



Improving the Performance of Decking Board for Use in Landscape Design

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Abstract

In recent years improving the efficiency of wood use is gaining ever-increasing relevance both in Russia and abroad. In issues related to the thermal modification of the properties of wood the increased interest of scientific community can be observed. Heat treatment causes a change in the physical properties and chemical composition of wood raw materials, which subsequently contributes to improvement of the performance characteristics of composite materials and the production efficiency of chemical products from thermally modified shredded wood. The purpose of developing this technology is to improve the performance characteristics of products made of wood-polymer compositions, as well as improved final qualities of the material, namely, the absence of the odor characteristic of thermowood and the formation of cracks on the surface of the material. The effect of the preliminary heat treatment of ground wood in disc-type reactors on water absorption, swelling and tensile strength and compression is established. In the future, the material obtained by this technology can be used in landscape design.

Keywords: thermo-modified wood, thermowood, wood-polymer composites.

1. Introduction

At the present time, wood is widely used in various industries ranging from the woodworking and pulp and paper industries to the production of building materials. The main advantage of wood is its natural durability in various exterior and complex interior exposures, first of all it concerns the resistance of wood to biological pests.

In recent years, studying the processes of increasing the natural resistance of wood, both to biological and to climatic influences without the use of antiseptics, has become more relevant. Special attention is paid to the issues of improving the physicochemical properties of wood by thermal modification [1] and obtaining new composite materials based on it. Studies of high-temperature processing of birch plywood in a rarefied environment are discussed in the article Khasanshin R.R., Safin, R.R. Razumov E.Y. [2], which presents the technology of vacuum contact heat treatment of birch veneer. This technology allows uniform heat treatment of the material. As a result of the study, experimentally confirmed increased water resistance of plywood based on heat-treated veneer.

The use of bioactive polylactide and thermally modified wood fibers for the production of biodegradable wood composites is the subject of Galyavetdinov N.R., Safin R.R., Voronin A.E. [3]. It has been established that with an increase in the temperature of treatment of wood filler, the strength characteristics of the obtained composite increase, thereby decreasing the efficiency of sorption of the composite.

The widespread use of shredded wood in the production of composite materials is due to many reasons: renewability, relative cheapness, ease of processing, good wettability. The use of wood in the production of chemical products is due to the diversity of chemicals in its composition. However, despite the large number

of positive qualities, wood is not without certain disadvantages, which can cause a reduction in the life of the product from a wood-filled composite or complicate the yield of qualitative or quantitative indicators of chemical products obtained. In this regard, in the production process of the respective product, the raw wood material undergoes various processing methods and modifications, the most studied of which include such traditional technological operations as mechanical processing, drying, hydrothermal processing, as well as various chemical exposure methods. To solve the problems of improving the performance characteristics of composites, a large number of studies have been devoted [4–8]. At the same time, in recent years, new methods of physicochemical effects on wood raw materials, based on the modification of the wood structure, have been actively developing [9]. Among them, the greatest interest of researchers is chained to the processes of heat treatment of wood, occurring in an airless environment at temperatures of 180 - 300 ° C. Heat treatment causes a change in the physical properties and chemical composition of wood raw materials, which subsequently contributes to the improvement of the performance characteristics of composite materials and the production efficiency of chemical products from thermally modified shredded wood.

2. Research Method

The authors carried out experimental studies of decking on water absorption, swelling, hardness in pressing the ball, tensile strength in tension and static bending.

Waste wood from coniferous and hardwood (aspen, birch, pine) was used as shredded wood on woodworking machines of the joinery workshop with maximum dimensions up to 30 mm. Heat treatment of the crushed wood material was carried out in dish-type reactors. This type of reactor is considered to be the most

technologically efficient, in which the processed bulk material is fed to the upper plate of the apparatus with subsequent mechanical movement through the pouring openings to the underlying plates. The method was used to determine water absorption, where the samples were immersed in a desiccator with distilled water and kept for 50 hours, while the samples were periodically weighed and measured. Simultaneously with the determination of the current moisture content of the samples, their basic dimensions were measured to study the swelling process. The humidity of the samples was determined by the gravimetric method: by measuring the current mass, followed by drying until absolutely dry at a temperature of 105 °C.

For research of DPKM samples for tensile strength and static bending, a universal testing machine of the brand ИР 5082-50 was used.

Tests for tensile strength were carried out using universal grippers installed on the testing machine. The sample is installed in the grip of the testing machine so that its longitudinal axis coincides with the axes of the machine heads, and the universal grippers capture the sample close to the rounded portion. With the help of the program installed on the computer, the process of work of the testing machine for determining the strength of the material on bending begins. The sample is loaded uniformly at a constant speed. The test time was 30-90 s.

For operation of the universal machine in the mode of determining the bending strength of the samples, a device was used, which consists of two parallel supports with cylindrical surfaces 1 that can be moved in a horizontal plane, and a loading knife 2 with a cylindrical surface parallel to the supports at an equal distance from them.

Just as in the case of determining the strength of a material in compression, tests on static bending are carried out with the help of a software and hardware complex that drives a universal testing machine and processes the information obtained.

3. Results and analysis

To analyze the effect of preliminary thermo-modification of wood filler in the production of composite materials, a series of experiments was conducted on the creation and testing of wood-polymer material samples.

In order to determine the influence of the process of thermal modification of wood filler on the performance properties of wood-polymer composite materials, DPKM prototypes were created and studies of the obtained samples for strength and water absorption were carried out.

The study of water absorption samples DPK was performed after soaking in distilled water for 50 hours. The results of the research are presented in Figure 2.

It can be seen from the graphs that as the treatment temperature of wood filler increases, water absorption of wood-polymer plates is significantly reduced, which is consistent with similar studies of other composite materials filled with thermally modified wood filler presented in the literature.

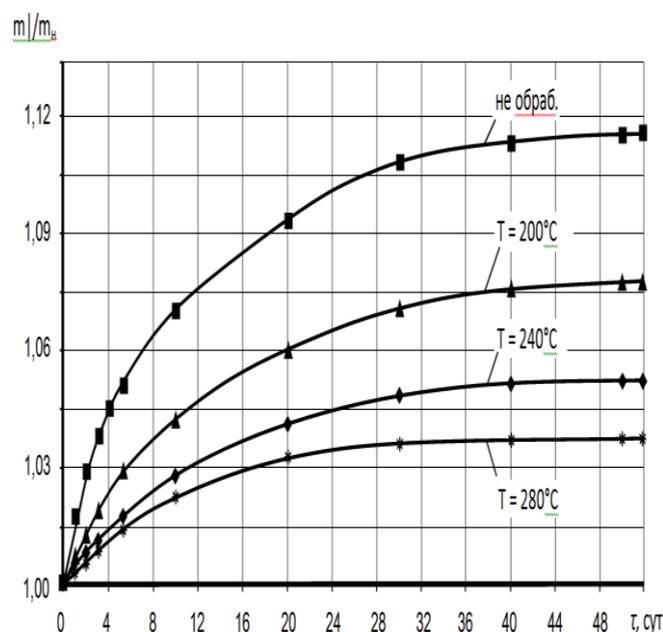


Fig.1: Kinetics of the relative mass of DPKM samples with aging in distilled water

Thus, it should be emphasized that the thermal modification of wood raw materials in the production of wood-polymer plates makes it possible to increase their water resistance.

As a result of the research, a pilot batch of a terrace board from a polymer composition with a heat-treated wood filler was produced in the amount of 250 running meters. The properties of the decking board of an experimental industrial lot in comparison with the requirements of the technical conditions for the finished product of class 1 according to the SIC "WPC" are presented in table 1.

As a result of the conducted research, in comparison with requirements of the finished product, the quality of the composite has increased significantly in terms of its physical and mechanical characteristics. Especially, water resistance of the product increased by 3-3.5 times. It is known that the low resistance of the material adversely affects the appearance of decking during their operation in wet conditions.

Table 1: Properties of a decking board of an experimental industrial batch

№	Name of the indicator	Requirements for finished products of class 1 on SIC "DPK"	The value of the indicator for TM decking boards experimental-industrial batch (T _{обр} = 220 °C)
1.	Density, kg / m ³ (EN ISO 1183-1)	1100-1400	1200
2.	Water absorption after soaking in distilled water for 50 hours,	4,0	1,08
3.	%	0,4	0,05
4.	Swelling in thickness after soaking in distilled water 50 hours,% Rel.	190-250	197
5.	Hardness with pressing the ball, N / mm ² (GOST 4670-91)	10-16	18
6.	Ultimate tensile strength, MPa	40	46

The conducted technical and economic analysis confirmed the effectiveness of the introduction of the thermal modification method in the industry, since there is an increase in the cost of production with a significant increase in operational characteristics.

In addition, it was found that changing the color of wood raw materials in the process of thermomodification (with increasing temperature of processing the material) has a positive effect on the appearance of the final product (brown, dark brown, claret), reducing the required number of coloring agents (dyes) and not showing up on the surface boards as a result of grinding (fig. 2)



Fig. 2: Polished decking from thermo-modified (a) and not treated (b) wood filler

4. Conclusion

Thus, the studied method of heat treatment of crushed wood in dish-type reactors can be effectively used in production of composite materials in order to increase their moisture and water resistance. It is revealed that increase in moisture resistance and water absorption of the composite, ultimately, affects the safety in

the process of operation of the strength indicators of the declared values.

Also, due to the complete lack of nutrients for biological organisms, the decking is not subject to the damaging effects of harmful insects and fungi. As a result of these changes, it becomes possible to freely use products from wood-polymer composites for landscape arrangement (Fig. 3), as well as in industrial premises with high temperature and extreme humidity.



Fig. 3: A terrace board a) as a floor covering, b) as a cladding of buildings

The dimensional stability of thermowood makes it suitable for use in difficult conditions with high humidity [10], or with humid differences, which have a negative effect on natural wood. Natural wood is not able to resist moisture changes as much as thermowood, which has a great effect on changes in the size of natural wood and requires maximum care for it. A very important role is played by the fact that the thermal modification of wood is a treatment in which no chemical or toxic substances are used that could have a harmful effect on the environment.

To enhance the decorative effect of natural wood, it is covered with all kinds of varnishes. Thermomodified wood allows you to do without any varnishes and coatings, and the color of the resulting product is uniform and much more intense. In appearance, a thermotree becomes like a valuable tropical wood. In addition, special eco-friendly paint and varnish products can give absolutely any color to products made from thermo-modified wood.

The production process of a composite material is based on the use of steam and heat energy; no chemicals and additives affect the material. The result of thermal modification is a product with significantly increased durability and stability. Thermowood is an exclusively natural material produced by natural methods using heat.

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