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(54) **A METHOD FOR THE THERMOMECHANICAL DENSIFICATION OF POPLAR PLYWOOD AND PLYWOOD**

(57) The subject of the invention is a method of the thermomechanical densification of poplar plywood consisting of heating poplar plywood characterised by the fact that plywood of a moisture of 5-15% is subjected to is subjected to interval compression between the press plates, where the poplar plywood is heated to a temperature between 70° -105°C, and then compressed in 2-3 cycles under pressure of 5-20MPa, reducing the thickness of the plywood to 25-50% of its original thickness. Furthermore, the plywood obtained by the method according to the invention is characterized by relative deformations of 50%-75%

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Description

[0001] The subject of the invention is a thermomechanical method of compression of poplar plywood, used in the production of thin, flexible poplar plywood, the density of which increases during the compression process.

[0002] Plywood is a composite material, made by gluing together thin layers of wood veneers, rotated so that the grains of the adjacent layers are at different angles, up to 90°. The physical and mechanical properties depend on the type of wood used, the quality of the face veneers (external layers), the thickness and arrangement of the veneers, the type of resin used and the method of gluing. Varieties of plywood include moisture-resistant plywood (glued with urea resin), semi-waterproof (glued using melamine resin) and waterproof (using Bakelite and synthetic resins).

[0003] Plywood is made from various types of wood, most commonly pine, birch, alder and beech or exotic trees. The core veneers are often from a different, cheaper type of wood than the face veneers.

[0004] Due to the roughness of the surface, we differentiate: unpolished (0) and polished (1) plywood. Plywood can relatively easily be shaped (bent) when hot, which allows for the production of shapes useful in furniture making: drawers, door panels, back panels, structural components of office and workshop furniture. Consequently, plywood is commonly used in the production of domestic and office furniture.

[0005] Currently, flexible plywood is produced from exotic soft woods such as Fume or Ocoumé, that have a spongy wood structure.

[0006] SUPERFORM bendy plywood has been well-known for several years, with a wide range of applications in the furniture making, boatbuilding industries etc. It is a material that, due to its properties, can be substituted for other currently-used flexible materials such as slotted MDF. SUPERFORM plywood maintains high rigidity after final fixing. It can be shaped into any designed shape. Use of SUPERFORM plywood eliminates the need to use skeleton structures when forming radii.

[0007] SUPERFORM three-layer plywood is made from the exotic deciduous tree fuma/ceiba, using a melamine based resin; its sheets are polished.

[0008] Patent description PL215663 describes the process of modifying wood by heating the wood and then pulsar compression at a temperature between 70 and 170°, for relative deformations between 5 and 40%, perpendicular to the grain between press plates with a high frequency field generator, or in a heated press. Once the compression process is completed, the compressed wood cools between the press plates, and then acclimatizes until it achieves a moisture content equal to that which it will have in service.

[0009] Patent description US7404422 provides the method of continuous viscoelastic thermal compression of wood or wood components. Wood processed in this way may have a moisture content of between 15% and 30%. The process employs a press to ensure continuous compression. The process takes place at the glass transition temperature of the wood and under pressure between 650 and 2000 kPa.

[0010] Unexpectedly, it was discovered that it is possible to obtain flexible plywood by its compression in an interval process at temperatures up to 100°C. This process differs from those previously known, in that the relative deformation of the plywood amounts to 50%-75%, and there is no need for cooling between the press plates, which drastically cuts the production process. High pressure, between 500kPa and 20000kPa is used. It is important that the moisture of the plywood not exceed 15%.

[0011] The essence of the invention is a thermomechanical method of compression of poplar plywood consisting of heating poplar plywood wherein plywood with a 5-15% moisture level is subjected to interval compression between the press plates, where the poplar plywood is heated to a temperature between 70° - 105° and then pressed in 2-3 cycles at a pressure of 5-20MPa, reducing the plywood to 25-50% of its initial thickness.

[0012] The plywood obtained according to the method of the invention is characterized by relative deformation from 50% to 75%.

[0013] The subject of the invention is a method for the production of thin, flexible poplar plywood, which is densified during compression.

[0014] The method of densifying poplar plywood according to the invention consists of the thermomechanical densification of plywood characterized by the fact that poplar plywood is heated to a temperature between 70°-105°C and then compressed in 2-3 cycles in a high-pressure press, reducing the thickness of the plywood to 25-50% of its original thickness. The lignin in plywood heated above 70°C is subject to plasticization, and rapid spring-back after the first compression of the wood causes the elastication of the cell walls of the wood thanks to which the wood cell walls are not destroyed during compression, but only moved by removing empty spaces, which used to transport water. Plywood densified in this way obtains unexpected mechanical properties, i.e., great elasticity, thanks to which it can be bent to a radius of 100mm. Additionally, the surface of the plywood is smoothed and divested of the initial pores, which reduces by 30-50% the amount of chemicals necessary to bond it and to finish the surface.

[0015] The method of densification of the plywood is presented in more detail in the examples given below.

Example 1

[0016] Three-ply poplar plywood, with a temperature of 18° and 2.8mm thickness, of 9.5% moisture is placed between press plates heated to 95°C, whereupon the press is closed, compressing the plywood to a thickness of 2.6mm. After 180 seconds, the plywood is heated to 90-95°C, when the press plates are lifted, and lowered once more, compressing the plywood to a thickness of

1.5mm for 30 seconds. The press is opened for a second tie and closed again, compressing the plywood to a thickness of 0.7mm for 60 seconds. When the press is opened, the plywood has a thickness of about 0.9mm. The compression was performed using an Italpresse GL260PS high pressure press, allowing the achievement of a force of 22000kN.

Example 2

[0017] Thermally modified poplar plywood (conditioning in a temperature 170-215°C for 6-10 hours), 3mm thickness and 8% moisture is placed between press plates heated to a temperature of 95°C, whereupon the press is closed, compressing the plywood to a thickness of 2.8mm. After 180 seconds, the plywood is heated to 90-95°C, when the press plates are lifted, and lowered once more, compressing the plywood to a thickness of 1.5mm for 30 seconds. The press is opened for a second tie and closed again, compressing the plywood to a thickness of 0.6mm for 60 seconds. During the final cycle, the press plates are pressed with a force of 10000kN - 20000kN which, depending on the area of the plywood, provides pressure of about 5-20MPa. After the opening of the press, the plywood has a thickness of about 0.9mm. It is then cooled and climatized to a moisture content equal to that which it will have in service. The densified poplar plywood, that had previously been subjected to thermal modification has additional properties: it is resistant to mould and woodworm as well as greater dimensional stability.

Example 3

[0018] Three-ply poplar plywood, with a temperature of 18° and 2.8mm thickness, of 15% moisture is placed between press plates heated to 95°C, whereupon the press is closed, compressing the plywood to a thickness of 2.6mm. After 60 seconds, the plywood is heated to 90-95°C, when the press plates are lifted, and lowered once more, compressing the plywood to a thickness of 1.0mm for 30 seconds. The press is opened for a second tie and closed again, compressing the plywood to a thickness of 0.7mm for 60 seconds. When the press is opened, the plywood has a thickness of about 1.67mm. The compression was performed using an Italpresse GL260PS high pressure press, allowing the achievement of a force of 22000kN. The resulting plywood has a hardness on the Brinell scale in the order of 35MPa (compared to raw plywood - 10MPa).

Claims

1. The method of the thermomechanical densification of poplar plywood consisting of heating poplar plywood **is characterized by the fact** that plywood of a moisture of 5-15% is subjected to interval compression between the press plates, where the poplar plywood is heated to a temperature between 70° -105°C, and then compressed in 2-3 cycles under pressure of 5-20MPa, reducing the thickness of the plywood to 25-50% of its original thickness.

2. The plywood obtained by the method described in Claim 1 **is characterized by** relative deformations of 50%-75%.

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EUROPEAN SEARCH REPORT

Application Number
EP 17 20 2100

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	CN 101 603 623 A (ZHEJIANG SHIYOU TIMBER CO LTD [CN]) 16 December 2009 (2009-12-16) * see automatic english translation joined * -----	1	INV. B27M1/02 B27K5/00 B27K5/06
X	US 4 606 388 A (FAVOT PETER [CA]) 19 August 1986 (1986-08-19)	1,2	
Y	* abstract * * figures * * column 1, line 6 - line 21 * * column 1, line 47 - line 56 * * column 2, line 57 - column 3, line 10 * * column 3, line 42 * * column 4, line 1 - line 8 * * column 4, line 47 - line 51 * -----	1	
X	US 6 689 301 B1 (MOYES HARTLEY [GB]) 10 February 2004 (2004-02-10) * abstract * * column 5, line 10 - line 12; figures * * column 5, line 24 - line 26 * * column 6, line 18 - line 21 * * column 7, line 11 * * column 7, line 33 - line 38 * * claim 1 * -----	1	

TECHNICAL FIELDS SEARCHED (IPC)

B27M
B27K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	28 March 2018	Hamel, Pascal

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 17 20 2100

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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28-03-2018

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US 6689301 B1	10-02-2004	NONE	

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- PL 215663 **[0008]**
- US 7404422 B **[0009]**