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(54) **BASE PAPER, ITS USE AND MULTILAYER STRUCTURE**

(57) The invention relates to a base paper for producing a multilayer product, such as laminate structure. The base paper comprises cellulosic fibre material and has a bulk density value ≤590 kg/m^3; a Bendtsen roughness value ≥800 ml/min; and a Gurley porosity value ≤15 s/100 ml. The invention further relates to a use of the base paper and to a multilayer structure.

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Description

[0001] The present invention relates to a base paper, its use, and a multilayer structure comprising at least one layer made from said base paper, according to the preambles of the enclosed claims.

[0002] Various multilayer products are used nowadays for a wide variety of purposes. Common examples of multilayer products are different laminate structures, such as high-pressure laminates, continuously pressed laminates, as well as technical laminates and electrotechnical laminates. Atypical laminate structure may comprise a base or core, possibly a decorative paper layer(s) arranged on the base or core and finally an overlay layer. The base or core may be a material board, such as a particle board, fibreboard or the like, or the base or core may be formed from a number of layers of core paper or base paper that have been permanently attached together during the manufacture of laminate structure, i.e. multilayer structure of multilayer product. In case the base or core of the laminate structure comprises a material board, the laminate structure usually comprises one or several layers of base paper between the material board and the possible decorative layer(s) and the overlay layer. Other multilayer products are, for example, evaporative cooling pads. In practice, multilayered products, such as laminate structures, usually thus comprise multiple layers of base paper, which usually is an absorbent kraft paper.

[0003] In multilayer products and multilayer structures, the layers may be attached together by a thermosetting resin which is cured during the manufacture of the multilayer product or structure. The individual base or core paper layers and the decorative paper layers are impregnated with the thermosetting resin, the layers are stacked in the desired order, pressed together and the resin is cured, resulting the final multilayer product or structure, such as laminate structure. In order to guarantee a proper attachment of the individual layers with each other and the formation of the laminate structure, it is important that the used core or base paper absorbs resin effectively and uniformly.

[0004] Most resins used in manufacture of laminate structures are synthetic polymers, such as melamine resins, formaldehyde resins, phenolic resins, and the like. There is a rising interest in sustainability in the industry, which has led to reduction of the use of the synthetic petroleum-based polymer resins, both due to the environmental reasons as well as the growing market pressure. This means that there is an increased demand and desire to use resins which are, at least partly, based on natural and/or renewable resources. One interesting resin possibility to use in multilayered structures or products would be various thermosetting resins, which are at least partly based on lignin. Lignin is a natural polymeric substance that is available in large quantities as a by-product, for example, from pulp industry. These lignin-based resins could provide a sustainable alternative to petroleum-based polymers, as they are at least partly based on renewable sources and they can be manufactured by using raw-materials that otherwise might be considered as waste and incinerated. However, lignin-based resins have not worked properly with the available base papers, and this have limited or prevented their use in these applications. Lignin-based resins have not been uniformly absorbed into the base paper, and a resin poor area has been formed in the middle of the base paper. As the consequence of the non-uniform resin absorption, the attachment of the layers during the manufacture of the multi-layered structures and products has been inadequate, which have resulted failed and/or non-usable structures or products.

[0005] In general, there is a constant need to improve the properties of base papers intended for use in multilayer structures or products in order to improve the quality of the produced multilayer structures or products, to ease the production process as well as to enable wide use of the new, exciting, at least partly lignin-based thermosetting resins, which are emerging on the market.

[0006] An object of this invention is to minimise or possibly even eliminate the disadvantages existing in the prior art.

[0007] Another object of the present invention is to provide a base paper, which shows improved properties in a manufacture of multi-layered structures or products, especially a good ability to absorb resin uniformly.

[0008] Another object of the present invention is to provide a base paper, which is especially suitable for use with at least partly lignin-based thermosetting resins in manufacture of multilayer products.

[0009] In order to achieve, *inter alia,* the objects presented above, the invention is characterised by what is presented in the characterising parts of the enclosed independent claims.

[0010] Some preferable embodiments of the invention will be described in the dependent claims.

[0011] The embodiments mentioned in this text relate, where applicable, to all aspects of the invention, even if this is not always separately mentioned.

[0012] A typical base paper according to the present invention for producing multilayer structure or multilayer product, such as laminate structure, comprises cellulosic fibre material and has

- a bulk density value $\leq$590 kg/m^3,
- a Bendtsen roughness value $\geq$800 ml/min, and
- a Gurley porosity value $\leq$15 s/100 ml.

[0013] A typical multilayer structure according to the present invention comprises at least one layer made from a base paper according to the invention impregnated with a thermosetting resin comprising lignin.

[0014] Now it has been surprisingly found that an improved absorption of a thermosetting resin, especially a lignin-based thermosetting resin, into the base paper is obtained when the base paper has a bulk density value

≤590 kg/m^3, a Bendtsen roughness value ≥800 ml/min, and a Gurley porosity value ≤15 s/100 ml, sometimes ≤10 s/100 ml or ≤5 s/100 ml. The selected combination of the base paper properties provides unexpectedly effective absorption of the resin into the base paper. It was found that the specific combination of the bulk density, Bendtsen roughness and Gurley porosity values enable uniform and fast absorption of the thermosetting resins, especially at least partly lignin-based thermosetting resins, throughout the base paper layer, while the absorbed resin amount is maintained at a proper level. The present invention solves many of the problems that have this far limited or prevented the use of lignin-based thermosetting resins in manufacture of multi-layered products, such as laminates.

[0015] The present invention enables uniform absorption of thermosetting resin, especially at least partly lignin-based thermosetting resin, throughout the base paper. This means that a high resin content can be attained even in the middle region of the base paper, and a uniform or nearly uniform absorption profile for the thermosetting resin can be achieved throughout the base paper. The base paper has a first large surface and a second large surface, which are parallel with each other. The distance between the first and the second surface defines the thickness of the base paper. According to one embodiment, the base paper may comprise a first edge region, a second edge region and a middle region extending between the first edge region and the second edge region. The first edge region extends from the first large surface of the base paper in the thickness direction towards the middle region of the base paper and the second edge region extends from the second large surface of the base paper in the thickness direction towards the middle region of the base paper. The respective edge region usually comprises 15 % of the thickness of the base paper, and the middle region usually comprises 70 % of the thickness of the base paper. According to one preferable embodiment the base paper is impregnated with a thermosetting resin, preferably a thermosetting resin comprising lignin, i.e. at least partly lignin-based thermosetting resin. Preferably the concentration of the thermosetting resin in the first and second edge regions is essentially the same as in the middle region. For example, the difference in concentration of the thermosetting resin between the first and second edge regions and the middle region is at most 30 %, preferably at most 20 %, sometimes at most 10 %. Sometimes, the difference in concentration of the thermosetting resin between the first and second edge regions and the middle region may be less than 15 % or even less than 5 %.

[0016] The multilayer structure or multilayer product, preferably a laminate structure, which comprises at least one layer made from base paper according to the present invention, may comprise at least 10 weight-%, preferably at least 20 weight-%, of thermosetting resin, especially thermosetting resin comprising lignin, i.e. at least partly lignin-based resin. The resin content in the multilayer structure or product in percentages is determined by calculating the weight difference between the impregnated base paper (structure/product) and unimpregnated base paper (structure/product), whereafter the weight difference is divided by the weight of the impregnated base paper (structure/product) and multiplied with 100. All weights are given as dry weights.

[0017] The base paper according to the present invention is especially suitable for impregnation or absorption with a thermosetting resin comprising lignin, i.e. at least partly lignin-based resin. The thermosetting resin solution, which is used to impregnate the base paper may comprise at least 4 weight-%, preferably 8 weight-%, more preferably at least 12 weight%, of lignin, calculated from the total weight of the resin solution.

[0018] In the present context, the term "base paper" denotes a paper made from cellulosic fibre material and intended for use as a layer in a multilayer structure or product, such as laminate structure. Typically, the base paper comprises bleached and/or unbleached cellulosic fibre material, preferably unbleached cellulosic fibre material obtained by kraft pulping. According to one embodiment the cellulosic fibre material may comprise virgin cellulosic fibres and/or recycled cellulosic fibres. Sometimes the cellulosic fibre material may comprise cellulosic fibres obtained by mechanical pulping methods and/or cellulosic fibres originating from kraft pulping of sawdust. Preferably the cellulosic fibre material comprises unbleached cellulosic fibres, recycled cellulosic fibres and/or cellulosic fibres originating from kraft pulping of sawdust. According to one embodiment, the cellulosic fibre material may comprise 0 - 100 weight-%, preferably 10 - 90 weight-% or 25 - 75 weight-%, of unbleached cellulosic fibres, and/or 0 - 100 weight-%, preferably 10 - 90 weight-% or 25 - 75 weight-%, of recycled cellulosic fibres.

[0019] The base paper may have a bulk density value ≤590 kg/m^3 or ≤555 kg/m^3, preferably ≤550 kg/m^3, more preferably ≤540 kg/m^3, sometimes even ≤525 kg/m^3. According to one embodiment of the invention the base paper may have a bulk density value in a range of 425 - 590 kg/m^3 or 440 - 555 kg/m^3, preferably 450 - 550 kg/m^3, more preferably 475 - 540 kg/m^3. It has been observed that the bulk density of the base paper may be significantly lower compared to conventional base papers, where the bulk values are typically round 600 - 680 kg/m^3. It is assumed that the low bulk value of the base paper, when combined with the selected porosity values, unexpectedly improves the absorption, i.e. impregnation of the thermosetting resin, especially at least partly lignin-based thermosetting resin, into the base paper. Improved resin impregnation enables smooth and effective operation of the manufacturing process for the multilayer structure or product, as well as enables the production of stronger and qualitatively more uniform and satisfactory structures or products. In the present context the bulk values are measured by using standard ISO 534:2005.

[0020] The base paper may have a Bendtsen rough-

ness value ≥800 ml/min, preferably ≥900 ml/min, more preferably ≥950 ml/min. According to one embodiment the base paper may have the Bendtsen roughness value in the range of 800 - 1300 ml/min, preferably 900 - 1200 ml/min, more preferably 950 - 1150 ml/min. Bendtsen roughness indicates the smoothness of the base paper surface. Conventionally, it has been assumed that the base paper should have a smooth surface, i.e. relatively low Bendtsen roughness value. However, now it has been unexpectedly found that increased surface roughness makes the base paper surface more "open" and facilitates the absorption or impregnation of the thermosetting resin, especially at least partly lignin-based thermosetting resin. In particular thermosetting resins having a large molecular size, such as at least partly lignin-based thermosetting resins, are more easily absorbed when the Bendtsen roughness of the base paper is within the selected range. In the present context the Bendtsen roughness values are measured by using standard ISO 8791-2:1990 part 2.

[0021] According to one embodiment of the invention the base paper may have a Gurley porosity value ≤15 s/100 ml, preferably in the range of 1 - 15 s/100 ml, more preferably 2 - 12.5 s/100 ml, even more preferably 4 - 8 s/100 ml. For example, the base paper may have a Gurley porosity value in the range of 3 - 9 s/100 ml, preferably 4 - 8 s/100 ml, more preferably 5 - 7 s/100 ml. The base paper may have a Gurley porosity value even in the range of 7 - 13 s/100 ml, preferably 8 - 12 s/100 ml, more preferably 9 - 11 s/100 ml. According to one preferable embodiment of the base paper may have a Gurley porosity value ≤5 s/100 ml, preferably ≤4.5 s/100 ml, more preferably ≤4 s/100 ml. The Gurley porosity value may be in the range of 1 - 5 s/100 ml, preferably 1.5-4.5 s/100 ml, more preferably 2 - 4 s/100 ml. In general, the Gurley porosity value describes the air permeability of the base paper. It was surprisingly found that when the Gurley porosity value is within the defined values, especially when the Gurley porosity value is ≤5 s/100 ml, in combination with the defined bulk density and Bendtsen roughness values, the base paper is able to absorb increased amounts of thermosetting resin, especially lignin-based thermosetting resin. The increased ability of the base paper to absorb resin ensures that the resin amount is sufficient during the pressing step in the manufacture of the multilayer product and the quality of the produced multilayer products is high. As the defined Gurley porosity for the base paper enables the absorption of proper amounts of thermosetting resin into the base paper, the overall efficiency of the process is improved. In the present context the Gurley porosity values are measured by using standard ISO SCAN-P 19:78.

[0022] According to one embodiment of the invention the base paper may have a moisture content of 4 - 10 weight-%, preferably 4 - 8 weight-%, sometimes 5 - 8 weight-%. In the present context the moisture content is measured by using standard ISO 287:1985. It has been observed that the higher moisture content of the base paper further improves the absorption of the thermosetting resin into the base paper during the manufacture of multilayer products. At the same time, it is possible to achieve savings in energy consumption of the manufacturing process for the base paper as the drying need for the base paper in the process is reduced.

[0023] According to one embodiment of the present invention the base paper may have a basis weight in a range of 30 - 350 g/m^2. According to one embodiment the base paper may preferably have a basis weight in a range of 30 - 120 g/m^2, more preferably 40 - 100 g/m^2. In the present context the basis weight is measured by using standard ISO 536:1995. The base paper according to this embodiment is thus especially suitable for manufacture of overlays.

[0024] According to another embodiment of the present invention the base paper may have a basis weight in a range of 120 - 350 g/m^2, preferably 150 - 300 g/m^2. The base paper according to this embodiment is thus especially suitable for manufacture of high-pressure laminates (HPL).

[0025] The base paper may preferably have a wet strength value at least 300 N/m, more preferably at least 350 N/m, even more preferably at least 400 N/m, sometimes even at least 450 N/m. The wet strength value is measured by using test method ISO 3781. Wet strength is an important property of the base paper, as it allows the effective absorption or impregnation of the base paper with the thermosetting resin. The base paper may comprise one or more suitable wet strength resins, such as polyamidoamine epichlorohydrin resins or glyoxylated polyacrylamide, which can be added to the cellulosic fibre material during the manufacture of the base paper. According to the one embodiment the base paper may comprise a wet strength resin in amount of at least 1 kg/ton paper (dry), preferably at least 2 kg/ton paper (dry), more preferably at least 4 kg/ton paper (dry).

[0026] The base paper according to the present invention is suitable for producing multilayer structures or multilayer products, such as laminate structures. The base paper according to the present invention is especially suitable to be used for making a multilayer product selected from decorative high-pressure laminates, continuous pressed laminates, postform laminates, fire retardant laminates, compact laminates, drilling boards, electrotechnical laminates, and technical laminates. The base paper according to the present invention is further especially suitable for use as cushion pads used in laminate impregnation, evaporative cooling pads, as plywood films, or as surface films.

[0027] The base paper according to the present invention can be manufactured as conventional in the art. By proper selection of process parameters at the press and drying sections as well as at the calandering, it is possible to produce base paper according to the present invention. The person skilled in the art is able to determine the required parameters with a few standard experiments. The present invention is not related to the manufacture

of the base paper as such, but the specific combination of base paper properties providing unexpected advantages.

[0028] An embodiment of the present invention is described more closely in the following non-limiting example.

EXAMPLE

[0029] Base paper was made from unbleached chemical pulps. The main raw material of base paper stock suspension was unbleached sawdust pulp. Another raw material used for the base paper stock suspension was recycled fibre originating from old corrugated cartons (OCC). Minimum virgin pulp quantity was 70 %. To increase wet strength properties of the base paper, wet strength resin was added to furnish. Wet strength resin quantity was 4 kg/ton to reach the required wet strength.

[0030] The headbox fed a very dilute stock suspension onto the wire. On the wire section, as much water as possible was removed from the stock suspension fed from the headbox. Water was removed by means of gravity and suction. After the wire section paper web was pressed in a nip rolls and press felt, forcing water out of the paper to the felt. The dryer section comprised steam-heated drying cylinders. The dryer section was followed by a machine calender which adjusted the thickness and density of the produced base paper.

[0031] Produced base paper had following properties:

Bulk density 525 kg/m^3
Bendtsen roughness average 1143 ml/min
Gurley porosity 3.5 s/100 ml
Grammage 193.3 g/m^2
Moisture content 5.9 weight-%

[0032] When impregnated with thermosetting lignin-based resin, it was observed that the absorption of the resin throughout the base paper was uniform, and no significant difference in resin content could be observed between the edge regions and the middle region of the base paper.

[0033] Even if the invention was described with reference to what at present seems to be the most practical and preferred embodiments, it is appreciated that the invention shall not be limited to the embodiments described above, but the invention is intended to cover also different modifications and equivalent technical solutions within the scope of the enclosed claims.

Claims

1. Base paper for producing a multilayer product, such as laminate structure, the base paper comprising cellulosic fibre material and having

   - a bulk density value ≤590 kg/m^3,
   - a Bendtsen roughness value ≥800 ml/min, and
   - a Gurley porosity value ≤15 s/100 ml.

2. Base paper according to claim 1, **characterised in that** the base paper has the bulk density value ≤555 kg/m^3, preferably in a range of 450 - 550 kg/m^3, more preferably 475 - 540 kg/m^3.

3. Base paper according to claim 1 or 2, **characterised in that** the base paper has the Bendtsen roughness value in the range of 800 - 1300 ml/min, preferably 900 - 1200 ml/min, more preferably 950 - 1150 ml/min.

4. Base paper according to claim 1, 2 or 3, **characterised in that** the base paper has the Gurley porosity value <15 s/100 ml, preferably in the range of 1 - 15 s/100 ml, more preferably 2 - 12.5 s/100 ml, even more preferably 4 - 8 s/100 ml.

5. Base paper according to claim 1, 2 or 3, **characterised in that** the base paper has the Gurley porosity value ≤5 s/100 ml, preferably in the range of 1 - 5 s/100 ml, more preferably 1.5 - 4.5 s/100 ml, even more preferably 2 - 4 s/100 ml.

6. Base paper according to any of preceding claims 1 - 5, **characterised in that** the base paper has a moisture content of 4 - 10 weight-%, preferably 4 - 8 weight-%.

7. Base paper according to any of preceding claims 1 - 6, **characterised in that** the base paper has a basis weight in a range of 30 - 350 g/m^2.

8. Base paper according to claim 7, **characterised in that** the base paper has a basis weight in a range of 30 - 120 g/m^2, preferably 40 - 100 g/m^2.

9. Base paper to according claim 7, **characterised in that** the base paper has a basis weight in a range of 120 - 350 g/m^2, preferably 150 - 300 g/m^2.

10. Base paper to any of preceding claims 1 - 9, **characterised in that** the base paper has a wet strength value at least 300 N/m, preferably at least 350 N/m, more preferably at least 400 N/m.

11. Base paper according to any of preceding claims 1 - 10, **characterised in that** that the base paper comprises wet strength resin in amount of at least 1 kg/ton paper (dry), preferably at least 2 kg/ton paper (dry), more preferably at least 4 kg/ton paper (dry).

12. Base paper according to any of preceding claims 1 - 11, **characterised in that** the cellulosic fibre material comprises virgin cellulosic fibres and/or recycled cellulosic fibres.

13. Base paper according to any of the preceding claims 1 - 12, **characterised in that** the base paper is impregnated with a thermosetting resin, preferably thermosetting resin comprising lignin.

14. Use of base paper according to any of claims 1 - 13 as cushion pads used in laminate impregnation; as evaporative cooling pads; as plywood films; or as surface films; or for making a multilayer product selected from decorative high-pressure laminates, postform laminates, compact laminates, fire retardant laminates, continuous pressed laminates, drilling boards, electrotechnical laminates and technical laminates.

15. A multilayer structure, comprising at least one layer made from a base paper according to any of claims 1 - 13 impregnated with a thermosetting resin comprising lignin, wherein the multilayer structure preferably comprises at least 10 weight-%, preferably at least 20 weight-%, of thermosetting resin comprising lignin.

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EUROPEAN SEARCH REPORT

Application Number
EP 20 20 8279

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

D21H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	7 April 2021	Ponsaud, Philippe

CATEGORY OF CITED DOCUMENTS

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