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Study of pressing temperature in membrane presses

BESNIK HABIPI[1]*, DRITAN AJDINAJ[1], HAZBI BIÇAKU[2]

[1] Department of Wood Industry; Agricultural University of Tirana, ALBANIA

[2] "EUROBIÇAKU" sh.p.k.; Autostrada Dr-Tr, Mbikalimi Fllakë, Durrës, ALBANIA

e-mail: * besnikhabipi@hotmail.com, dajdinaj@ubt.edu.al, biku@eurobicaku.com

Abstract

In this research, the effect of different pressing temperatures on overlaying quality of membrane presses was studied. There were applied six pressing temperatures for overlaying medium density fibreboard with polyvinyl chloride film, respectively 80°C, 85°C, 90°C, 95°C, 100°C and 105°C. These temperatures were lower than those usually applied, which range between 110°C and 120°C. The pressing time continued in total 2 minutes and the pressure applied by air was 6 bars. The PVC film was 0.4 mm thick and weighted 2.5 kg/m^2. The MDF to be overlaid was with density 790 kg/m^3. There were produced 8 pieces for each temperature, in total 48, with dimensions 12×12 cm. After 72 hours, from each piece was sawn one sample from central zone, with dimensions 5×5 cm. For measurement of surface soundness was applied the method specified by the standard EN 311. This method measures the overlaying quality by means of tensile force through a steel axe, glued with MDF sample with PU adhesive. Resultes showed that temperatures 80°C and 85°C totally failed to achive a strong bond between MDF and PVC foil. The temperature 90°C failed in 75% of tested pieces, while temperature 95°C failed in 25% of them. The two highest temperatures gave a strong bond for all samples, resulting to MDF substrate destruction. The results obtained present useful information for furniture manufacturing sector, by the cost effective viewpoint.

Keywords: pressing temperature, membrane press, PVC, overlaying.

1. Introduction

Combinations of wood based panels with plastic foils are nowadays being used more and more, due to their advantages regarding to special properties and cost, beyond of reach by a single material. These combine chemical and physical properties of wood material with plastic ones. For more resistance to time, the panel coating or lamination is a need.

Overlaying with thermoplastic foils is performed through membrane presses. It is applied to curved panels and those with three-dimensional surfaces processed by routers or CNC machines.

The technology that supports a better membrane pressing is too complex and a good result can only be achieved if basic parameters (temperature, pressure and time), are kept carefully under control.

These factors are related between them, determining so the amount of heat that can be transferred over the panel (board) surface. Greater to be the amount of heat, greater is the temperature applied and as consequence, greater will be "the gripping" of overlaying. Unfortunately, this important parameter has a maximal limit that must not be crossed and is characterized by the capacity of overlaying to store energy. For this reason pressing time in membrane presses are relatively longer compared with other types of presses, because of low temperature of the membrane.

The transferable amount of heat is directly related with the weight of the foil and its temperature, while this last one is in relation to preheating time [1]. To achieve a satisfactory quality, a very good knowledge of these parameters, their change in function of the type of overlaying material (foil), the type of material that will be laminated and the working temperature, is a decisive factor.

In the case of polyvinyl chloride foils (PVC), all the pressing cycle is performed for about 2 minutes. Preheating runs 60 ÷ 90 seconds, the time of applying pressure 10 seconds and the final pressing

time (time of keeping under pressure), 50 ÷ 60 seconds. The pressure ranges from 2 to 6 bars, while the temperature heat is usually 110 ÷ 120°C.

In this research, the effect of different overlaying pressing temperature on quality of membrane presses is studied. This is directly related to the issue of increasing the quality and reducing the cost. The study is focused on analysis of pressing parameters applied for laminated MDF with PVC foils in membrane presses, a significant and actual problem referring to the sector of furniture manufacturing.

2. Material and Methods

Lamination (overlaying) process was carried out according to technological procedure at company "EURO BIÇAKU". Medium density fibreboards (MDF) pieces with dimensions 12×12 cm were used as substrate. The density of MDF panel and its thickness resulted 796 kg/m^3 and 18 mm and were measured according to procedure specified by technical standard SSH EN 1058 [2]. As lamination was used PVC RENOLIT (Germany), 0.4 mm thick and weight 2.5 kg/m^2. Before application of PVC, on MDF pieces was sprayed a KLEIBERIT (Germany) polyurethane (PUV) dispersion adhesive. The quantity of applied adhesive resulted 2.9÷3.1 gr. per piece and was verified by weighing the pieces before and after application of adhesive. For lamination was used ORMA (Italy) membrane press with air pressure system. There were applied six membrane temperatures, respectively 80°C, 85°C, 90°C, 95°C, 100°C and 105°C. These temperatures were lower than those usually applied, which range between 110°C and 120°C. The temperature of bottom platen was held for all cases 60°C. The pressing time continued in total 2 minutes and the pressure applied by air was 6 bars.

There were laminated 8 MDF pieces for each temperature, in total 48. After 72 hours, from each piece was sawn one sample from central zone, with dimensions 5×5 cm. For measurement of surface soundness was applied the method specified by the standard SSH EN 311 [3]. This method measures the overlaying quality by means of tensile force through a steel axe, glued with MDF sample with adhesive.

On the surface of each sample was cut a circular channel 0.3±0.1 mm deep, with inner diameter 35.7 mm, resulting in an area of 1000 mm^2. In the zone limited by the channel was glued a steel axe using ProLoc (Turkey) *P.*42 *Express Polyurethane (PU) Montage Adhesive* which combined high bond strength with fast curing (figure 1).

Axes were held fixed on circular surfaces by means of hand clamps for more than 24 hours, in order to hardened glue to give the maximum strength. After that, the samples were tested by mechanical testing machine (CONTROLAB, France), applying a force in a way that destruction of joint to happen within 30 ÷ 90 seconds (figure 2). Data were obtained using LabView software. Modulus of rupture of joint was calculated in N/mm^2 by equation $S=F/A$, where F was the breaking load in newtons (N) and A was channel limited area (1000 mm^2).

Figure 1. Samples with glued steel axes

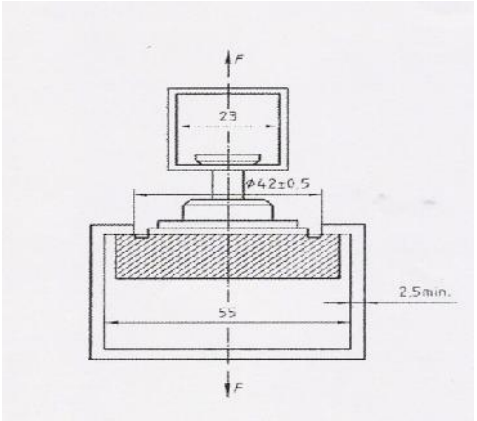

Figure 2. Scheme of the test

3. Results and Discussion

Mean values of surface soundness of samples, together with respective standard deviations are shown respectively in table 1.

From results presented below was noted that temperature 100°C gave the highest surface soundness, followed by temperature 105°C with 4% lower, 90°C with 6%, 95°C with 8% and at the end by 80 and 85°C with 37% surface sundness lower. But the surface soundness is not a sufficent indicator for an objective judgement. The most appropriate indicator is how the sample is destroyed.

Table 1 Surface roughness class

Pressing temperature [°C]	**80**	**85**	**90**	**95**	**100**	**105**
Surface soundness [N/mm^2]	0.72	0.72	1.08	1.04	1.15	1.10
Standard deviation	0.08	0.17	0.19	0.03	0.07	0.08

The destruction of laminated sample consists in separation of PVC by MDF because of failure of adhesion located in glue line or in MDF substrate. If lamination glue line is not strong enough as MDF substrate to afford forces in tension than a clear separation between PVC and MDF occurs. If lamination glue line resists against forces in tension, than the MDF substrate will be destroyed. Referring to lamination process, a good quality (adhesion) give a higher resistance than that of material laminated [4].
Resultes showed that temperatures 80°C and 85°C totally failed to achive a strong bond between MDF and PVC foil. The temperature 90°C failed in 75% of tested pieces, while temperature 95°C failed in 25% of them. The two highest temperatures gave a strong bond for all samples, resulting to MDF substrate destruction (figure 3).

Figure 3. Samples after testing

4. Conclusions

Based on laboratory results we can conclude that temperatures not lower than 100°C give a good quality of PVC lamination, satisfying the quality standards of furniture manufacturing industry, which actually applies temperatures from 110°C to 120°C. Lower than 100°C the quality is not guaranted.

It should be noted that this estimation is based on a short-term control method and does not take into account the degradation that can occur over time on lamination quality.

5. References

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