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DETERMINATION OF CONTACT ANGLE VALUES OF GLUES WITH VARIOUS GLUE-JOINT PROPERTIES

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Abstract

The goal of the work was to determinate contact angle values of various glue-joints. There were done studies of static contact angle of glues. Their values were compared to deflections of boards that were veneered with using each type of glue. Results shows that the higher contact angle, the lower absorption ability of a surface. So the best results (the lowest deflections of boards) were for polyisocyanate glue, but the worst were for popular in industry poly(vinyl acetate) glue.

Key words: *glue-joint, contact angle, absorption, wetting*

INTRODUCTION

Strength of a glue-joint is mainly determined by physical, chemical and mechanical properties of the adhesive. The adhesive in liquid form should exhibit the following features: ability to form sufficient number of intermolecular interactions with the substrate (e.g. hydrogen bonds, covalent bonds for polyisocyanates) as well as ability to wet and penetrate the substrate. Additional requirements can be defined for the cured glue-joint. Namely: high cohesion (preferably higher than that of the substrate), low shrinkage upon polymerization, elasticity providing stress dissipation accompanied by high toughness and stress bearing without fracture of the glue-joint.

One of the basic test that is performed for glues in solid state is wetting test. Wetting is defined as surface ability of adsorption. The most often there are used two kinds of wetting test: [Cagle, 1977]:

1. adhesion work test- that is considered to be less accurate method. Value of adhesion work is counted upon value of heat generated during touching of glue with glued surfaced. Obtained value gives the opportunity for determination of liquid adsorption.
2. determination of contact angle- more accurate measurement, anyway demanding preparing a flat surface. Determination of contact angle can be done in two ways:
   - taking measures of static contact angle- in this method drop deposited on surface of testing material has to have stable measure to determination of contact angle;
   - taking measures of dynamic contact angle, that means testing of contact angle change in time function. This method is usually used for materials characterized by high porosity, where after some time drop is completely spilled.

It is known that the higher contact angle, the lower absorption ability of a surface.

MATHERIAL AND METHODS

Measurements of contact angle (θ) were made on a contact angle analyzer Phoenix 300 of Surface Electro Optics, using method of static contact angle. This method is based on the assumption that drop of a liquid, located on stable unabsorbing surface, achieves the equilibrium at the moment when size of drop base stops changing. In presented tests angle was measured after 30 seconds since deposition.

It is important to deposit the drop on the surface in the softest way, so that measured contact angle was as high as possible. In case of pressing the drop to surface, it spreads over the surface and contact angle decreases. That is the reason for using analyzer that is equipped with stepper motor computer controlled, that allows for precise batching of small drop (5 μL). Additionally, in order to control drop drifting, goniometer has built-in camera with microscopic lens.

Contact angle was determined for reference liquid on three types of adhesives:
- poly(vinyl acetate),
- polychloroprenic,
- polyisocyanate.

Measurement of contact angle was based on the definition of contact angle that specified it as an angle formed by flat surface of solid body and the plane that is tangent to surface of liquid that borders with solid body or to plane that divides two contacting liquids [http://kbn.icm.edu.pl].

There were done five measurements for each kind of adhesive material. Mean values of contact angle were set with results of deflections measurements of wood-based panels of dimensions 900x450x18mm that were asymmetrically one-side veneered.

RESULTS AND DISCUSSION

There are presented results of determination of contact angle that are set with results of geometrical stability of wood-based panels veneered asymmetrically with tested glues. In figures 3, 5 and 7 significants were used as follow:
♦- unveneered board,
■- board veneered, unvarnished,
×- board veneered, varnished.

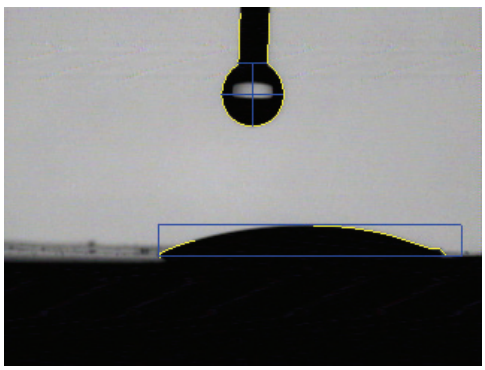

Figure 1. Determination of contact angle for poly(vinyl acetate) glue

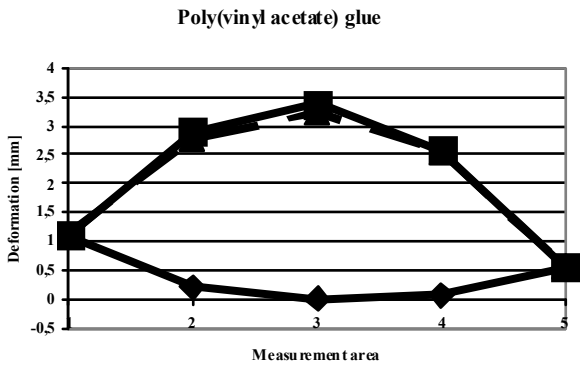

Figure 2. Graph of deflection of wood-based panel veneered with poly(vinyl acetate) glue [Oleńska et all, 2010]

In figure 1 it is seen that water drop deposited on poly(vinyl acetate) glue-joint is spilled and its contact angle is relatively low. It means that hydrophobic properties of this glue are small. In figure 2 significant fact is high values of board deflections that were the effect of asymmetrical veneering process.

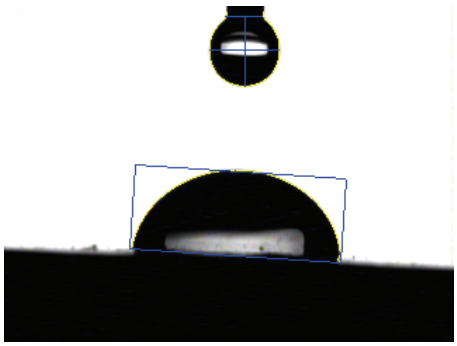

Figure 3. Determination of contact angle for polychloroprenic glue

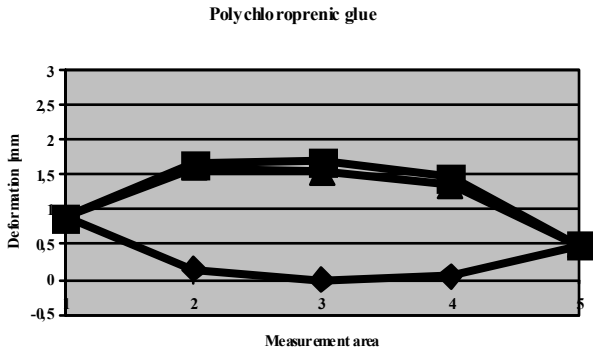

Figure 4. Graph of deflections of wood-based panel veneered with polychloroprenic glue [Oleńska et all, 2010]

In figure 3 it is seen that contact angle of contact glue is considerably higher than that of poly(vinyl acetate) glue. It means that this glue has better hydrophobic properties. Graph of deflections in figure 4 shows that wood-based panel asymmetrically veneered with contact glue wrapped less than the one veneered with poly(vinyl acetate) glue.

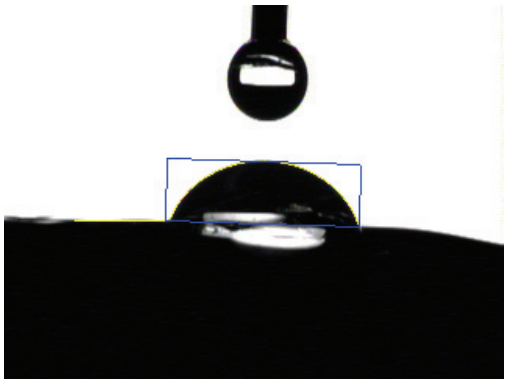

Figure 5. Determination of contact angle for polyisocyanate glue

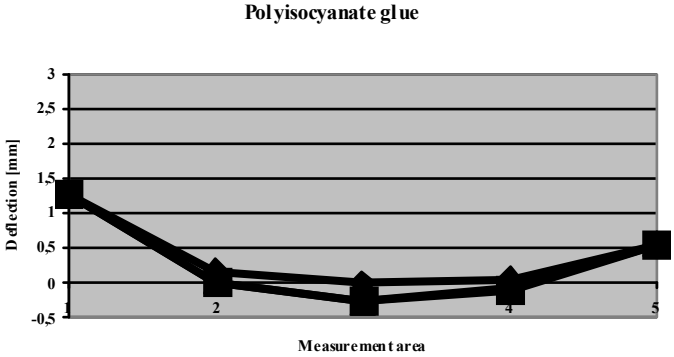

Figure 6. Graph of deflections of wood-based panel veneered with polyisocyanate glue [Oleńska et all, 2011]

In figure 5 it is apparent that contact angle of polyisocyanate glue is the highest of all presented. It indicates that this type of glue-joint has the best hydrophobic properties. Measurements' results of wood-based panel deflections presented in figure 6 show that elements asymmetrically veneered with this type of glue were hardly undeformed after veneering process.

Full collection of obtained results of contact angle measurements are presented in figure 7.

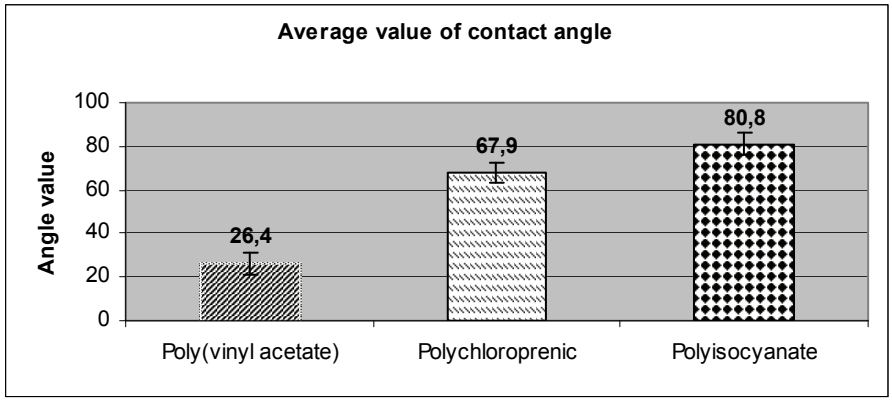

Figure 7. Measurements results of contact angle for all glues

The lowest value of contact angle obtained for poly(vinyl acetate) glue (26,4°) which is considered to create rigid glue-joint. Consequently, this type of glue exhibited highest absorption properties. Using this glue in asymmetrically veneering leads to high deformations of wood-based panel. Polychloroprenic glue that in industry is considered to form elastic glue-joint has higher contact angle (67,9°). However, using it for asymmetrical veneering leads to high deformations of board, despite the fact that they are lower than these in panels veneered with poly(vinyl acetate) glue. The lowest deformations of elements were observed for polyisocyanate glue with elastic glue-joint. For that glue, the highest value of contact angle (80,8°) was obtained which proved its high hydrophobicity.

CONCLUSION

Obtained results show distinct correlation between contact angle of glue and deflections of asymmetrically veneered wood-based panels. It was stated that the lower contact angle, the higher are deflections of asymmetrically veneered wood-based panels. Consequently, it is assumed that glue used for composite bonding in asymmetrically veneered boards should have low water wetting ability.

ACKNOWLEDGEMENT

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