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THERMODYNAMIC FEATURES OF GLUE STATE IN THE PROCESS OF VENEER GLUING

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Keywords: veneer, bonding, temperature, surface tension, curing the adhesive.

Abstract. The paper discusses the possibility to describe character of changes in thermodynamic state of the adhesive for bonding the veneer pack on the basis of application of the main provisions of the molecular-adsorption theory of adhesion, surface properties of the contacting phases. To determine the thermodynamic characteristics of the glue in the glued veneer package, the methods taking into account the pressure-temperature state of the glued veneer package are applied.

ТЕРМОДИНАМИЧЕСКИЕ ОСОБЕННОСТИ СОСТОЯНИЯ КЛЕЯ В ПРОЦЕССЕ СКЛЕИВАНИЯ ШПОНА

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Ключевые слова: шпон, склеивание, температура, поверхностное натяжение, отверждение клея.

Аннотация. В работе рассмотрена возможность описания характера изменения термодинамического состояния клея для условий склеивания пакета шпона на основе применения основных положений молекулярно-адсорбционной теории адгезии для поверхностных свойств контактирующих фаз. Для определения термодинамических характеристик клея в склеиваемом пакете шпона применены методики, учитывающие пьезо-температурное состояние склеиваемого пакета шпона.

The process of hot gluing veneer is accompanied by heating and compaction of wood in the process of pressing. One of the most important parameters when gluing veneer is the temperature, because it improves the interaction between the glue and the wood (increase in the reactivity of the glue, improving the wetting and spreading conditions, the formation of curing products, etc.) [1]. However, with a further increase in temperature, the strength of the connection decreases, as the probability of internal stresses from thermal degradation of the adhesive and shrinkage of the veneer increases.

The rate and extent of heating depends on the initial temperature of the press plates, and also probably from the package structure, i.e. the thickness of the bonding veneer to the layering of the package and the ratio of the number of sheets of veneer pressed in one package, provided that the temperature of the pressing, the adhesive consumption and moisture content of veneer is permanent.

Thus, to determine the duration of exposure of the package in the press, it is necessary to know the temperature and time of transition of the adhesive layer into a solid insoluble state.

To solve this problem, experiments were carried out to determine the temperature change in a multilayer glued veneer package. The results of the experiments in the form of graphical dependencies are presented in Fig. 1.

The combination of heat and moisture present in the veneer and made with glue, contributes to the initial rapid heating of the outer layers, and then when the

outer layers reach a temperature of 90 ... 100°C, moisture evaporation begins and heating of the middle of the glued package intensifies. In this case, the transition of glue from liquid to solid state occurs initially in the outer adhesive layer, and then in the inner, which is accompanied by a change in the density of the sheets of the glued package, and this contributes to the development of internal stresses after removing the pressing pressure. As a result, the bonding strength of veneer sheets in the finished product is reduced.

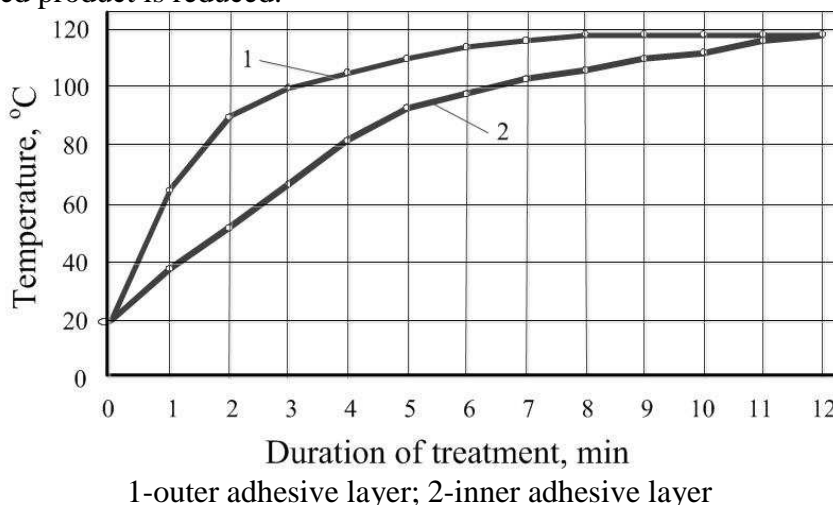


Fig. 1. The dependence of the temperature change from the duration of treatment

But the quality of bonding in this case can be quite high only if the transition time of the glue in the solid state is longer than the time to achieve the desired contact of the glued layers with each other.

To develop new and improve existing modes of pressing, it is necessary to know the gelatinization time of the glue in the adhesive layer and the duration of formation in the resin of at least 70% of the curing products.

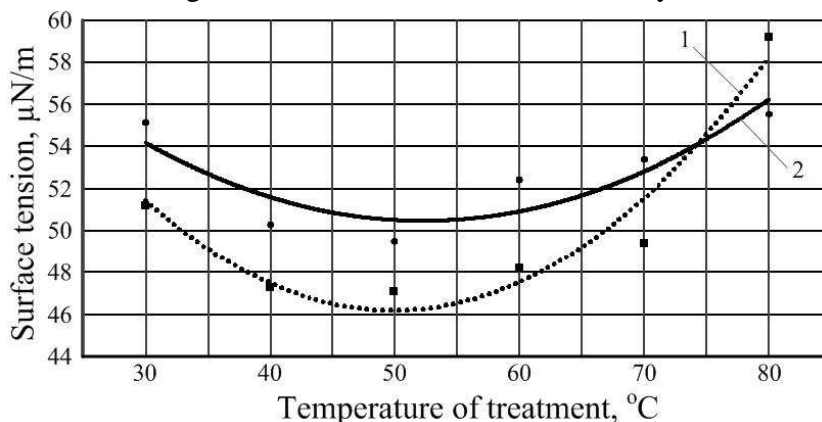
Studies have found [2] that increasing the depth of penetration of glue into the wood veneer reduces the tensile strength when chipping plywood samples on the adhesive layer. The depth of penetration of the glue depends on the value of the surface tension of the glue and veneer, as well as the value of the pressing pressure.

To determine the surface tension of the adhesive when exposed to temperature, a special technique was used.

As a result of the experiments, the dependencies shown in Fig. 2.

As can be seen from the dependencies presented in the figure, the dependence of the surface tension of the adhesive on the temperature is extreme. The minimum value of the surface tension of the adhesive is noted when it is heated to 45 ... 55 °C, regardless of the initial viscosity of the adhesive. As a result of determining the critical surface tension of the cured glue, it was also found that its value is slightly less than the surface tension of the glue in the liquid state and is $56, 6 \times 10^{-3} \text{ N/m}$, and the value of the critical surface tension of the cured glue does not depend on the initial viscosity of the adhesive. This is confirmed by the results of tests of samples

in dry form [3], where the residual stresses from the shrinkage of the veneer slightly depend on the depth of penetration of the glue in the wood, since the curing of the polymer and the shrinkage of the veneer occur simultaneously.



1 - the initial viscosity of the glue 80 s to VZ-4;
 2 - the initial viscosity of the glue 160 s to VZ-4

Fig. 2. The dependence of the surface tension of the adhesive on temperature

Determination of the amount of insoluble substances and the duration of gelatinization of glue in the adhesive layer was carried out according to the standard method. Curing of the binder was carried out on a metal plate heated in accordance with the heating nature of the adhesive layer in the veneer package.

As a result of experiments it was found that within the studied limits the initial viscosity of the resin does not affect the gelatinization time and the duration of formation of 70% of insoluble substances in the rejected glue (Fig. 3).

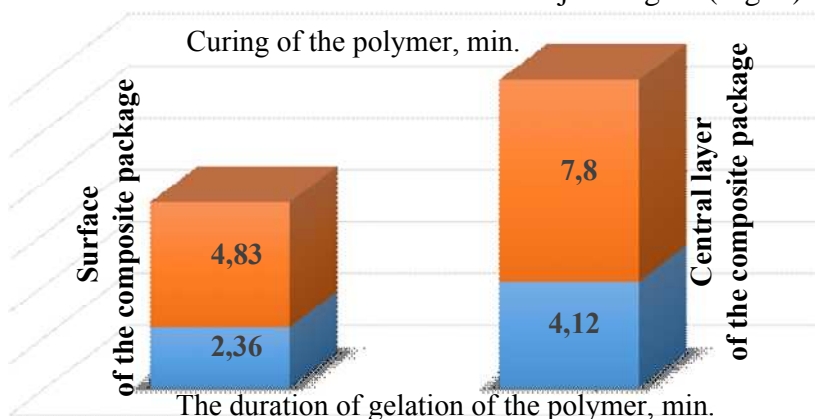


Fig. 3. The time of gelation and the curing of the glue in the layers of plywood

The dependence of the duration of formation of curing products in the adhesive layers of the package is explained by the difference in the rate of heating of its cross-section. Since the heating of the front layers of the veneer package is faster, there is a transfer of heat and moisture to the middle of the package. The presence of this gradient of heat and mass transfer leads to a slow increase in

temperature and an increase in the specific duration of the formation of curing products in the adhesive layers located closer to the heated plates.

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