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Research Influence of Humidity of Resined Screw-Polymer Weight on Parameters of Physical and Mechanical Properties of Composite Wood and Plastic Plate Materials

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ABSTRACT: This article presents the results of studies on the influence of the moisture content of the tarred chip-polymer mass on the parameters of the physicomechanical properties of composite wood-plastic plate materials. It has been established that the best tensile strengths for bending and swelling are observed when tarring wood chips within 10-11% humidity.

KEY WORDS: composition, wood-plastic slab ,, bending strength, moisture of wood shavings, swelling of slabs, grinding of particleboard, fractional composition, inner layer of wood pulp, polymer binder, process, physicomechanical properties of the slabs.

I. INTRODUCTION.

The indispensability of this issue is due to the fact that no effective compositions and technology for producing composite wood-plastic materials from the mentioned raw materials have been developed, providing high and physic-mechanical properties. For this reason, the production of wood-plastic materials is not yet sufficiently developed in the republic.

A thorough study of all the laws of material formation during the manufacturing of plate materials from cotton stalks has not been carried out. If huge scientific material has been accumulated on particle boards (numerous factors determining the quality of this object have been studied and studied), then studies on the development of technology for wood boards from stems of annual plants, in particular from cotton stems, have not been studied enough, especially the effect of moisture of tarred particles of fillers from cotton stems with a polymer binder on the parameters of the physic mechanical properties of composite wood-plastic slab materials has not been studied.

In this regard, the study of the effect of humidity of the tarred wood-polymer mass using cotton stalks and polymer binders from the fillers on the physicomechanical properties of plate materials is an urgent task.

Object and research method. The study was carried out according to the method described in [1], in particular, the fractional composition, particles, the type of chip package and the conditions for obtaining a plate of the same method were studied. A distinctive factor was the setting variable factor - the moisture content of the initial shavings before grounding. The studied parameters of the accepted humidity values were from 1 to 10% humidity with an interval of 1%. The desired moisture content of the chips is achieved by drying the chips in a stream of heated air at a temperature of 400 ° C.

During the drying process, the moisture content of the chips was measured using a VLV-100 moisture meter, and when the desired moisture content was reached, the chips were placed in plastic bags so that they did not absorb moisture from the air and kept in it 180 in order to reduce the temperature to room temperature and even the humidity mass. After this, mixing with the resin was carried out. Since the moisture content of the chips before mixing is set different, then the weight of the chips placed on one plate will be different.

Research results and their analysis. The study found that under the influence of pressure and high temperature in the pressed bag complex physical and chemical processes take place, which significantly depends on the moisture content of the tarred chips.

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The chip package consists of a mixture of chip particles of a wood polymer binder and water. During the pressing process, the moisture content of the chip package decreases, and the temperature inside the chip package increases, and the polymer binder is cross linked, and the quality of the resulting plates with good physic mechanical properties depends on the correct pressing mode (humidity, temperature, pressing time and pressing pressure), especially with a minimum pressing time. The moisture content of the tarred chips is one of the important factors that directly affect the pressing process and the quality of the boards.

It has been found that compaction of a chip pack with high humidity requires less force, and compression deformation proceeds with less micro fractures and with greater shrinkage compared to compaction of a chip pack with low humidity. This explains the decrease in the thickness of the finished plates with an increase in the moisture content of the tarred chips. The moisture content of the chip package affects the layer-by-layer density of the plate, the outer layers of the plates under the influence of moisture and heating are less resistant to the pressure of the plates and more denser than less heated inner layers of the plate, which leads to an increase in the density of the outer layers. With increasing humidity of the chip package, the resistance to compression during hot pressing is significantly reduced.

In the process of hot pressing from contact heating of the press plates, the humidity of the outer layers of the chipboards drops sharply, and the rest of the moisture penetrates into the inner layers, increasing the humidity of these layers. In the beginning, the humidity of the inner layer increases, but after a while under the influence of heat, it gradually decreases due to the partial release of steam through the thickness of the packet.

Humidity is known to adversely affect the cure time of carbide resins. With increasing moisture content of the tarred chips, the curing process of the binder slows down. Therefore, to eliminate premature curing of the surface layers of the slab, it is necessary to level the humidity of the outer layers with the inner layers. This can be achieved by increasing the binder content in the outer layers, by varying the concentration of the binder, or by wetting the surface of the bag before pressing. An increase in the humidity of the outer layers is also necessary for quick heating of the inner layers of the bag, since under the influence of heat from heated press plates, the moisture on the outer surfaces of the bag quickly turns into steam, which will bring heat to the inner layers of the bag.

It is noted that with an increase in total humidity, the duration of heating of the inner layer increases, which is explained by an increase in heat by mass transfer. However, this significantly increases the duration of evaporation of excess moisture. And in order for the total humidity of the package not to increase, it was necessary to reduce the humidity of the inner layer and increase it in the outer layers. This is achieved by reducing the heating time of the inner layer, as well as reducing the exposure time of the package during pressing.

In literary sources [2-6], the influence of moisture from wood chips after grinding on the quality of plate materials is adequately covered. Given the influence of the moisture content of the tarred chips on the intensity of the pressing process of the plates, as well as their physical and mechanical properties, it was advisable to conduct a study to study the effect of humidity of the tarred particles of chips from cotton stems on the physical and mechanical properties of the plates.

As you know, the moisture of the tarred wood-particle particles is determined by the water content in the binder, which depends on the concentration of the resin (in which 40-60% water), the moisture in the chips before tarring and the moisture formed during the pressing as a result of the polycondensation of the resin during curing. In our studies, the desired chip moisture was achieved by adding water to the original resin, i.e. by changing the concentration of the resin, with the same resin content for all samples equal to 10% of the dry residue. The characteristics of the starting resin are shown in table 1.

Table 1

Characterization of the initial urea-formaldehyde resin brand KFMP

Indicators	Values
Mass fraction of solids,%	65
Refractive index	1,463
Conditional viscosity on the VB-4 viscometer, with	35
Curing time when adding 1% at 100 ° C	35

For the experiments, for each given moisture content of the tarred shavings, 5 plates were pressed, 280x410x16 mm in size with a design plate density of 750 kg / m3. Before pressing, the chips were dried to a moisture content of 2%. The plates were pressed in a single layer with a stable fractional composition of all samples. Of these, the 30/10 fraction was 30%, 10 / I - 54, 3% and 1/0 - 16%.

Tarred shavings and fractions with an interval of 1% were investigated. The required resin concentration is determined by the formula:

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$$W_{oc} = [W_{стр} + P\,(\frac{100}{K} - 1)]\ /\ (P+100)$$

In this case, the calculation of all necessary parameters and components was carried out according to the formulas known in the technical literature [7-9] The required concentration of diluted resin (Cr) was determined by the formula:

(2)

$$К_р = \frac{10^4 P}{W_{oc}\,(P+100) + 10^2\,(P - W_{стр})}$$

where:

Woc - the specified moisture content of the chip after grinding, equal to 10 - 20%

Wst- chip moisture content before grinding, equal to - 2%

P is the resin content concerning the absolutely dry chip weight of 10%.

To determine the added water, we set the weight of the initial resin equal to 250 g. then by the formula (3) the weight of the added water is determined:

(3)

$$q_в = q_{исх}\,(\mathcal{K}_{исх} - \mathcal{K}_p)\ /\ \mathcal{K}_p$$

where: Q is the mass of the initial dilute resin,

Kiss - the concentration of the starting resin is 65%.

The calculation results are shown in table (1).

The required number of Gstrs shavings with a moisture content of 2% per plate can be determined by the formula:

(4)

$$G_{стр} = \frac{10^2\,\mathcal{P}\,\mathcal{V}\,(100 + W_{стр})}{(100 + W_{п})(100 + P)}$$

The mass of consumed amount of binder for each selected concentration of resins is determined by the formula:

(5)

$$Q_{ж} = \frac{100\,G_{стр}\,P}{(100 + W_{стр})\mathcal{K}_p}$$

where: P = 10%; Wst = 2%;

The solids content of the binder is the same for all samples and is:

$$Q_о = \frac{Q_ж \cdot \mathcal{K}_p}{100} = 134{,}75\ г \quad (6)$$

Ammonium chloride was chosen as a hardener, in an amount of 1% by weight, which is 1.34 g. Diluted 5.32 g of distilled water per plate. Moreover, their ratio is 20 and 80%, respectively. Their mixing was carried out on heated water to 45 ° C.

Upon receipt of the experimental plates, the mixing conditions, holding time after mixing, and the pressing conditions were the same as in previous experiments.

From the graph (Fig. 1) it can be seen that the tensile strength in bending is incremented with chip moisture from 7 to 9%, reaching a value of 22.9 MPa. This growth is explained by the fact that at low moisture content of the chips, the resin of high concentration, due to its higher viscosity, was poorly sprayed through the nozzles and unevenly applied to the surface.

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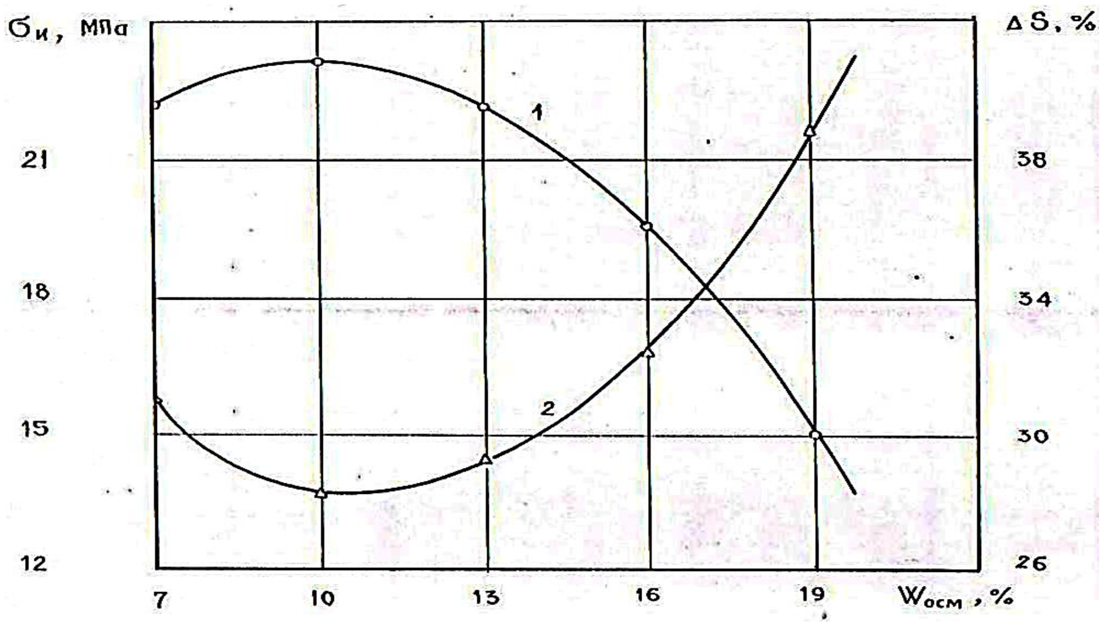

When the moisture content of the tarred chips equal to 9-11%, the maximum values of bending strength are obtained. With an increase in humidity up to 20%, a decrease in bending strength to 12.5 MPa is observed. The decrease in strength is explained by the fact that at these humidity the chips absorb an excessive amount of water, which complicates the molecular adhesion of the cell tissue of cotton to the polymer resin, while playing the role of an insulator. This moisture, which is removed from the bag during pressing, leaves behind empty air spaces, resulting in reduced plate strength.

The low concentration resin is more easily incorporated into the particles, thereby reducing the proportion of resin on the surface of the particles involved in the bonding. Excess moisture in the bag during pressing creates additional vapor-gas pressure inside the bag, which, at the moment of opening the plates, can exceed the adhesion force of the particle contacts and destroy them completely or partially. At the same time, swelling of the central zones of the plate or their delamination is observed in the samples. To localize this phenomenon, an increase in the exposure time of the package under the press is required to reduce moisture and increase the polymerization of the resin.

The dependence is extreme at a chip moisture of 10-11%, with a tarred chip moisture of 1%, the swelling is 31.3%, which is 15.9% lower than at the maximum value. Thus, we can conclude that at low humidity the tarred chips the density in the inner layers of the plate is much lower, this contributes to the penetration of water deep into the plate from the outside and from the end surfaces. Therefore, the swelling process is accelerated throughout the volume of the plate.

The decrease in density is due to the fact that, at low humidity, the chips are more rigid and therefore deformed worse when pressed. As a result, the packing density of the particles in the bag is much lower. In addition, in the outer layers of the package, deformation occurs at higher temperatures. This contributes to the plasticization of particles and the tight packing of chips among themselves. Note that the non-uniform adhesion of particles at high resin concentrations also promotes the penetration of moisture into the inside of the plate. With an increase in the moisture content of the tarred chips to 20%, the swelling process increases, reaching 42%. As mentioned, increasing the moisture content of the chips reduces the adhesion of the polymer binder to the wood. This explains the slight disruption of the contact of the chips with the chips in a humid environment, when tested for swelling. The swelling of the slab also contributes to the low concentration of the resin, in which a large proportion of the resin penetrates into the inner layers of the slab, thereby reducing the proportion of binder involved in bonding.

II. CONCLUSION.

Based on the studies performed, it can be concluded that the best results in terms of physicomechanical and technological properties, namely, flexural and swelling tensile strengths, are observed when wood chips are ground in the range of 10–11% moisture [182].

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