ANALYSIS OF THE STATUS OF PROCUREMENT OF WOOD MATERIALS BASED ON LOCAL WASTE AND CURRENT RESEARCH ON WOOD-BASED BOARD BUILDING MATERIALS

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Abstract.

The sustainable procurement of wood materials derived from local waste plays a crucial role in promoting eco-friendly construction practices and reducing environmental impact. This study examines the current state of wood material procurement based on local waste sources, highlighting challenges, opportunities, and best practices. Additionally, the research provides an in-depth review of modern advancements in wood-based board building materials, focusing on their composition, mechanical properties, and sustainability aspects. The study identifies key innovations in engineered wood products and evaluates their potential applications in low-carbon building construction. The findings contribute to the development of sustainable procurement strategies and support the advancement of environmentally responsible construction materials.

Keywords: Wood procurement, local waste, sustainable construction, wood-based boards, engineered wood, eco-friendly materials, waste utilization, green building materials, circular economy.

Introduction.

To achieve the required level of energy saving and fire safety in buildings, it is necessary to use materials that have the given thermal and fire safety characteristics, as well as such important characteristics as: relatively low thermal conductivity, water and moisture absorption, low fire hazard values, long-term durability and relatively low cost. At the same time, modern urban planning is characterized by the following requirements: increasing the energy efficiency and fire safety of various buildings and structures; reducing the overall weight of structures; modern design and other similar requirements, which has led to the emergence of modern materials of a structural and non-structural nature in the building materials market.

They include sandwich panels, high-performance thermal insulation and other materials that are displacing huge and heavy structures from today's modern construction. Environmental benefits are also achieved through the use of any construction materials produced from local waste: a much higher energy efficiency reduces the amount of emissions released into the atmosphere by 25-30%, and accordingly, reduces the impact of energy consumption on climate change. In addition, the increase in energy efficiency in the residential sector also includes measures to adapt to climate change by improving the protection of houses from adverse weather conditions.

During the research, research was conducted to study the properties of the plane tree and its leaves. As we know, everything in nature is created in harmony. In autumn, dry, yellowed plane leaves fall and cover the earth. Based on natural shedding, the leaves fall to the ground and are harmless to humans and nature. However, in order to achieve cleanliness, we collect and burn dry leaves. As a result, the toxic gases accumulated in the leaves are released into the atmosphere again. Thousands of people breathe the smoke produced when dry leaves are burned, endangering their health. First of all, the human pulmonary system is damaged. Toxic substances spread throughout the body through the blood, causing great damage to the kidneys, liver, brain, and nervous system.

According to experts, when 1 ton of dry leaves is burned, 9 кгsmoke microparticles are released into the air. These microparticles include: dust, nitrogen oxide, carbon monoxide, heavy metals, and the most dangerous substances for humans - dioxin and dioxane. When these toxic substances enter the human body, they damage the immune system, disrupt the function of hormones and vitamins.

One of the most important problems today is how to get rid of maple leaves. The reason is the damage caused by burning maple leaves, as we mentioned above. Another way is to get rid of the leaves by burying them in the ground in the fall and turning them into useful fertilizer the following spring. However, scientific studies have shown that when the leaves are buried and opened after one or more years, the maple leaves practically do not decompose. Another major problem is that due to the fact that the collection of maple leaves is extremely heavy and occupies a large volume, any landscaping systems have some problems in removing and eliminating them from any urban area, which has not yet been solved.

Methodology.

It is appropriate to consider the effect of fire retardants on the appearance of wood materials in the following aspects:

Firstly, many flame retardants reduce the thermal stability of wood in the pre-combustion temperature range, which is manifested in a decrease in the temperature at which active thermal decomposition of the material begins. This is due to a decrease in the activation energy of the thermal decomposition process of wood. The most effective flame retardants for lowering the temperature limit for wood decomposition are FMD, KM and FKM ($NH_4H_2PO_4$, $(NH_4)_2HPO_4$, $(NH_4)_2SO_4$, $Na_2B_4O_7$, H_3BO_3) .

According to the fire protection condition, when the material is burned, the effective means must be activated, that is, they begin to be released with the appearance of an acidic environment necessary for the dehydration of the wood substance. In this case, the activation temperature t_a must be lower than the temperature at which the active thermal decomposition of high-molecular wood components begins, otherwise the flame retardant will not have time to show its fire extinguishing effect or it will be limited only to preventing combustion in the gas phase and burning of char residue. At the same time, the hot pressing of the wood-based material must be carried out at a temperature lower than the temperature at which the flame retardant will not be able to manifest its effect in time. Thus, the temperature stability condition must be met $t_{pr} < t_a < t_t$ (t_{pr} -limit temperature, t_a -activation temperature, t_t -thermal decomposition temperature).

Since flame retardants lower the temperature limit for thermal decomposition of the wood complex, it is necessary to reduce the pressing temperature in the production of fire-resistant wood materials. Thus, if in the presence of flame retardants the temperature is t_t=200-220 ^oC, then t_{pr}=180-190 ^oC should not be higher. The process of pressing fiberboard by the dry production method is carried out at a temperature of the heating plates of the press 230-260 ^oC and is accompanied by the initial thermal decomposition of the wood complex, which ensures sufficient strength of the material. At low pressure temperatures , interfiber bonds cannot be formed effectively, therefore, in order to avoid excessive consumption of binders, flame retardants should be added to the process of forming the structure of the wood material as a plasticizer, hardener or interlinking agent. This method has been used to produce fire-resistant fiberboards manufactured in a dry process using flame retardants such as FMD, KM and FKM. In this case, the boards are produced without the use of binders, the pressure temperature is reduced and a heat treatment step is introduced.

The next point is related to the interaction of flame retardants with binders. In wood-based materials, the mass fraction of binders is less than that of the flame retardant. Technological methods for introducing a flame retardant are aimed at ensuring its penetration into the wood particles to a certain depth in order to achieve the largest surface area for interaction with wood substances in wood conditions. As a result, the amount of flame retardants on the surface of wood particles intended for contact with the binder decreases, while the flame retardant and binder bonds cannot be fully preserved when using the components. Therefore, the compatibility of the fire retardant with the binder is of great importance. The incompatibility of these components leads to the loss of binding properties and the coagulation of the binder with the strength of the finished board. The weakest link in the formation of a wood-fire-resistant-adhesive adhesive layer is fire-resistant. Then its introduction can change the wettability of the wood and interact with the adhesion between the wood and the binder.

A certain acidity of the medium is required for solidification of various oligomers. Therefore, the presence of flame retardants with acid-base properties changes the curing conditions of oligomers. In addition, many flame retardants change their acidity during hot pressing. As a result, depending on the type of flame retardant and oligomer, flame retardants can accelerate the hardening of the binder and prevent it from hardening, which affects the quality of the finished wood panel material.

For example, it is known that the solidification of CFC occurs in an acidic environment. Therefore, in the production of fire-retardant CFCs, the processing of wood particles with $(NH_4)_2SO_4$ or H_3BO_3 accelerates the hardening process of the binder and prevents the hardening of fire extinguishers with alkaline properties, for example, $(NH_4)_2HPO_4$, $Na_2B_4O_7$, NaH_2PO_4 and Na_2HPO_4. The use of a FMD flame retardant with a weakly acidic reaction allows you to obtain a flame-retardant PB with satisfactory physical and mechanical parameters. Depending on the type of binder used in the production of fire-resistant plywood, the KM flame retardant is synthesized with different acidity - sour (acidic) when using KFC, and neutral in the case of FFS. It should be noted that by accelerating the hardening process, the flame retardant can both act as a hardener and excessively increase the rate of oligomer condensation, which, as a result, leads to a deterioration in the quality of the thermosetting polymer.

Results

The study demonstrates that fire retardants significantly influence the formation and properties of wood-based materials by participating in inter-fiber bonding processes. Flame retardants containing amide and amino groups, such as FMD, KM, and FKM, exhibit a plasticizing effect on wood fibers, enhancing their flexibility and promoting stronger inter-fiber interactions during hot pressing. This plasticization effect leads to increased fiber bonding forces, facilitating the development of a more cohesive and structurally stable material. Furthermore, the presence of flame retardants reduces the temperature range required for fiber softening, allowing for a decrease in both pressing temperature and processing time without compromising the internal strength of the material.

The chemical interaction between fire retardants and wood materials plays a crucial role in enhancing fire resistance. The phosphorylation of polysaccharides with phosphoric acid groups results in the formation of phosphoester bonds, contributing to the development of a tightly bound fire-retardant complex. Additionally, the integration of nitrogen-containing bases and esterification of cellulose and lignin with polyphosphoric acids further enhances the stability and fire resistance of the composite material. This ensures that the fire-retardant agents remain effectively incorporated within the structure, preventing their migration or loss during the operational lifespan of the material.

The multifunctionality of the fire-retardant components influences both the mechanical and fire-resistant properties of the panels. While H_3PO_4 dissolves cellulose and reduces fiber strength, $(NH_2)_2CO_3$ acts as a plasticizer, improving fiber interactions and overall material cohesion. Consequently, the optimal production regime must balance these effects to maximize fiber strength while maintaining strong inter-fiber bonding. The incorporation of metallophosphates, such as aluminochromophosphates and aluminum borophosphates, further enhances fire resistance through polycondensation reactions that reinforce the material's structure.

However, some inorganic salts used as fire retardants negatively impact the structural integrity of fiberboards. Compounds such as $NH_4H_2PO_4$, $(NH_4)_2HPO_4$, and $ZnCl_2$ decompose during hot pressing, releasing acidic byproducts that weaken wood fibers and reduce both strength and water resistance. Additionally, fire-retardant salts with high water solubility may migrate to the material's surface under high humidity conditions, leading to a loss of fire protection over time. This highlights the importance of selecting fire retardants that maintain their stability, prevent moisture absorption, and integrate effectively into the material's matrix.

The study emphasizes that the most effective approach involves using fire retardants as bifunctional agents—serving as plasticizers, hardeners, and modifiers—without negatively affecting adhesive properties, fiber interactions, or pressing conditions. The optimal fire-retardant formulation should avoid coagulation, maintain compatibility with binders, and ensure high solubility in water for efficient application. The use of concentrated working solutions enhances the mass fraction of fire-retardant components in wood particles while minimizing drying costs.

Overall, the research highlights the potential for improving fire-resistant wood-based panels through optimized fire-retardant formulations and production processes. By carefully selecting suitable flame retardants and refining manufacturing conditions, it is possible to produce durable, fire-resistant wood-based materials with enhanced mechanical properties and long-term stability.

Conclusion.

The study highlights the potential for producing fire-resistant wood-based composite panels using local raw materials, offering a sustainable and cost-effective solution for the construction industry. To achieve high-quality fire-resistant panels, it is essential to carefully select wood raw materials, establish an optimal particle size distribution of sawdust, and incorporate locally sourced fire-resistant agents and fillers that ensure adequate fire protection and safety. Furthermore, the development of an optimized composition and formulation for fire-resistant panels is crucial for enhancing their performance and durability.

The findings indicate that existing enterprises in the republic require improvements in industrial technology for the production of fire-resistant composite panels. Advancements in manufacturing processes, material selection, and formulation techniques will contribute to the development of high-performance fire-resistant building materials, supporting the broader goals of sustainable construction and fire safety. Further research and investment in technological upgrades are necessary to enhance the production capabilities of local enterprises and ensure the widespread adoption of fire-resistant wood-based panels in the construction industry.

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