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(54) Method for the three-dimensional wrapping of wood panels

(57) A method for the three-dimensional wrapping of wood panels and the like with a surface-enhancing sheet of thermoplastics material which is glued to the surface of the panel, in which a layer of adhesive is applied both to the surface of the panel and to the surface of the surface-enhancing sheet and these are glued together by contact between the adhesive layers and the pressing of the surface-enhancing sheet onto the surface of the panel.

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Description

The present invention relates to a method for the three-dimensional wrapping of wood panels and the like with a surface-enhancing sheet of thermoplastics material which is glued to the faces of the panel.

The three-dimensional wrapping of wood panels, such as MDF boards and chip-board, particularly doors for domestic appliances which are shaped to a greater or lesser extent, with a sheet of polyvinyl chloride (PVC) or other thermoplastics material, such as polypropylene or ABS (acrylonitrile-butadiene-styrene), is a fairly recent surface-enhancing technique which has achieved considerable success in a very short period of time.

The gluing method universally adopted by manufacturers in this field employs the following operative steps:

- applying the adhesive by spraying onto the panel, which is typically a medium density board (MDF),
- drying the adhesive layer for about 30 minutes at ambient temperature or for 5-10 minutes with moderate heating,
- pre-heating the board in a press at a temperature which may vary between 60 and 90°C,
- coating the board with the sheet of plastics material, and
- pressing and gluing the coating sheet to MDF board at a sheet temperature of the order of 80-90°C.

The coating process is carried out to as to wrap the board, whereby the side faces and the upper face of the board are coated. A membrane press is typically used for such a purpose; more recently, a membraneless coating process has been introduced which makes use of a membraneless coating press, wherein the thermoplastics foil to be coated act as the press membrane.

The pressing is carried out with heat in order to thermally reactivate the adhesive and consequently achieve uniform contact between the two adherent members constituted by the MDF board and the coating plastics material. Usually, the adhesive is constituted by an aqueous-based polyurethane emulsion, possibly associated with additional vinylic or acrylic aqueous emulsions according to the requirements.

Often, in order to improve the resistance to heat or water, the adhesive is pre-mixed with a certain percentage of an isocyanate hardener which has a cross-linking effect on the adhesive bond.

A basic characteristic of the surface-enhancing sheet is its thermoplasticity, that is its ability to adapt itself perfectly to the shaped surfaces of the board as a result of heating. The coating material most widely used today is PVC, but other polyolefin materials, particularly polypropylene and ABS are making their appearance on the market, rendering the gluing problems more complicated.

The surface-enhancing sheet, whether it consists of PVC, polypropylene or other thermoplastics, is always provided with a coating layer of a primer on its surface which is to be glued, the primer typically consisting of chlorinated polymers in a solvent-based carrier suitable to promote, during the pressing step the adhesion of the thermoplastics sheet onto the board faces on which the adhesive is applied.

In the conventional process, the need to transfer the adhesive from the faces of the board to that of the plastics coating sheet imposes a series of operational constraints and performance limits.

In particular, the critical aspects of the conventional method are:

- the difficulty of obtaining a homogeneous transfer of the adhesive layer from the board to the surface-enhancing sheet;
- insufficient tackiness and hence difficulty in obtaining adhesion on shaped regions of the board, such as edges and grooves;
- extreme delicacy of the heating process for reactivating the adhesive layer; too forced a heat treatment in fact reduces the cohesion of the adhesive and hence its capability to bond; on the other hand, too weak a heat prevents the adhesive film from reaching that condition of plasticity which is essential to achieve satisfactory adhesion;
- long pressing cycle which is typically 2 to 2.5 minutes, but may be even 3 to 3.5 minutes with very shaped boards and/or with very thick plastics material.

In order to avoid these problems, the present invention provides a method for the three-dimensional wrapping of wood panels and the like with a surface-enhancing sheet of thermoplastics material which is caused to adhere to the side faces and upper face of the panel by gluing, characterised in that a layer of adhesive is applied both to the faces of the panel to be coated and to the face of the surface-enhancing sheet and gluing is achieved by contact between the adhesive layers by pressing of the sheet onto the side faces and upper faces of the panel.

To advantage, the method of the invention uses a thermoplastics sheet having a pre-applied layer of adhesive coated onto its face intended to adhere to the board. According to this preferred embodiment, in the method of the invention the adhesive is spread onto the MDF board in the conventional manner, the adhesive layer is dried under ambient or hot conditions and the board is wrapped with the sheet of plastics material which carries a previously applied and dried layer of adhesive compatible with the adhesive applied to MDF board. In this case, adhesion develops by direct contact

between the two adhesive films and not by transfer of adhesive from the panel to the coating sheet as occurs in the prior art.

The adhesives used in the method of the invention include any adhesive in aqueous emulsion, which can develop adhesion by direct film-to-film contact. Such adhesives include aqueous emulsions of polyurethane, polyethylene-vinyl acetate, polychloroprenes, nitrile rubbers, SBS, SBR, emulsions of vinylic polymers and copolymers, emulsions of acrylic polymers and copolymers.

Preferred adhesive systems include polyurethane emulsions and emulsions of polyurethane and polyethylene-vinyl acetate in a ratio of 1:2 to 2:1 to each other.

When, according to the preferred embodiment, use is made of a thermoplastics sheet or foil, which is wound in a roll, having a pre-applied adhesive layer, the adhesive advantageously comprises an anti-blocking agent suitable to prevent the accidental adhesion of the turns of the sheet with each other, thereby to avoid blocking events in the unwinding process.

The anti-blocking agent is to be selected so as not to jeopardise the contact adhesion properties of the adhesive. The anti-blocking agents which are used for such a purpose are non-thermoplastics polymers which are compatible with the adhesive system being used. High molecular weight polyvinylalcohol is preferably used in combination with polyurethane-based adhesive systems; however, also cellulose and starch ethers, such as hydroxypropyl or hydroxyethyl cellulose or starch could be used if sufficiently compatible with the adhesive system. The amount of the anti-blocking agent in the adhesive emulsion is typically from 0.3 to 2% by wt., or from about 1 to about 6% by wt. referred to the dry adhesive.

The adhesive which is pre-applied to the coating sheet preferably comprises a surfactant suitable to provide adequate wetting properties to the thermoplastics sheet thereby to foster the good anchoring of the adhesive and exclude the need for the traditionally used primer coating. The surfactant is preferably an anionic surfactant. In order to achieve the desired wetting properties, the surfactant is preferably incorporated in the adhesive emulsion in a concentration ranging from 0.3 to 1% by wt. referred to 100 parts of the emulsion, most preferably of from 0.3 to 0.6 by wt..

It will be understood that the choice of the adhesive applied to the coating sheet must also depend on the material constituting the thermoplastics surface-enhancing sheet which, in the method of the invention, is preferably PVC or some other polyolefin materials, particularly polypropylene and ABS.

When the thermoplastics sheets consist of polypropylene, the adhesive advantageously comprises a carefully controlled amount of a cross-linking isocyanate hardener which has been found to provide for an improved anchoring of the adhesive to the thermoplastics sheet and which allows to exclude the use of traditional solvent-based primer coating.

The amount of the isocyanate hardener must be carefully controlled in order not to jeopardise the thermal-activation properties, that is the possibility to develop the adhesion by contact. The amount of isocyanate hardener should preferably not exceed 2.5% by wt. referred to 100 parts of the wet adhesive emulsion.

The adhesive which is applied to the faces of the board to be coated may have the same nature as the adhesive applied onto the coating sheet or a different nature. The adhesive to be spread onto the board surfaces is selected among those mentioned hereinbefore.

It has been found that the performance of the wrapped panel in terms of its being water-proof or heat-proof may be improved by pre-mixing the adhesive spread onto the board with an isocyanate hardener which can induce suitable cross-linking over the entire adhesive bond formed by the contact adhesion. Whenever used, the isocyanate hardener is present in a concentration of from 1 to 10% with reference to 100 parts of aqueous adhesive emulsion.

The advantages of the method of the invention for the three-dimensional wrapping of panels and in particular of shaped doors, comprises:

a) substantial reduction in the pressing time, since contact adhesion develops almost instantaneously;

b) no particular need to operate at very high pressures which are, on the other hand, absolutely necessary when the adhesive layer must be made to transfer from one adherent member to the other;

c) better instantaneous adhesion and hence no risk of the coating sheet lifting from tensioned regions of the manufactured article, such as edges and superficial grooves;

d) greater versatility of the process both in terms of control of the reactivating heat conditions and in the level of tension needed in the step in which the adhesive is spread onto the panel; in the prior art, non-uniform spraying of the adhesive onto the panel or an inappropriate reactivation temperature compromise the bonding, while this is facilitated when both of the surfaces brought into contact have already been spread with adhesive;

e) the use of a primer coating onto the surface-enhancing sheet is avoided; in fact, with the new method the sheet is previously spread with adhesive, which makes redundant the pre-treatment with a primer which is steadily used according to the conventional prior art process;

f) since the conventionally used primers comprise an organic solvent as the carrier, the process allow to exclude the use of solvent-based products;

g) the possibility of operating with a mixed adhesive system in that the adhesive spread onto the board may be different from that spread onto the sheet of plastics material.

Experimental tests

Two adhesive-based formulations were used for practical tests, one of these being for the pre-spreading of the thermoplastics sheet and the second for the spraying of the MDF panel. The adhesive formulations were as follows:

ADHESIVE 1 (for the panel)		ADHESIVE 2 (for the thermoplastics sheet)	
55% s.s. EVA emulsion	44.0	40% s.s. polyurethane emulsion	87.0
40% s.s. polyurethane emulsion	48.0	40-88 polyvinyl alcohol	1.25
Trisodium phosphate	0.1	Water	6.25
Water	7.9	Anti-fermentation agent	0.15
	100.0	Wetting agent Lumiten AFK	0.50
		Water	4.85
			100.00
Brook Visc:	230 mPa.s	Brook Visc:	800 mPa.s
pH:	8.5	pH:	8.2
Solids:	44%	Solids:	36%

Polyvinylalcohol 40-88 is a high molecular weight polymer having a hydrolysis degree of 88% and 40 Hoeppler viscosity; it provides anti-blocking properties to the adhesive spread onto the coating sheet.

Lumiten AFK (trademark) is an anionic surfactant which is chemically defined as the sodium salt of a fatty acid condensation product; it is employed as an aqueous solution including 55% by wt. solids and with an alkaline pH; the anionic surfactant improves the anchoring properties of the adhesive to the thermoplastics sheet and allows to avoid the use of a conventional primer coating.

When a thermoplastics sheet of material other than PVC, such as polypropylene, is used, the use of a conventional primer may be avoided by pre-mixing the adhesive composition with a controlled amount of isocyanate hardener.

A first series of adhesion tests was carried out with these two formulations, the object of which was essentially to check the basic practicality of the system and the possibility of improving the stability to heat by incorporation of an isocyanate hardener only in the adhesive intended to be applied to the board.

The table which follows gives the test conditions of example 1 (without hardener) and of example 2 (with hardener present in the adhesive composition applied to the board in quantities of 5% by wt. with respect to 100 parts of adhesive):

	Example 1 (without hardener)	Example 2 (with hardener)
- Coating sheet:	PVC without primer	As 1
- Thickness of adhesive 2 on PVC:	40 µm	As 1
- Drying of adhesive:	under ambient conditions	As 1
- Panel:	MDF	As 1
- Adhesive 1 on panel:	Spread (60-80 g/m^2)	Adhesive 1 pre-mixed with 5% hardenerBasonat DS 3425 (60-80 g/m^2)
- Drying of adhesive on panel:	Ambient conditions for 30 minutes	As 1
- Bonding T:	60°C	As 1
- Bonding pressure:	5 kg/cm^2	As 1
- Pressing time:	3 seconds	As 1
Results		
- Adhesion:	Good (support tear)	Good (support tear)
- Stability to heat at 90° (laboratory method)	10 minutes	50 minutes

Examples 3 and 4

The adhesives described above at 1 and 2 were used in coating tests to coat doors in a membrane press with the use of PVC as the coating sheet without primer coating. The test conditions were as follows:

- thickness of adhesive 2 on PVC: 40 µm;
- type of the shaped doors: MDF 50x35 cm;
- adhesive 1 on the doors, pre-mixed with 5% Basonat DS 3425 (trademark of the isocyanate hardener);
- drying of adhesives 1 and 2: under ambient conditions;
- time between spraying of the door and subsequent bonding with PVC sheet: about 30 minutes;
- applied pressure: 18 kg/cm^2;
- membrane temperature: 83°C;
- pre-heating time: from 20 to 30 seconds;
- pressing time: from 5 to 30 seconds.

A very good adhesion and stability were achieved as shown by tearing of the support in the adhesion test. The method of the invention, which operates by contact adhesion, does allow satisfactory adhesion to be achieved with extremely short pressing times. Some of the experimental tests also confirmed the possibility of reducing the applied pressure from 18 to 10 kg/m^2.

Positive results were always obtained even without the primer coating. The incorporation of the isocyanate hardener only in the adhesive for the MDF enables the stability to heat of the entire adhesive bond to be improved, as shown by examples 1 and 2.

Example 5

With the same adhesives 1 and 2, as above described, tests were carried out by using a polypropylene sheet without primer coating as the wrapping thermoplastics material. In this case, adhesive 2 - before being applied onto the polypropylene sheet - was mixed with 2% by wt. of the isocyanate hardener Desmodur DA (trademark), thereby to obtain an adequate anchoring onto the polypropylene without compromising the thermal reactivation properties of the adhesive layer.

It was found that, when the amount of isocyanate hardener exceeds the value of about 2.5% by wt, the activity of the isocyanate hardener becomes too strong so as to exclude the possibility to activate the adhesive by heat and to develop the contact adhesion properties in the following pressing step. One week after having applied the adhesive onto the polypropylene sheet, the sheet was used for wrapping doors for domestic appliances with a membrane press, according to the following conditions:

- shaped doors: MDF board with dimensions: 50x35 cm;
- adhesive 1 on the door: pre-mixed with 5% by wt. Desmodur DA and then applied by spraying;
- drying time of adhesive 1 on the door: about 30 minutes;
- applied pressure (membrane press): 18 kg/cm^2;
- membrane temperature: 95°C;
- pre-heating time: 25-35 seconds;
- pressing time: 20-30 seconds.

Notwithstanding the reduced pressing time and the exclusion of the traditional primer coating onto polypropylene, positive adhesive results were obtained; the wrapping was fully satisfactory even on highly shaped parts of the door, such as projecting profiles and grooves. The test confirmed the possibility of achieving a selective cross-linking of the adhesive pre-applied onto the polypropylene sheet when the amount of isocyanate hardener is below the threshold of about 2.5% by wt.; in fact, the adhesive layer, which was firmly anchored to the polypropylene sheet, was shown to be sufficiently thermoplastic so as to allow contact adhesion in the final pressing step.

Claims

1. A method for the three-dimensional wrapping of wood panels and the like with a surface-enhancing sheet of thermoplastics material which is caused to adhere to the side faces and upper face of the panel by gluing by means of a single pressing step, characterised in that a layer of adhesive is applied both to the faces of the panel to be wrapped and to the face of the surface-enhancing sheet and gluing is achieved by contact between the adhesive layer by pressing of the sheet onto the side and upper faces of the panel.

2. A method according to claim 1, characterised in that a sheet of thermoplastics material is used having a previously applied and dried adhesive layer, the adhesive been capable of reactivation by heat.

3. A method according to claims 1 or 2, in which the surface-enhancing wrapping sheet is a sheet of PVC, polypropylene or ABS.

4. A method according to any one of claims 1 to 3, in which the adhesive applied to the surface of the panel and to the surface of the surface-enhancing sheet is constituted by an aqueous emulsion of polymers selected from polyurethanes, polychloroprenes, nitrile rubbers, SBS, SBR, vinyl polymers and copolymers, acrylic polymers and copolymers.

5. A method according to any one of claims 1 to 4, in which the adhesive applied to the surface-enhancing sheet includes an anti-blocking agent.

6. A method according to claim 5, in which the anti-blocking agent is selected from the group consisting of high molecular weight polyvinylalcohol, cellulose ethers and starch ethers.

7. A method according to any one of claims 4 to 6, wherein the concentration of the anti-blocking agent is from 0.3 to 2% by wt. referred to the weight of the aqueous adhesive emulsion.

8. A method according to any one of claims 1 to 7, wherein the adhesive applied to the surface-enhancing wrapping sheet includes an anionic surfactant suitable to promote the wetting properties of the thermoplastics sheet.

9. A method according to claim 8, wherein the anionic surfactant has a concentration of from 0.3% to 1% by wt. referred to the weight of the aqueous adhesive emulsion.

10. A method according to any one of claims 5 to 9, in which the adhesive applied to the panel and the adhesive applied to the coating sheet is constituted by an aqueous emulsion including polymers selected from polyurethane, polyethylene-vinyl acetate and mixtures thereof.

11. A method according to any one of the preceding claims, wherein the thermoplastics sheet consists of polypropylene or ABS and the adhesive applied onto the thermoplastics sheet includes an isocyanate hardener.

12. A method according to claim 11, wherein the isocyanate hardener has a concentration below 2.5% by wt. referred to the weight of the aqueous adhesive emulsion.

13. A method according to any one of the preceding claims, in which the adhesive is applied to the surface of the wrapping sheet intended for adhesion without the prior application of a primer.

14. A method according to any one of the preceding claims, including the steps of:

- applying the adhesive by spraying onto the panel,
- drying the adhesive layer onto the panel,
- wrapping the panel with the surface-enhancing sheet having a previously applied and dried adhesive coating, and
- pressing and gluing the wrapping sheet to the side surfaces and upper surface of the panel in a membrane press, under heat treatment suitable to thermally activate the adhesive layers.

15. A method according to any one of the preceding claims, in which the panel is a shaped MDF board or a chip-board.

16. A method according to any one of the preceding claims, in which the adhesive applied onto the panel includes an isocyanate hardener in the amount of from 1 to 10% by wt. with reference to 100 parts of aqueous adhesive emulsion.

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EUROPEAN SEARCH REPORT

Application Number
EP 95 10 9906

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US-A-3 296 056 (BECHTOLD) 3 January 1967 * column 1, line 18 - line 24 * * column 4, line 22 - line 27; figures 3-10 * ---	1-3, 13-15	B27N7/00
X	US-A-4 743 509 (KOKRHANEK) 10 May 1988 * column 3, line 38 - line 68; claims; figures * ---	1,2, 14-16	
A	US-A-5 264 467 (DISTEFANO) 23 November 1993 * column 1, line 12 - line 18 * * column 2, line 14 - line 43 * * column 4, line 32 - line 37 * ---	1-16	
A	DATABASE WPI Week 8434 Derwent Publications Ltd., London, GB; AN 84-211061 & JP-A-59 123 659 (DAISO CO LTD, OSAKA SODA KK) , 17 July 1984 * abstract * ---		TECHNICAL FIELDS SEARCHED (Int.Cl.6) B27N
A	DE-A-25 07 714 (HERMANN BERSTORFF MASCHINENBAU GMBH) 2 September 1976 -----		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	2 October 1995	Soederberg, J

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
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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
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