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PRODUCTION AND DEVELOPMENT OF A POLYMER COMPOSITION RECEPTION BASED ON WOOD INDUSTRY WASTE

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ABSTRACT

The scientific significance of the results of this research is that the scientific basis of the relationship between the physico-chemical and structural properties of wood-polymer composite materials obtained from various wood wastes and primary and secondary polyvinyl chloride, and the quality indicators of the products included in the composition has been created. Based on local raw materials, wood-polymer composite materials were obtained, and the obtained materials are used as the main raw material in the furniture industry, i.e. wood shavings (DStP), sheet-like main raw material replacing medium-density fiberboard (MDF) boards, and decorative material for exterior facade parts of buildings in the field of construction, yard it is recommended to use it as a board panel for terraces and formwork (formwork) for concrete foundations during the construction process.

KEYWORDS

Wood-polymers, composites, primary polyvinyl chloride, secondary polyvinyl chloride, wood chipboard (WCP), medium density fiberboard (MDF) boards.

Introduction

As the consumption of wood and wood products increases, so does the amount of waste generated both in the production and consumption of these products. These wastes form a rich base of raw materials, the proper use of which can significantly reduce the use of natural wood raw materials. Unfortunately, the various wastes generated from the wood industry are used only as fuel. However, it is desirable to use these wastes to obtain various composite materials. Including the use of polymer-wood composites in the form of reinforcement.

For example, Laurent Augier and others produced a material based on secondary PVC and PVC composite, and it was shown that the flexural strength increased when processed by extrusion for 5 or more cycles, while other indicators remained almost unchanged. Such a change is evidenced by the

future strengthening of wood in the recipe [1, p. 75-77], when using rice husk as a filler, it can be observed that after 5000 hours, the strength index of the samples also increased. This indicates that additional radicals occur as a result of UF irradiation [2, p. 6-8].

Research conducted by researchers in recent years shows that the requirements for the obtained polymer compositions are increasing, including the resistance of the material to melting. In this regard, a composite material was obtained by adding glass fiber based on three types of wood waste (XyliakerriiCraib&Hutch., HeveabrasiliensisLinn. i MangiferaindicaLinn.). In this case, the amount of wood did not have a significant effect on the hardness index of the sample, but glass fiber showed an increase in tensile strength. The flexural modulus is from 52 to 129% [3, p. 2721-2723]. In a similar work, the effect of glass fiber size on the properties of wood composite materials (WCM) was studied. In this case, glass fiber sizes of 3, 6 and 12 mm and i 10, 20, 30 mass fractions were studied. In this system as well, it was observed that the tensile and flexural modulus increased with the increase in the amount of glass fiber. But the size of the glass fiber did not significantly affect the properties [4, 67-69 p.], as a result of the addition of wood flour fillers, it was possible to obtain PVC and wood composites with high tensile and friction properties [5, 67-69 p.], and in other studies, asbestos and In the case of using WCM together with aminopropyltriethoxy silane, it was determined that the mechanical properties were higher than when asbestos fiber was used alone [6, 124-127 p.], in another similar study, it was found that when asbestos fiber filler was used in the composition, the degradation of PVC was achieved by 50% [7, 346 -347 p.].

Other researchers have used unprocessed sawdust as a filler in polyvinyl chloride (PVC) composites. The effect of chip composition on structural changes, rheological and mechanical properties was studied. The results of the study showed that the values of moment of force and pressure drop during mixing were found to be independent of the chip particles in the state up to 23.1 mass %. The tensile strength, impact strength, flexural strength and stiffness and weight of PVC composites were significantly reduced by 16.7% (chip content). The reduction of mechanical properties of PVC with chipping has been shown to be related to moisture, interface defects between fibers and polymer, and dispersion of fibers in the PVC matrix. This certainly means that the fibers and polymer macromolecules are strengthened by re-hydrogen bonding. In this process, it is recommended that the moisture value of the material does not exceed 5% [8, p. 287-291; 9, pp. 57-59].

Scientists studied the properties and structure of wood-polymer composites based on polyvinyl chloride and modified with short basalt fiber. As a result, the effect of short-length basalt fiber on the physical-mechanical properties of the composition was determined. It was found that flexural strength decreased by 22% and water absorption decreased by 32% as a result of changing wood-polymer composites. This leads to the expansion of the fields of application of the material [10, p. 427-431]. In another work, mechanical strength indicators were studied by performing nano-modification of wood composition based on fatty carboxylic acid [11, 2-5 p.]. And as a result, water resistance is reported to be 1.5% and thermostability is up to 840^{o}C. Taking into account the above, we aimed to create a technology for the production of profile-pogon products with high physical-mechanical and operational characteristics based on the waste of the furniture industry in our Republic and primary and secondary polyvinyl chloride (PVC).

Research results and their discussion

It is known from the literature that PVC-based composite materials cause technological inconveniences in production. Especially the technological parameters, i.e., the temperature regimes in production, change depending on the climate and the hot and cold weather, so choosing the required temperatures is somewhat complicated.

In preliminary studies, a recipe for PVC and wood composite was developed and its indications were determined. As a result of the study, it was found that with a decrease in the amount of wood flour and flour, the heat resistance and water absorption index decreased from 127°C to 95°C and from 1.4 to 1.2%, respectively.

1 – Table Wood polymer composition recipe based on PVC

Components	1	2	3	4	Chinese example
Recipe, mass. kg					
Polyvinyl chloride PVC SG8	40	50	60	63	30-60
Wood flour	15	10	10	11	40-70
Mel ($CaCO_3$) $S_{уд}$≥250 m^2/kg	45	40	30	26	40-60
Polyethylene wax	0,55	0,5	0,45	0,35	0,4-0,6
Foaming agent	0,55	0,65	1	0,75	0,8-1,1
Thermostabilizer	4,5	4,0	4,5	6	4-8
Modifier	8	7	6	8	2-10
Methacrylic acid	2,5	2,2	2,3	3	2,5-3
Stearic acid	0,5	0,3	0,4	0,6	0,1-1,0
Plasticizer (dioctylphthalate)					0,55-1,2
Zinc sulfate					1-1,5
Titanium dioxide (pigment)					0,85-1
Operational properties					
Heat tolerance, 180°C, min	125	103	110	97	61-99
Water absorption, in 24 hours, %	1,4	1,35	1,2	0,85	0,8-2,4
Impact viscosity, kDj/m2	17,5	16,6	17,2	17,8	13,7-15,8

Based on this, a test sample was initially taken at the "Khamkor R" LLC enterprise and they have the following indicators.

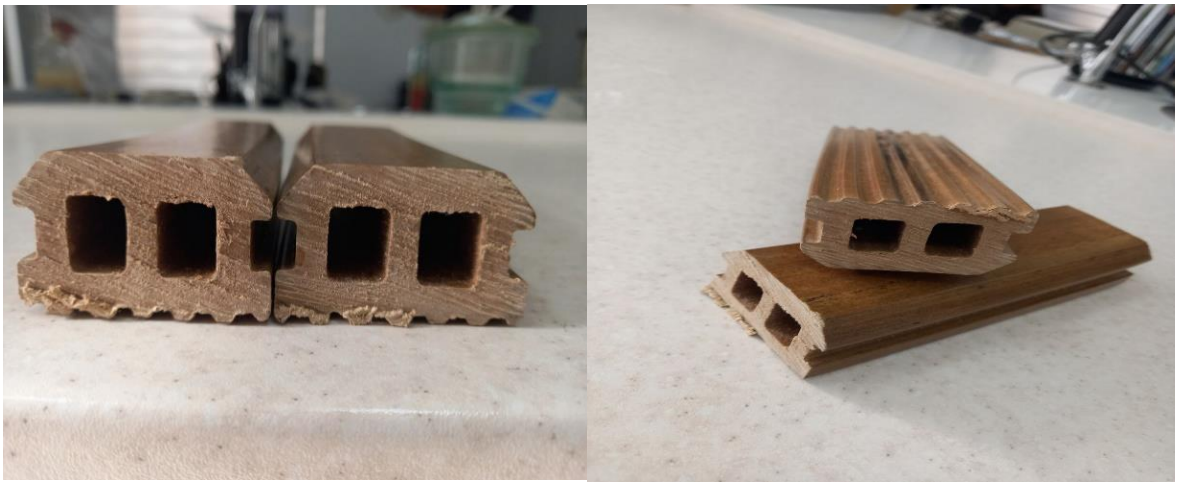

Fig. 1. Experimental sample of wood polymer composite material based on PVC and wood waste

Preliminary studies have shown that in some cases foaming was observed in the recipe proposed by us, this process was found to affect the quality of the product.

Table 2 Physico-mechanical properties of wood-polymer composites

Indicators	Sample №1	Sample №2	Sample №3	WCM (China)
Sample weight, g	165±5	165±5	135±10	140-165
Thickness, mm at least	4-6	14-16	14-16	16
Density, kg/m^3	965	1050	1100	950-1100
Bending strength, MPa	48,8	52,7	45,6	45-52
Density according to GOST 15139-69, kg/m^3	965	1050	1100	750

The most basic requirements for wood-polymer composites were tested through 3 samples and compared to the Chinese-made WCMs. It can be seen from table 2 that the indicators such as bending strength and density are superior to those imported from China.

At the same time, the amount of fillers and thermostabilizers is of great importance in the production of a strong ribbed product based on PVC [12]. These were also taken into account when the recipe was changed.

The conducted studies showed that the use of secondary PVC rather than primary PVC in the production of WCM materials resulted in obtaining a product with relatively high physical and mechanical parameters. But in this technology, compared to the above production technology, it was mainly achieved by changing the temperature regimes in the extruder zones and in the mixing process.

As a result of the research, it was possible to obtain a high-quality PVC-based wood-polymer composite material by developing a standard recipe. But our republic now has a lot of poplar and MDF cores (more than 20+30 thousand tons, both). This motivates the development of a new recipe based on this source.

Analysis of the physical and mechanical parameters of the samples obtained on the basis of the recipe was tested and analyzed using certain established GOST and methods.

Initially, based on the above experience we obtained on the basis of PVC and poplar shavings in various proportions, a recipe was developed and technological and strength properties were studied. The tensile strength of wood-polymer composite materials was carried out according to the GOST 11262-2017 methodology. For this, samples were prepared according to GOST 26277. That is, the dimensions are 120x4x15 mm. In addition, the rate of tension of the device was set as (0.5) % according to this GOST. When preparing the samples for testing, they were conditioned in atmospheric conditions for 16 hours according to GOST 12423-66. The tensile strength was calculated by applying the test results to the following formula and expressed in the following table.

$$\sigma_{рм}=F_{рм}/A_0 ; \qquad (1)$$

where, F_{rm} is the force N to the maximum elongation; A_0–initial transverse surface of samples.

Table 3 Analysis of the results of testing the tensile strength of wood-polymer composite materials based on a new recipe

№	Samples		Tensile strength, MPa	Maximum elongation, mm	Average tensile strength, MPa
1	The amount of wood in the composition (3.96%)	a	2.7	2.03	3.008
		b	3,8	2,88	
		c	4,020	1,98	
2	The amount of wood in the composition (5.46%)	a	3.7	3.03	4,908
		b	4,8	2,08	
		c	5,016	1,83	
3	The amount of wood in the composition (7.96%)	a	6,63	2,326	6,11
		b	7,25	2,513	
		c	4,45	1,529	
4	The amount of wood in the composition (10.46%)	a	8,15	2,995	6,925
		b	6,36	3,356	
		c	6,26	2,558	
5	The amount of wood in the composition (12.96%)	a	12,06	4,185	12,097
		b	10,2	3,747	
		c	14,03	4,101	

From the results presented in the table above, we can see that increasing the mass fraction of wood filler in the recipe based on the composition led to an increase in tensile strength. Below are the graphs produced when testing the samples.

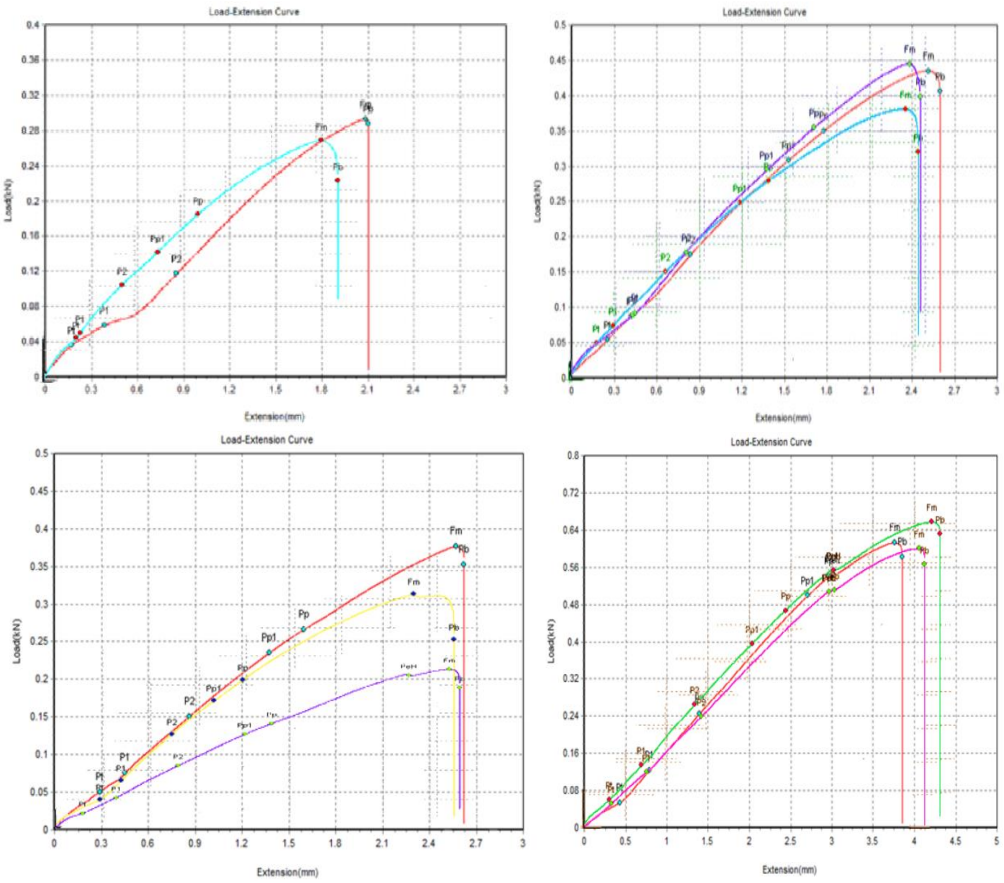

Fig. 2. The influence of composition composition on the tensile strength of wood-polymer composite materials

As can be seen from the picture, the three samples with the most positive results were compared with four types of recipes. The amount of wood in the composition of the obtained new type of composite material affects several of its quality indicators. In particular, it is resistant to stretching. The analysis of the experiments showed that we can see that the above-mentioned main indicator of the samples with the content of wood in the composition (10.46%), the content of wood in the composition (12.96%) is high. The reason for this is the formation of hydrogen bonds in the composition.

Summary

The composition and structure of fillers (poplar wood and wood fiberboard (MDF) waste) used in the production of wood-polymer composites based on polyvinyl chloride (PVC) were studied. An optimal recipe for obtaining a polymer wood composite from poplar wood and wood fiber boards (MDF) waste was developed, samples were taken in the created technological lines and their technological and operational properties were studied, and appropriate changes were made to the recipe. The nature and character of bonds between ingredients in wood-polymer composite materials, as well as the structure of wood-polymer composite materials, were studied.

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