



DETERMINATION OF THE DEFECTS IN THE PRODUCTION OF FURNITURE BENT PANEL BOARDS

Vladimir Mihailov – Dimitar Angelski – Vasil Merdzhanov

Abstract

The use of vacuum membrane technology makes the manufacturing of bent panel boards in something routine and easy compared to the costly molding technology used up to 10 years ago that were also difficult to manufacture. This article examines the problems with the defects in the production of bent furniture boards and their subsequent lining. The technological possibilities for making such details are compared by using the adhesive dispersions and coating materials used. The resulting defects in the production of curved furniture boards are examined as well as the subsequent lining with synthetic cladding materials. The defects are grouped, analyzed and represented graphically.

Key words: *defects, membrane technologies, vacuum, adhesive dispersions, cladding materials*

INTRODUCTION

The most common lamination processes apply overlay material to the substrate by cold or hot pressing with either flat (platen) or continuous (roll or double belt) laminating presses.

Because each type of overlay material has unique properties and lamination requirements, the choice of laminating material introduces variables that affect the laminating process and influence the performance of the finished product. As with the most lining technologies and the vacuum technology, it is very important to follow the technological regimes for obtaining non-defective production. Defects in bent furniture boards made with vacuum membrane technologies can be grouped into two main groups - those that appear between the individual layers of the boards and those that are on the surface (of the lined material) of the workpiece. This paper describes the defects obtained using the most commonly used adhesive in making such details - PVA dispersion recommended for membrane presses. Wherever the defects are formed in the structure of the parts or their surface, they are highly dependent on the satisfactory adhesion achieved between the details or the individual elements. Adhesion is a complex physico-chemical phenomenon for which, however, there is not a rigorous theoretical definition. Adhesion is difficult to define, and an entirely satisfactory definition has not been found (Landrock A. 2008). The adhesion strength is the bond between the lined material and the substrate, which can be the weakest link of the system. Due to this fact, adhesive systems must be rationally selected to ensure satisfactory adhesion between both the elements forming the bent furniture boards and the coating materials such as PVC foil or veneer (Angelski D., Mihailov V., 2017).

MATERIAL AND METHODS

The test samples are made of high density fiberboard - HDF and poplar plywood. The HDF boards are with a thickness of 2,8 mm produced by "Kronospan" and a density of 900 kg/ m³. The plywood boards are produced by "WELDE Bulgaria" with a thickness of 6 mm and density of 500 kg/ m³. One pattern with corresponding internal radius of curvature 100 mm was used to make them. The test body is made up of 3 lamellas with sizes 260/100 mm bonded with polyvinyl acetate adhesive - PVA glue with trade mark of Jowacoll / Jowacoll 103.05. The glue utilization used is the minimum of 160 g/m² being unilaterally applied to the lamellas. For gluing the cladding material three quantities of glue were chosen – 100, 160, 220 g/m². For cladding material was chosen polyvinyl chloride - PVC mat foil by manufacturing by "Skai", Germany, 3D formable with thickness of 0,4 mm (Fig 1). The reverse side of the foils is coated with primer to ensure a safe and temperature-resistant bond.



Figure 1. 1 - Test samples series; 2 - Test sample vacuumed under the rubber membrane and the matrix of bending with 100 mm radius of curvature

The test samples were made with a vacuum mebrane press equipt with a rubber mebrane of thickness of 3 mm and 600 % elasticity. The technological regime chosen for the producing them is 30 min of pressing time and the value of the vacuum applied under the membrane is -0,04 N/mm². After the producing the test samples are left of 24 hours of free stay. The tehcnological regimes is determined that the test samples are glued and linned at once.

RESULTS

After the free stay the sereis of the bent furniture boards can be monitored two groups of defects – the first - of delamination of the core of the lammelas and second - on the surface by the cladding material of the samples. The amount of the glue plays a very important part in ensuring faultless cladding of the bent furniture boards. By the testing the adhesion by the pull-off test method, the greater the volume does not increase the adhesion strength. By the type of the cladding material – PVC foil, as its known it's a synthetic material and it's very difficult to achieve reliable adhesion with the used PVA adhesion, even it has primer applied on the back of the used foil (Fig. 2).



Figure 2. 1 - Test samples with poor adhesion between the PVC foil and the substrate;
2 – No adhesion can be seen by the ends of the samples, of the fact that the glue dries too fast by the initial vacuum

From the carried-out study, it was found that for the non-defective producing of bent furniture boards it is extremely important to consider the duration of the working cycle defining the time from the beginning of the vacuuming to reaching the defined vacuum. When the maximum vacuum is reached quickly, the test samples are being destroyed. The cracks are at the boundary between the radius of curvature and the straight parts of the template. For this also helps the high density of the material used, which makes it difficult to bend. On the other hand, the applied adhesive moistens the surfaces of the lamellas and plasticizes the material. It was found that in order to avoid this destruction the vacuuming time must be between 120 and 180 s. For a longer vacuum time, the glue partially dries and the required technological strength is not reached. This leads to the self debonding of the test samples, or the adhesion dries faster on the outer ends of the test sample and there is no adhesion observed (Fig. 3).



Figure 3. 1 - Self debonding of the test samples

The test samples made with the poplar plywood, can observed delamination of the lamellas, or cracks of the outer lamella of the plywood. Also, here affects the time of the initial vacuum – it should be between 120 and 180 s. Another way to prevent these types of delamination or cracks is to put an additional piece of bendable plywood between the test sample and the membrane, so that it distributes the pressure applied by the membrane more evenly.

By both series of test samples, from HDF lamellas and poplar plywood, can the observe a typical defect for the chosen matrix. The cracks are located in the area between the flat part of the matrix and that with a curvature of 100 mm radius. That could be explained of the small radius that was chosen and the big pressure that is loaded the outer

lamella of the bent board in that area (Fig. 4). The upper lamellas are loaded of critical tensile stress, that exceeds the strenght of the used material.

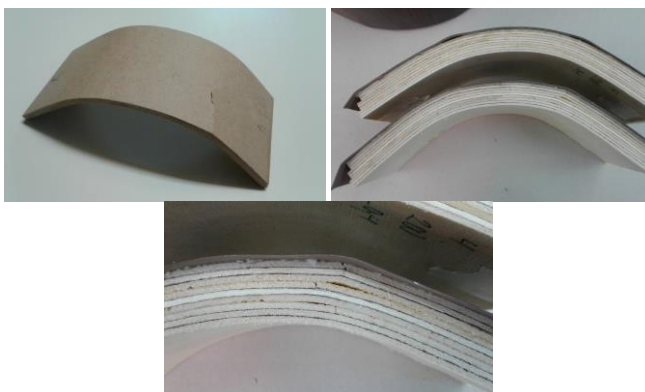


Figure 4. Cracks of the outer lamella that is loaded to critical tensile stress

When the used adhesive is chosen with higher consumable amount from the recommended of the manufacturer a wavy surface of the foil can be monitored. That phenomenon is called „orange peel“, and its appearance can be explained by the physical nature of the cladding material. The PVC foil doesn't pass water to evaporate and stays trapped under the foil. This leads to buckling of the foil and uneven surface. The trapped places more glue can be monitored as it dries. (Fig. 5)



Figure 5. Uneven surface of the foil with bubbles in the end of the sample, by the high amount of the adhesive

CONCLUSION

Based on the research, the following conclusions could be made:

- The amount of the glue plays a very important part in ensuring faultless cladding of the bent furniture boards. Higher amount of PVA glue doesn't make the joint between the substrate and PVC foil.
- For achieving more reliable adhesion between the substrate and the PVC foil, it has to be applied primer of the back surface of the foil.

- The duration of the working cycle defining the time from the beginning of the vacuuming to reaching the defined vacuum. When the maximum vacuum is reached quickly, the test samples are being destroyed.
- Another way to prevent the delamination or cracks is to put an additional piece of bendable plywood between the test sample and the membrane, so that it distributes the pressure applied by the membrane more evenly.
- Higher consumable amount from the recommended of the manufacturer a wavy surface of the foil can monitored. That phenomenon is called „orange peel“.

Acknowledgements: This document was supported by the grant No BG05M2OP001-2.009-0034-C01 "Support for the Development of Scientific Capacity in the University of Forestry", financed by the Science and Education for Smart Growth Operational Program (2014-2020) and co-financed by the European Union through the European structural and investment funds.

REFERENCES

1. Angelski D., Mihailov V., (2017), The influence of various types of adhesive on the adhesion strength between bonded HPL and furniture boards
2. Landrock A. H., Ebnesajjad S. (2008) Adhesives Technology Handbook. William Andrew - Technology & Engineering, 475 p. - ISBN 9780815516019
3. Kayis S., Bektas I., Kilic Ak A. (2016): Comparing The Technological Properties Of Mdf's Coated With Pvc Folios Using Wrapping And Membrane Press Methods, International Furniture Congress. Mugla
4. Zosel A. (1991) Effect of cross-linking on tack and peel strength of polymers. The Journal of Adhesion, 34: 201-209.
5. Slabeyoga G., Smidriakova M., Petrilak J., Adhesion of foils to MDF board, (2016) Annals of Warsaw University of Life Sciences – SGGW