is possible to conduct the dual density process in a way that allows for optimisation of the fibre orientation in the upper layer substantially independent of the orientation in the lower layer.

[0011] Thus one method aspect of the present invention broadly provides a continuous method of forming a bonded mineral fibre batt comprising an upper layer intermeshed with a lower layer having a lower density than the upper layer in which each layer is a bonded non-woven fibre network, wherein the method comprises providing a continuous mineral fibre web which contains binder, separating the web depthwise into upper and lower sub-webs, subjecting the upper sub-web to thickness compression and greater lengthwise compression than is required to compensate for the thickness compression,

and subjecting the upper sub-web to lengthwise stretching and/or the lower sub-web to lengthwise compression so that the upper and lower sub-webs are travelling at substantially the same speed and rejoining the sub-webs to form an uncured batt wherein the upper sub-web provides the upper layer of the batt, and curing the binder.

[0012] Thus the two sub-webs have substantially the same speed of travel when they are separated and when they rejoin. It is also desirable that the path lengths of the two sub-webs are not significantly different. For instance it is convenient for apparatus and space reasons that both sub-webs should follow the same path length or that the longer path length should not be more than 1.3 or 1.5 times the shorter. Minor differences in speed just before rejoining can be tolerated provided that any resultant tension in either or both sub-webs when they are rejoined is so low that there is no distortion or delamination of the batt.

[0013] In one preferred process the upper sub-web is subjected to lengthwise compression before or during thickness compression, the lower sub-web is not subjected to significant lengthwise or thickness compression, and the upper sub-web is subjected to lengthwise stretching between the lengthwise compression and rejoining the lower sub-web.

[0014] Some or all of the lengthwise stretching may be applied during the thickness compression but after earlier lengthwise compression, or all the lengthwise stretching may be applied after the thickness compression has been completed. Stretching may be applied by pulling the upper sub-web towards the position where it is to rejoin the lower sub-web by a roller nip pair which rotates faster than rollers or belts causing the longitudinal and/or thickness compression. The stretching is preferably such as to relax the structure without making any change in fibre orientation visible to the eye.

[0015] In some processes the lengthwise compression is conducted in two or more stages, or may increase gradually, and often the lengthwise compression is applied during the thickness compression.

[0016] Instead of or in addition to applying lengthwise stretching to the upper sub-web before rejoining it to the lower sub-web, the lower sub-web may be subjected to lengthwise compression sufficient that it has substantially the same overall lengthwise compression as the upper sub-web.

[0017] The amount of lengthwise compression in the upper sub-web is generally in the range 5 to 35%, preferably around 10 to 20%. Thus, for instance, if both sub-webs have a speed of V at the time they are separated, the speed of the upper sub-web prior to any final lengthwise stretching is usually around 0.8 to 0.9 or $0.95V$, and if no lengthwise stretching of the sub-web is applied then a similar lengthwise compression of the lower sub-web is preferably applied.

[0018] The fibres of the initial web may have the fibres substantially oriented parallel to the surface of the web. By this we mean that the fibres in the web have the tra-

ditional essentially horizontal configuration which is typical for mineral fibres collected by an air-laying process, without any deliberate longitudinal compression or other vertical rearrangement of the fibres. Naturally the lay-down is not wholly horizontal, but the predominant orientation is clearly visible to the naked eye as being essentially parallel to the surface of the web.

[0019] The web at this stage may be a web formed by direct collection of mineral fibres by air-laying to the desired thickness or it may be a web formed by laying several such primary webs on one another or, more usually, by cross lapping a primary web to form a web of the desired thickness.

[0020] Preferably, however, the fibres have an orientation with a significant vertical component at the time of separation of the web into the upper and lower sub-webs, as a result of longitudinal compression of the total web prior to separation. This longitudinal compression may be such as to give either a macro structure or a micro structure, as described in EP-A-0,889,981 or in EP-A-1,111,113.

[0021] The web is separated depthwise into upper and lower sub-webs in conventional manner by a knife or other splitting device which is usually arranged substantially horizontally at a desired spacing above a conveyor on which the web is carried continuously. The positioning of the separating device is chosen to provide the appropriate relative thicknesses of the upper and lower webs. The thickness of the upper sub-web, at the time of separation, is usually from 5 to 60% of the thickness of the total web. Usually it is at least 20% and often at least 30% of the total thickness, because the upper web is usually subjected to very high thickness compression and requires adequate thickness after this. Generally the upper sub-web is not more than about 50% or, at the most, about 55% of the total web thickness because usually it is required that the lower layer has sufficient thickness and structural content to impart significant properties to the final product. However, if the upper layer is to be rather thick, and possibly even thicker than the lower layer, the upper sub-web may need to be thicker than 55% of the web.

[0022] Throughout this specification we are using the terms "upper" sub-web and layer and "lower" sub-web and layer in their conventional usage wherein conventionally a dual density batt is considered as having the higher density layer on its topmost surface. However the invention does, of course, include batts which are used the other way up and production processes in which the higher thickness compression is applied to the sub-web which is beneath the other sub-web, although in practice this is less preferred.

[0023] Also, it should be understood that although the invention is described wholly in terms of upper and lower layers and upper and lower sub-webs the invention also extends to processes in which there are one or more other layers and corresponding sub-webs in the final product, wherein these other sub-webs may be subjected

to the same or different thickness and/or lengthwise compressions as the upper sub-web and/or the lower sub-web. In particular there may be a higher density layer above the upper layer, for instance as described in WO00/73600.

[0024] The thickness compression of the upper sub-web is always large, in order that this sub-web provides the required high density upper layer. Generally the overall thickness compression of the upper sub-web when it rejoins the lower sub-web is above 50%, preferably above 70% and most preferably above 85% (so that the final thickness of the upper sub-web is less than 15% of its thickness when initially separated from the lower sub-web. Usually, the overall thickness compression is less than 97%, and most preferably less than 95% of the initial thickness.

[0025] Usually the upper and lower layers in the final product have a total thickness of 30 to 300mm. The upper layer usually has a thickness of 8 to 30mm, but it can be more. The upper layer is usually 3 to 25% of the total thickness but it can be more, for instance up to 50% or even 75%.

[0026] Each longitudinal compression can be achieved in conventional manner by passing the relevant sub-web from one set of conveying surfaces (which may be belts or rollers) to a second set which are travelling slower. For instance the upper sub-web may be passed from a series of rollers or belts travelling at one speed to the converging passage between two conveyors which are travelling at a slower speed (so as to cause lengthwise compression followed by thickness compression). The lengthwise compression of the lower sub-web can be achieved by passage from rollers or converging belts that provide thickness compression to a set of rollers or belts which are moving slower and which are parallel to one another so that they do not provide thickness compression.

[0027] Although there is uncured binder in the upper and lower sub-webs, and this may be sufficient to achieve adequate integrity of the final batt, it is possible to apply additional binder at the interface between the upper and lower sub-webs where they are rejoined, so as to promote the integrity of the final batt.

[0028] The batt is then passed through a curing oven in order to cure the total binder in conventional manner.

[0029] The mineral fibres may be any suitable mineral fibres such as glass, rock, stone or slag. The invention is of particular value when applied to mineral fibres obtained by centrifugal fiberisation, and in particular by fiberisation of a rock, stone or slag melt by a cascade centrifugal spinner.

[0030] Preferred processes according to the invention are carried out as illustrated and described with reference to Figures 7a and 7b of EP-A-1,111,113.

[0031] In one preferred process rollers 53 all operate at the same speed which is 90% of the speed of the rollers 50 and the conveyor 51, thereby producing 10% longitudinal compression. This may be followed by a stretching

stage between rollers 55 and where the upper sub-web rejoins the lower web.

[0032] In this embodiment, the rollers 54 may operate at the same speed as rollers 53. However in another embodiment they operate at a slower speed, thus providing another longitudinal compression between rollers 53 and 54. In another embodiment they operate at a speed midway between the speed of the rollers 53 and the speed of the upper sub-web and the lower sub-web. For instance if the rollers 53 cause travel at 90% of the speed of the web as it is separated, rollers 54 could travel at, for instance, 95% of that speed.

[0033] Instead of or in addition to this the conveyor 49 can be replaced by a conveyor along part of the length, to control the movement of the lower sub-web, followed by a conveyor or set of rollers moving slightly slower, so as to provide longitudinal compression.

[0034] We have established that the orientation of the fibres in the top layer is unique and that the attainment of this unique orientation results in the top layer giving better penetration resistance and performance, as the top layer of a dual density product, than is achieved by a top layer which does not have this orientation, when all other conditions are the same. Thus, as a result of obtaining the unique orientation it is possible to obtain equivalent results with a lower fibre amount and/or better results with the same fibre amount, when the lower layer is unchanged. Similarly, it is possible to obtain better results when using the same lower layer or equivalent results with an inferior lower layer.

[0035] The novel fibre orientation obtainable by the methods of the invention is also obtainable by other methods, and thus is another aspect of the invention.

[0036] In particular, in this product aspect of the invention we provide a dual density layer wherein the upper, higher density, layer is definable by its Kappa and Tau values in one or more cross sections, wherein these values are obtained by scanning examination of parts of each respective cross section through the thickness of the layer and Fast Fourier Transformation of the data.

[0037] In particular, in this product aspect of the invention we provide a dual density layer wherein the upper, higher density, layer is definable by its Kappa and Tau values in one or more cross sections, wherein these values are obtained by measuring parts of each respective cross section through the thickness of the layer in a flat-bed scanner like Hewlett Packard ScanJet 6100C. The product to be examined is placed on the scanner so that it fits on top of the scanner with the shortest distance perpendicular to the scanning direction, see drawing.

[0038] For the set-up of the scanner use was made of the scanner-software Desk Scan II with the following settings: Sharp B, and W. Photo; Resolution 120x120dpi, and automatic adjustment of brightness and contrast. The scanned image (15mm x 270mm) was divided into a number of local windows (1x33) of equal size (32x32pixels) in which the dominant fibre orientation was estimated using Fast Fourier Transformation.

[0039] As is known, a two-dimensional pattern, for instance of parallel stripes, can be expressed, by Fast Fourier Transformation, as a small number of dots and a complex two-dimensional pattern, such as a cross section of a mineral fibre network can be expressed by Fast Fourier Transformation as a large number of dots. These dots will be arranged in a pattern, which may be circular but more usually is elliptical.

[0040] The Tau value for the cross section is defined as the geometric mean of the ratio of the length of the ellipse to the width for each of the 33 local windows and thus a high value indicates a local well organised pattern (high consistency locally) and a lower value near 1 indicates that the pattern locally cannot be defined. The Kappa value is an indication of the statistical distribution of the different angles at which the ellipse is arranged locally for different parts of the overall structure, which is being examined. A high Kappa value indicates a narrow statistical distribution of angles whilst a low Kappa value indicates a broad distribution.

[0041] A description of the principles of the Tau and Kappa values for cross sections through the thickness of mineral fibre networks is described in "S.Dyrbol, Heat Transfer in Rockwool Modelling and Method of Measurement" Dept. of building and Energy, Technical University of Denmark and Rockwool International A/S. Ph.D-thesis, 1998. Reference should be made to that article for a description of how to examine a cross section and how to conduct a Fast Fourier Transformation on the result of the examination and calculate the Tau and Kappa values for the cross section. Other relevant publications are Russ, "Computer-Assisted Microscopy. The Measurement and Analysis of Images". Plenum Press, New York, 1990; Larsen, and Hansen, "Orientation Analysis of Insulation Materials, A feasibility Studie for Rockwool International A/S". Department of Mathematical Modelling, Technical University of Denmark, 1997. IMM-TR-2001-03; and Ersboll and Conradsen "Analysis of directional data for Rockwool A/S". Department of Mathematical Modelling, Technical University of Denmark, 1998. IMM-TR-2001-04.

[0042] In every instance it is necessary to determine the Tau and Kappa values by taking the mean value of at least 5 separate determinations each consisting of 3 cross sections.

[0043] In one embodiment of the product of the invention, the upper layer has Tau, determined on a first thickness cross section X (T_x) of below 4.5. The Tau value can be 1 or close to 1 but in practice the Tau value is often at least 1.5 and usually at least 2 and preferably it is below 4, most preferably below 3.5. These values are satisfactory when the upper layer has a conventional density typically of 100 to 200kg/m³. However good results are also obtained at slightly higher T_x values when the density is high. Thus in an alternative embodiment the upper layer has a density of above 200kg/m³ up to 300kg/m³ and has T_x below 5.0. Preferably T_x , even for these high density products, is below 4.5, most preferably

below 4.

[0044] We have found that upper layers of a conventional type and which are less effective as the upper layer in the dual density product typically has a Tau value of 6 or 7, or around 5 when the density is only moderate, for instance not more than 200kg/m³.

[0045] We have found that another way of defining satisfactory fibre arrangement for the upper layer is by reference to the ratio of $T_y:T_x$ where T_y is the Tau value (T_y) measured on a thickness cross section Y perpendicular the thickness cross section X. In this embodiment, the ratio $T_y:T_x$ should be at least 1.8 and is preferably at least 2.0. Often it is in the range 2.3 to 3.5, but can be up to 4.0 or even higher. We find that conventional, less satisfactory, upper layers typically have a ratio $T_y:T_x$ of not more than 1.7, often not more than around 1.5 or 1.6.

[0046] Preferred products have T_x below 4.5, or possibly up to 5 when the density is 200 to 300kg/m³, and $T_y:T_x$ at least 1.8, wherein preferred values for T_x and the ratio are each as described above.

[0047] The direction X is preferably the lengthwise production direction of the batt. During initial production the batt is obtained by collecting the fibres as a web travelling in direction X, wherein the web contains uncured bonding agent, splitting the web in the thickness direction into upper and lower layers, consolidating the upper layer depthwise to provide it with a higher density than the lower layer, rejoining the layers and then curing the binder. In practice the lengthwise production direction and thus the preferred orientation of direction X, can be determined by observing the pattern impressed on the upper and lower surfaces of the batt by the curing oven, when cured in conventional manner. Alternatively, in some instances the fibre orientation in the lower layer may be apparent to the naked eye to have been cross lapped, in which event the cross lapping will be substantially in the direction Y, transverse to the overall collection direction X.

[0048] We find the significance of the Tau values in the high density upper layer can be very different from the significance of numerically similar Tau values in the lower density lower layer and that the values quoted above are the values which indicate optimum properties in the high density upper layer. We also find the Kappa value in the high density upper layer is usually very high, above 10 or even 15, in one or both of the directions whereas in the lower, base layer, the Kappa value in both directions is usually relatively low, for instance below 8. Generally the upper layers of the invention have a Kappa value in at least one direction of above 10, and often at least 13 or even at least 15. Generally the direction of this high Kappa value is the Y direction, i.e., transverse to the production direction X.

[0049] It should be appreciated that when we refer to, for instance, the Tau value T_x on a thickness cross section X where X is the lengthwise production direction, we mean the cross section is cut vertically (when the batt is on a horizontal surface) in the lengthwise direction and

the cross section is then scanned transversely, i.e., looking in the transverse direction. Similarly, when we refer to Tau in a thickness cross section in the transverse direction, we mean the Tau value derived when conducting examination by looking in the lengthwise direction at the cross sections.

[0050] We find that obtaining the desired relatively low value of T_x and the desired relatively high ratio $T_y:T_x$ is promoted by the web which is split to provide the upper and lower sub-webs having been subjected to longitudinal compression so as to impart a tendency towards a vertical orientation of the fibres before the separation into upper and lower sub-webs. However the fibres preferably do not have a vertical orientation which is clearly visible to the naked eye, and in particular they preferably are not arranged as pleats. In particular it is preferred that the orientation should be of the type which is obtainable by the longitudinal compression described in EP-A-0,889,981 to give a structure which does not have any overall pleated configuration, and thus has a micro structure more like Figures 4, 5 and 12 in EP 1,111,113 than a macro structure as in Figure 2 of that specification.

[0051] The desired Tau and Tau ratio values are also promoted by subjecting the upper sub-web to significant depthwise compression but relatively small lengthwise compression, for instance as described in the process embodiments of the invention described above.

[0052] The desired Tau value and ratio of Tau values is also promoted by accompanying the lengthwise compression by lengthwise stretching, as in the process embodiment of the invention described above.

[0053] Accordingly, if it is found that any particular product has a Tau value which is higher than desired or a Tau ratio which is lower than desired, values within the defined and desired ranges can be obtained by varying the conditions generally so as to promote the web before splitting to have a structure more like the shown front faces of Figures 4 and 5 of EP 1,111,113 than Figures 1 and 2 and/or by applying only low to moderate longitudinal compression of the upper sub-web, often after most or all of the thickness compression has been applied.

[0054] In general, the Tau value can be minimised by arranging that the fibres have as disorganised a structure as possible, for instance as a result of tending to be arranged in tufts. However having low Tau value in both the X and Y directions is undesirable since it appears that, for optimising the properties of the upper layer, the Tau value in one direction should be considerably greater than the Tau value in the other.

[0055] In general if T_x is too low the process should be adjusted by lowering the length compression of the upper layer. If the ratio $T_y:T_x$ is too low, the process should be adjusted by increasing the length compression of the upper layer. The adjustments may be made before or after splitting into sub-webs, but preferably is done after splitting.

[0056] The Kappa value in the upper layer of above 10, and preferably of at least 12 or 15 up to 30 or even

40, is preferably in the thickness cross section in the Y direction, i.e., extending transverse to the production direction and examined looking in the production direction. Achieving high values of this type tends to follow automatically from selecting the right Tau values in combination with thickness compression to impart to the upper layer the required high density. The Kappa value determined on a thickness cross section X, i.e., in the lengthwise production direction, is generally in the range from 1 to about 12 or 15, often around 2 to 6, and these values also tend to be achieved automatically by applying appropriate lengthwise compression to allow which, as a result of the overall treatment, has the required Tau values.

[0057] The lower layer usually has both K_x and K_y below 8. Usually K_y is above 2, and often above 3. K_x is usually below 3 and preferably below 2.5. Generally the ratio $K_y:K_x$ is at least 1.3:1 and often at least 2:1 or 3:1.

[0058] T_x in the lower layer is usually below 3, and T_y is usually above 2.5 and most usually above 3. The ratio $T_y:T_x$ is usually above 1, typically at least 1.2.

[0059] In all these products the X value is preferably the value determined on a cross section in the lengthwise production direction, i.e., the value looking transversely across the web.

[0060] A measure of the effectiveness of an upper layer in a dual density product is the point load resistance, especially when plotted against fibre weight per unit area at a certain thickness of product. For instance two products of thickness 130mm were made each having a density in the upper layer of around 150 to 160kg/m³ and a density in the lower layer of around 110 to 115kg/m³ and a fibre weight per unit area of about 15.0 to 15.5kg/m³. One of them was made by a conventional process in which the web, before splitting, had been made by cross lapping with the fibres substantially parallel to the surfaces, followed by splitting into upper and lower sub-webs and mere thickness compression of the upper sub-web. This product gave a value of T_x of about 7 and a ratio $T_y:T_x$ of 1.4. Its point load value was measured as 364N.

[0061] The other was made by the preferred process described above, with the initial web being subjected to longitudinal compression substantially without visible pleating, followed by splitting into upper and lower sub-webs with the upper sub-web being subjected to thickness compression and to low longitudinal compression followed by stretching before rejoining the lower web. The upper layer had T_x 3.9, $T_y:T_x$ 2.1 and the product had point load resistance of 645N.

[0062] In order to ensure that the difference in point load resistance was due to the T_x values and the relationship of $T_y:T_x$, the Kappa values for the upper layer was also measured and the Kappa and Tau values for the lower layer were measured. The K_y and K_x values of the upper layer for the inferior product were slightly higher than for the superior product but other experiments which have been conducted have indicated that the small difference would not be significant. In each instance K_y was

above 20.

[0063] The Kappa and Tau values in each direction in the lower layer appear to be substantially the same and other work that we have done indicates that the differences would not be sufficient to explain the differences in point load performance for the total product.

[0064] Accordingly, the difference in point load values can be attributed to the differences in Tau values for the upper layer.

[0065] Best results are achieved when the upper layer has the fibre orientation described above and the lower layer has the fibre orientation described in PCT application reference PRL04398WO filed even date herewith claiming priority from European application 01310777.6.

[0066] The invention may be utilised for production of roof boards, facade boards or similar boards produced from bonded mineral fibres when a certain point load resistance is required. They may be used generally for thermal insulation, fire proofing, fire protection, sound proofing, sound protection, and as horticultural growth medium.

Claims

1. A continuous method of forming a bonded mineral fibre batt comprising an upper layer intermeshed with a lower layer having a lower density than the upper layer in which each layer is a bonded non-woven fibre network, wherein the method comprises providing a continuous mineral fibre web which contains binder, separating the web depthwise into upper and lower sub-webs, subjecting the upper sub-web to thickness compression and greater lengthwise compression than is required to compensate for the thickness compression, and subjecting the upper sub-web to lengthwise stretching and/or the lower sub-web to lengthwise compression so that the upper and lower sub-webs have substantially the same overall lengthwise compression, and then rejoining the sub-webs to form an uncured batt wherein the upper sub-web provides the upper layer of the batt, and curing the binder.
2. A method according to claim 1 in which the upper sub-web is subjected to lengthwise compression before or during thickness compression, the lower sub-web is not subjected to lengthwise or thickness compression, and the upper sub-web is subjected to lengthwise stretching between the lengthwise compression and rejoining the lower sub-web.
3. A method according to claim 2 in which the upper sub-web is subjected to a lengthwise compression which reduces its speed of travel to from 70 to 95% of the speed of travel of the lower sub-web.

4. A method according to claim 3 in which the upper sub-web is subjected to lengthwise compression to a speed of 70 to 95% of the lower sub-web, the upper sub-web is subjected to thickness compression, and the upper sub-web is then stretched to substantially the velocity of the lower sub-web.

5. A method according to any of claims 1 to 4 in which the web is subjected to lengthwise compression before it is split into upper and lower sub-webs.

Patentansprüche

1. Kontinuierliches Verfahren zum Erzeugen eines gebundenen Mineralfaservlieses, umfassend eine obere Schicht, die mit einer unteren Schicht vermascht ist, welche eine geringere Dichte als die obere Schicht hat, in welchem jede Schicht ein gebundenes Mineralfasernetzwerk-Vlies ist, wobei das Verfahren umfasst Bereitstellen einer kontinuierlichen Mineralfaserbahn, welche Bindemittel enthält, Auftrennen der Bahn in der Tiefe in obere und untere Teilbahnen, Unterwerfen der oberen Teilbahn der Dickenkompression und einer größeren Längskompression als erforderlich ist, um die Dickenkompression auszugleichen, und Unterwerfen der oberen Teilbahn der Längsdehnung und/oder der unteren Teilbahn der Längskompression, so dass die obere und die untere Teilbahn im Wesentlichen die gleiche Gesamt-Längskompression haben, und dann Wiederverbinden der Teilbahnen um ein ungehärtetes Vlies zu erzeugen, wobei die obere Teilbahn die obere Schicht des Vlieses bereitstellt, und Härten des Bindemittels.
2. Verfahren gemäß Anspruch 1, bei welchem die obere Teilbahn vor oder während einer Dickenkompression der Längskompression unterworfen wird, die untere Teilbahn nicht der Längs- oder Dickenkompression unterworfen wird, und die obere Teilbahn zwischen der Längskompression und dem Wiederverbinden der unteren Teilbahn der Längsdehnung unterworfen wird.
3. Verfahren gemäß Anspruch 2, bei welchem die obere Teilbahn einer Längskompression unterworfen wird, welche ihre Durchgangsgeschwindigkeit auf 70 bis 95% der Durchgangsgeschwindigkeit der unteren Teilbahn verringert.
4. Verfahren gemäß Anspruch 3, bei welchem die obere Teilbahn zu einer Geschwindigkeit von 70 bis 95% der unteren Teilbahn der Längskompression unterworfen wird, die obere Teilbahn der Dickenkompression unterworfen wird und die obere Teilbahn dann zu im Wesentlichen der Geschwindigkeit der unteren Teilbahn gedehnt wird.

5. Verfahren gemäß irgendeinem der Ansprüche 1 bis 4, bei welchem die Bahn der Längskompression unterworfen wird, bevor sie in die obere und die untere Teilbahn aufgetrennt wird.

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Revendications

1. Procédé pour former en continu une nappe de fibres minérales collées comprenant une couche supérieure entremêlée avec une couche inférieure ayant une densité inférieure à la couche supérieure, dans lequel chaque couche est un réseau de fibres non-tissées collées, ledit procédé comprenant de fournir un voile continu de fibres minérales qui contient un liant, de séparer le voile dans le sens de la profondeur en un voile partiel supérieur et un voile partiel inférieur, de soumettre le voile partiel supérieur à une compression en épaisseur et une compression en longueur plus forte que requis pour compenser la compression en épaisseur, et de soumettre le voile partiel supérieur à un étirage en longueur et/ou le voile partiel inférieur à une compression en longueur de telle façon que le voile partiel supérieur et le voile partiel inférieur présentent sensiblement la même compression globale en longueur, puis de réunir les voiles partiels pour former une nappe brute dans laquelle le voile partiel supérieur constitue la couche supérieure de la nappe, et de faire prendre le liant.

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2. Procédé selon la revendication 1, dans lequel le voile partiel supérieur est soumis à une compression en longueur avant ou pendant la compression en épaisseur, le voile partiel inférieur n'est pas soumis à une compression en longueur ou en épaisseur, et le voile partiel supérieur est soumis à un étirage en longueur entre la compression en longueur et la réunion avec le voile partiel inférieur.

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3. Procédé selon la revendication 2, dans lequel le voile partiel supérieur est soumis à une compression en longueur qui réduit sa vitesse de déplacement à 70 à 95 % de la vitesse de déplacement du voile partiel inférieur.

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4. Procédé selon la revendication 3, dans lequel le voile partiel supérieur est soumis à une compression en longueur à une vitesse de 70 à 95 % de celle du voile partiel inférieur, le voile partiel supérieur est soumis à une compression en épaisseur, et le voile partiel supérieur est alors étiré sensiblement à la vitesse du voile partiel inférieur.

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5. Procédé selon l'une quelconque des revendications 1 à 4, dans lequel le voile est soumis à une compression en longueur avant d'être scindé en un voile partiel supérieur et un voile partiel inférieur.

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REFERENCES CITED IN THE DESCRIPTION

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