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RESEARCH ON THE MECHANISM OF WOOD PROTECTION WITH ECO-FRIENDLY PAINT AND VARNISH COATINGS

The problem of using wood products is to ensure their protection with a paint and varnish coating in order to increase their durability. Therefore, the object of research was the resistance of the paint and varnish coating when finishing wood to the destruction of adhesion and the action of chemical reagents during operation. It has been proven that for a wood sample finished with nitro-urethane varnish SU-29, when determining adhesion, slight delamination in the form of small scales is observed in the places where the grid lines intersect. However, there are no signs of delamination on a wood sample finished with melamine varnish Plastofix 96 RF. Comparing the samples finished using different technologies, they can be evaluated by points: samples finished with nitro-urethane varnish SU-29 received an adhesion rating of 2 points, namely, slight delamination in the form of small scales in the places where the grid lines intersect. The damage is observed on no more than 5% of the surface of the grid, and the samples finished with Plastofix 96 RF melamine varnish are rated at 1 point – the edges of the cuts are completely smooth, there are no signs of delamination in any square of the grid, i. e. they have better adhesion to wood. The wood surface treated with varnish was assessed for staining, and it was found that the wood surface belongs to 1 point, i. e. there are no visible changes. The results of determining the resistance to water of a wood sample treated with SU-29 nitro-urethane varnish showed a visible trace left by water with a diameter of about 20 mm. In contrast, there are no traces of water on the sample of wood treated with melamine varnish. The practical significance is that the results obtained justify the use of eco-friendly varnish for wood finishing. Thus, there is reason to argue about the possibility of directed regulation of the wood protection process through the use of coatings capable of forming a protective layer on the surface.

Keywords: *protective agents, paint and varnish coating, adhesion, surface treatment, protection efficiency.*

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1. Introduction

Paint and varnish coatings are widely used in construction both for protecting surfaces from atmospheric influences, in particular wood, and for decorative decoration of various structures and improving their sanitary and hygienic properties, including aesthetic indicators. However, finishing wood with paint and varnish materials is usually associated with the risk of surface defects that nullify the resulting material. Further correction of defects in a wooden structure increases its cost. Therefore, the main direction regarding the quality of the resulting product should be made in the direction of compliance with the technological regime, the use of modern equipment and the quality of paint and varnish materials themselves. When applying a paint and varnish coating, it is necessary to take into account the type of wood and the conditions of its operation, as well as the appearance of the coating film. Since the varnish coating on wood creates a hard film, which protects the wood surface during its service life and must be eco-friendly. Thus, when covering furniture with melamine varnish, formaldehyde emissions decreased to 94% [1], and in the work [2] the resistance to aging and scratches of the wood surface was proven.

Thus, varnishes for wood processing, which are made on a water basis or from natural substances, are eco-friendly and have practical value, since they do not contain harmful volatile organic substances, which makes them safer for the environment. In addition, they provide the same resistance to mechanical damage and moisture as traditional varnishes.

Therefore, the main point of finishing wood with varnish is not only its environmental friendliness, but also ensuring high-quality and long-term adhesion of the coating. At the same time, the applied paint and varnish coating, which acts as a design decor, which increases the commercial value of the manufactured product, should be distinguished by increased resistance to gradual destruction of the surface, so the development of coatings for wood is relevant.

In [3], the resistance of modified teak species to subterranean termites was investigated to obtain valuable information for their further application. Design/methodology/approach: the wood tested in this study was fast-growing teak wood, which was prepared in the untreated state and treated with furfuryl alcohol (FA), glycerol maleic anhydride (GMA) and thermally. The SFE values were calculated using the Rabel method. The wettability values were measured based on the contact angle between the varnish liquids and the wood surfaces using the sitting drop method, and the Shea and Gardner model was used to evaluate the wettability of the varnishes on the wood surface. The adhesion quality of the varnishes was measured using the cross-cut test based on the ASTM 3359-17 standard. In addition, the resistance to subterranean termites in the field of these modified teak trees was investigated according to ASTM D 1758-06. Conclusions: the results showed that furfurylated and GMA-thermal temperature of 220°C improved the termite resistance of teak. Furfurylated teak had the roughest surface with an arithmetic mean roughness (*Ra*) of 15.65 μm before aging and 27.11 μm after aging. Teak treated with GMA-thermal temperature of 220°C had the smoothest surface with an *Ra* value of 6.44 μm before aging and 13.75 μm after aging. Untreated teak had the highest SFE value of 46.90 and 57.37 mJ/m^2 before and after aging, respectively. The *K* values of untreated and treated teak increased due to aging treatment. The *K* values of water-based acrylic varnish were lower than those of solvent-based alkyd varnish. Untreated teak with the highest SFE score provided the highest bond quality (classes 4–5) for both acrylic and alkyd varnishes. The solvent-based alkyd varnish was more wettable and had better bond quality than the water-based acrylic varnish. Originality/value: the originality of this research work is that it provides estimates of durability and SFE. The SFE value can be used to quantify the wettability of varnishes on the wood surface and the adhesion quality to the varnish.

The study [4] aims to find sustainable solutions in the field of building coatings. Traditionally, varnish has been crucial for the protection and decoration of structures, but its environmental impact and strong concentrated odors have raised concerns. In this context, an innovative alternative is proposed: a dairy-based varnish. The main objective is to develop a sustainable dairy-based varnish for use on masonry and wooden walls in the city of Cajamarca (Peru). The main motivation is the growing demand for sustainable solutions in the construction industry. The methodology is based on a quantitative approach using laboratory tests and ASTM standards to measure properties such as water resistance, adhesion, viscosity and durability. The results obtained are promising. Both cow's milk and artisan yogurt-based varnishes have proven their viability in providing high-quality color and finish on wood and stone walls, indicating their suitability for various applications.

The work [5] aimed to improve the stain resistance and durability of varnish on wood surfaces. A superhydrophobic solution was created by mixing synthetic ZIF-8/paraffin with hexadecyltrimethoxysilane (HDTMS) in a defined mass ratio. Then, this superhydrophobic mixture was applied directly onto the wood varnish coating using a one-step method. Testing of the microscopic characteristics, transmittance, abrasion resistance, and water contact angle (WCA) of the hydrophobic coatings showed that the mass ratio of ZIF-8 to HDTMS affects the surface microstructure and roughness of the wood coatings. When the ratio reached 10:1, 5:1 and 2:1, the nanoparticles were dispersed at the interface of the varnish, and the film formation effect was uniform. The transmittance of the varnish coating was about 90%, and the light transmittance of the superhydrophobic coating was about 80%. The water absorption rate of the treated sample was significantly lower than that of the untreated sample. After 10 cycles of abrasion tests, the WCA decreased but remained above 150°. Water droplets on the surface of the coating can remove contaminants by "rolling washing", demonstrating good self-cleaning efficiency. The one-step method can quickly form superhydrophobic films on the wood surface varnish coating.

In [6], a varnish was developed and characterized before testing on Ayous wood. The properties of the finished varnish (FV) were compared with those of a reference varnish (RV). The FV density was 0.99 and RV was 1.6. FV showed better absorption (0.63) compared to 0.03 for RV, while the transmittance of RV was 94.5% compared to 23.7% for FV. MALDI results showed that FV contained oleic, linoleic, stearic and palmitic acids, probably from Jatropha curcas, and unsaturated fatty acids from Canarium schweinfurthii resin, such as 2-methyl-5-propan-2-ylcyclohexa-1,3-diene, 1-methyl-4-propan-2-ylcyclohexa-1,4-diene, 4,7,7-trimethylbicycloheptane. Catechin oligomers were also detected, reacted with one molecule of 4-methylcyclohexa-propan-2-yl, resulting from the reaction of the hardener of the tannin extract of Vachellia nilotica with one of the main components of the resin. Some resinite oligomers were also identified, resulting from the addition of rosin. All of these significantly reduced the water absorption of the wood. The FV application changed the color parameters of Ayous more than RV. RV showed a gloss of 60GU (Glossines Unit), compared to 35GU for FV. According to the ISO/CIE 11664–6 standard, Ayous wood was significantly protected from atmospheric aggression after 4 months of exposure. All varnishes significantly protected the wood against all tested fungi with a mass loss of less than 5%. Finally, FV was more protective of Ayous wood against termites with a mass loss of 2% compared to 40% for RV. FV is an effective alternative for the preservation of Ayous wood and possibly other wood species.

The aim of the work [7] was to investigate the effect of acrylic-based varnishes, including TiO_2 and Al_2O_3 nanofillers, on surface protection during the conservation of natural and worn surfaces of historical and religious wooden structures. The varnishes were applied to wooden surfaces with a brush, and the varnished samples were artificially aged in a weathering chamber. Changes in the surfaces of the samples were evaluated according to color change, microhardness, abrasion tests, scratch tests, surface durability and surface characteristics using scanning electron microscopy (SEM). Also, the thermal properties and morphological characteristics of the varnishes with nanofillers were determined, and ultraviolet-visible (UV-visible) and FTIR analysis were performed. The results showed that the values of microhardness, abrasion and scratches of the varnishes were not statistically significant. However, the values for TiO_2 varnishes were slightly higher than those for Al_2O_3 varnishes. The surface stability of the pure varnish was significantly improved by the addition of nanofillers. With the addition of nanofillers, SEM revealed a reduction in the thickness of the varnishes on the surfaces of the wood samples. The thermal properties, UV-visible optical properties and morphological structure of the pure varnish were improved by the addition of nanofillers, while FTIR did not reveal any difference in the binding of the varnishes. The UV spectra of TiO_2 and Al_2O_3 generally showed a peak at wavelengths of 354 nm and 210 nm, which means that they showed good absorption in the UV region. The results showed that the addition of nanofillers to the pure varnish can generally improve the external characteristics and service life of the cultured wood structures.

Wood and wood-based materials are considered eco-friendly building materials [8]. However, since they are susceptible to degradation by biotic and abiotic factors, they have often required the addition of protective coatings. In this context, water-based coatings are the preferred options, as they are solvent-free (odor, toxicity, fire hazard) and ultimately eliminate volatile organic compound (VOC) emissions. Despite this, these reductions mean lower durability and protection compared to conventional organic coatings. This study demonstrates that the incorporation of nanocellulose derived from blueberry pruning residues, as well as titanium dioxide and silicon dioxide NPs, into water-based varnishes can improve the mechanical properties and stability of wooden surfaces. In particular, adhesion and abrasion properties are improved without significant changes in other properties such as optical transparency, color and gloss of the coating. These results present promising potential for various applications in the context of developing products for the circular economy in furniture, flooring and wood-based panels.

In [9], the effects of thermochromic powder on the surface color difference, film adhesion and gloss of furniture after painting were analyzed. The application of the intelligent response material in wooden furniture can be improved, resulting in a remarkable decorative effect that is different from the traditional painting method. The results showed that the thermochromic powder microcapsules had a beautiful appearance, a smooth surface, a mostly spherical structure, no obvious cracks on the surface and good dispersion. By measuring the size and distribution of the microcapsules, it was found that the size range of the microcapsules was 1.44–7.95 μm with an average size of 3.94 μm, and the size distribution of the microcapsules was 0.97–8.71 μm with an average size of 3.27 μm. At room temperature, the addition of thermochromic powder can change the color of wood coated with paint and

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greatly increase the color difference. When the temperature rises to the response temperature of thermochromic powder, the color of the wood surface coated with 3–10% thermochromic red and 3% thermochromic blue paint becomes dull. At the same time, the color difference decreases, and the color of the wood surface can return to the same state as the color of the wood surface coated with paint without thermochromic powder. When 3% thermochromic powder was added to the paint, the surface of the varnish film without temperature-sensitive discoloration powder was relatively flat, and there were no obvious grainy impurities.

Many historical artifacts and furniture are now only reconstructed, not restored [10]. They have been preserved in terms of material recovery, but their historical value has been significantly reduced. This work aims to compare the durability of high-gloss polyurethane varnish with traditional shellac varnish. The varnishes were applied to oak wood and subjected to internal artificial accelerated aging in a Xenotest. Before and after aging, the samples were tested for resistance to cold liquid, and gloss, color, and adhesion were evaluated. Surface structures were also analyzed using a confocal laser scanning microscope. As expected, the polyurethane varnish was much more durable than shellac varnish. Interestingly, shellac was initially quite resistant to water, but after artificial accelerated aging, this resistance decreased significantly. This illustrates the importance of sheltering shellac-treated artifacts in stable temperature and humidity conditions with minimal exposure to solar radiation.

In [11], changes in surface gloss after 100 and 300 hours of accelerated weathering of beech wood (*Fagus orientalis L.*) coated with polyurethane, cellulose and water-based varnishes after impregnation with 5% and 10% concentrations of mimosa (*Acacia mollissima*) and quebracho (*Schinopsis*) were investigated. The highest gloss values were observed in untreated control samples before and after accelerated weathering. In addition, with the exception of samples coated with polyurethane varnish, the surface gloss values of other samples decreased after accelerated weathering. Among the varnish types, polyurethane varnish showed the best result in terms of surface gloss, with higher values observed after 100 hours of weathering than before weathering. Increasing the tannin concentration from 5% to 10% led to a decrease in gloss values. Wood impregnated with mimosa and quebracho extracts and coated with polyurethane was able to maintain both durability and surface gloss for longer.

The main objective of the study [12] is to verify whether composites reinforced with cellulose nanocrystals (CNC) and tung oil (TO) are effective for wood finishing and offer improved mechanical and atmospheric properties due to the high strength, stiffness and barrier properties of CNC. To achieve uniform dispersion of CNC particles in the polymer coating film, the CNC surface was hydrophobized by grafting oligomers of poly (lactic acid) and oleic acid. These new TO coating formulations contain from 0 (control sample) to 10 wt. % of hydrophobized cellulose nanocrystals (hCNC). This study investigated the coating characteristics (wrinkle degree, leveling and instant filling) of hCNC-TO finishes, as well as their coating properties (relief, optical properties, mechanical properties and gas permeability). The effect of hCNC content in tung oil composite coatings was investigated by scratch/impact resistance tests and oxygen transmission rate (OTR) measurements. Increasing hCNC content resulted in increased scratch/impact resistance, as well as a slight decrease in color change b, gloss, surface roughness and OTR values of their film coatings. The hCNC-TO wood coating composites presented here demonstrated improved performance for use in woodworking processes (scratch and impact resistance). Also, the change in atmospheric characteristics (color stability) and ease of production without any deterioration in gloss and surface roughness after the addition of hCNC to the TO matrix were considered. The improved hCNC coating system is a promising candidate for significant protection of wooden surfaces in difficult conditions.

Thus, it has been established from the literature that during the operation of wooden structures, their surface may be destroyed, which requires effective protection. In addition, the parameters that ensure the resistance of paint and varnish materials to environmental impact have not been established. Therefore, establishing the parameters of wood resistance to destruction and the influence of paint and varnish coatings on this process necessitated the need for research in this direction.

The aim of research is to study the mechanism of protecting wood with an eco-friendly paint and varnish coating against destruction during operation. This makes it possible to substantiate the directions of expanding the scope of application of paint and varnish coatings.

To achieve the aim, the following objectives were solved:

– to establish an assessment of the adhesion ability of the paint and varnish coating on the wood surface;

– to investigate the resistance of the paint and varnish coating to staining when exposed to chemical reagents on the coating and water resistance.

2. Materials and Methods

2.1. The object and hypothesis of research

The object of research is the resistance of the paint and varnish coating when finishing wood to the destruction of adhesion and the action of chemical reagents during operation.

The scientific hypothesis is to inhibit the destruction indicators of eco-friendly paint and varnish coating when processing wood.

The study adopted the following simplifications that relate to the wood processing process, namely, external and internal influences, temperature, humidity, atmospheric pressure.

2.2. Materials for experimental studies

For the study, pine wood samples measuring 200 × 150 × 10 mm were used. To study the effectiveness of paint and varnish protection, surface treatment with varnishes was carried out. Samples with SU-29 nitro-urethane varnishes were finished according to the technological process adopted in production, samples with Plastofix 96 RF melamine varnish according to the proposed process.

Since the melamine material is designed for use with only one hardener (catalyst), it is solvent-free (non-toxic), dries quickly and forms a hard film, which with increasing drying temperature increases productivity by reducing the sanding time between layers.

The first batch of samples: alcohol-soluble dye and subsequent three-time varnishing SU-29.

The second batch of samples: treatment with alcohol-soluble dye and subsequent treatment with melamine varnish.

To determine the resistance of the paintwork to staining, a sample of wood treated with a paintwork coating measuring 150 × 150 × 10 mm was used, on the surface of which tea, juice, vinegar, solvent 646, Khortytsia vodka were applied.

To determine the moisture resistance of paintwork coatings, a sample of wood treated with a paintwork coating measuring 150 × 150 × 10 mm was used, on the surface of which distilled water was applied.

2.3. Methodology for research into the effectiveness of melamine varnish

The main parameters when finishing wood with paint and varnish materials are the adhesive ability to wood and resistance to the effects of various liquids that can change the appearance.

Since adhesion is one of the most important indicators of a paint and varnish coating and is manifested in the intermolecular and chemical interaction between the paint and varnish material and the substrate (wood), and without reliable adhesion it is impossible to form a strong and stable coating. Therefore, the determination of adhesion is carried out to establish optimal application modes, paint and varnish material quality, hardening modes, conditions and product service life.

Adhesion tests were carried out using the lattice incision method according to DSTU EN ISO 2409:2022 [13].

Materials used for the experiment: sample holder, metal ruler, hairbrush, magnifying glass, tape, razor blades.

Adhesion is assessed in points (Table 1).

Table 1

Adhesion assessment in points by the grid incision method

Score	Description of the paintwork surface after applying grid-like cuts
1	The edges of the cuts are completely smooth, there are no signs of delamination in any square of the grid
2	Slight delamination in the form of small scales at the intersections of the grid lines. The defect is observed on no more than 5% of the grid surface
3	Partial or complete delamination of the coating along the grid-like cut lines or at their intersections. The defect is observed on no more than 35% of the grid surface
4	Complete or partial delamination of the coating, which exceeds 35% of the coating surface

Determination of the resistance of the paint and varnish coating to staining was carried out using a method based on the action of chemical reagents on the coating for a set period of time and visual assessment of the change in the condition of the coating.

The test was carried out in accordance with EN 335-1:2010 [14]. The exposure time of the chemical reagents was selected for 30 min. The samples, finished using two technologies, were installed in a horizontal position. Then, filter paper was moistened with the listed chemical reagents and placed on the test samples. Covered with a Petri dish. After testing and exposure, the samples were treated with a cloth moistened with a detergent solution, then dry. After exposure for 30 min the coating surface was evaluated.

The test results were evaluated on a 5-point scale:

– 1 point – no visible changes;
– 2 points – barely noticeable changes in gloss or color;
– 3 points – slight changes in gloss or color, in the absence of changes in the structure of the tested coating;
– 4 points – clearly distinguishable changes in gloss or color; the structure of the coating has minor changes;
– 5 points – clearly distinguishable changes in gloss and color; the structure of the coating is noticeably changed or destroyed.

The determination of the moisture resistance of paint and varnish coatings was carried out according to the working method, the essence of which was that 10–15 drops of distilled water were applied to wood samples coated with different technologies, which were installed in a horizontal position, in several places. To prevent the water from evaporating quickly, the places where it was applied were covered with a Petri dish. The experiment was carried out for 24 hours. Then the drop was removed with filter paper. The change in the decorative and protective properties of the coating was determined visually.

3. Results and Discussion

3.1. Research results on the adhesion of paint and varnish coatings to wood

The test was carried out on samples finished using two technologies. On the treated samples, notches were made in three areas of the surface (Fig. 1, 2). Then, the notches were treated with a hair brush and possible delamination of the varnish film was observed through a magnifying glass.

The sample (Fig. 1) shows minor delamination in the form of small scales at the intersections of the grid lines. The failure is observed on no more than 5% of the grid surface.

There are no signs of delamination on a wood sample finished with melamine varnish (Fig. 2).

Fig. 1. Sample coated with SU-29 nitro-urethane varnish during adhesion testing

Fig. 2. A wood sample finished with melamine varnish during adhesion testing

Comparing samples finished using different technologies, they can be evaluated by points:

– samples finished with nitro-urethane varnish SU-29 received an adhesion score of 2 points, namely, slight delamination in the form of small scales at the intersections of the grid lines, the violation is observed on no more than 5% of the grid surface;
– samples finished with melamine varnish Plastofix 96 RF are evaluated by 1 point – the edges of the cuts are completely smooth, there are no signs of delamination in any square of the grid, i. e. they have better adhesion to wood.

3.2. Research results of the resistance of the paint and varnish coating to staining

Fig. 3 shows the process of determining the resistance of a paint and varnish coating to staining.

Fig. 3. Testing a sample of varnished wood for staining

Both varnishes, by their method of hardening, are those that dry as a result of chemical transformations, i. e. they create a strong crystal lattice that is resistant to the action of chemical reagents. The wood surface treated with varnish was evaluated and it was found that the

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wood surface belongs to 1 point, i. e. there are no visible changes. Thus, on any sample there were no changes in the wood surface from the action of chemical reagents.

Fig. 4, 5 show the results of the water resistance test.

Fig. 4. Sample during water resistance test

The inspection compared the area of the coating on which the drop was placed with the area that was not exposed to water (Fig. 5).

a *b*

Fig. 5. Samples after water resistance testing:
a – sample finished with SU-29 nitro-urethane varnish, on which a trace left by water is visible; *b* – sample treated with Plastofix 96 RF melamine varnish

As can be seen from Fig. 5, *a*, a trace left by water with a diameter of about 20 mm is visible on the wood sample treated with SU-29 nitro-urethane varnish. In contrast, there are no traces of water on the wood sample treated with Plastofix 96 RF melamine varnish. It should be noted that urethane resins are quite stable, but their share in the paint and varnish coating is varnish colloxylin, which is not very resistant to water. Therefore, on the wood sample treated with SU-29 nitro-urethane varnish, it is possible to observe a trace from the action of water.

3.3. Discussion of the research results of the wood protection mechanism by paint and varnish materials

The research results on the adhesion of the paint and varnish coating to wood showed that samples finished with nitro-urethane varnish showed slight delamination in the form of small scales at the intersections of the grid lines in the amount of about 5% of the grid surface. However, samples finished with melamine varnish showed that the edges of the cuts are completely smooth and there are no signs of delamination. This indicates that wood samples treated with melamine varnish exhibit high adhesion to wood.

Tests of wood samples finished with varnish for staining showed that both varnishes, by their method of hardening, are those that dry as a result of chemical transformations, i. e. create a strong crystal lattice that is resistant to the action of chemical reagents. The wood surface treated with varnish was evaluated and it was found that the wood surface belongs to 1 point, i. e. there are no visible changes. Thus, there were no changes in the wood surface from the action of chemical reagents on any sample.

The results of the water resistance test of wood treated with nitro-urethane varnish SU-29 showed a visible trace left by water with a diameter of about 20 mm, while on the wood sample treated with melamine varnish Plastofix 96 RF, there were no traces of the presence of water.

Unlike the studies cited in [3, 6, 8], where the main focus is on the development of an eco-friendly varnish and increasing resistance to biological degradation agents, this study considered substances that are widely available on the market.

However, unlike the results obtained in [15, 16] regarding the inhibition of the destruction process and increasing the effectiveness of its protection, the results of this study allow to state the following:

– the regulator of the inhibition of the destruction process of the paint and varnish coating is the use of polymer resins, the oxidation of which forms a stable polymer film;
– a significant impact on the process of protecting the wood surface with paint and varnish coatings is carried out in the direction of the use of additives resistant to the action of water, which as a result of chemical reactions may not form a protective layer of the coating.

However, as established from the studies, when treating wood with nitro-urethane varnish SU-29, the proportion of the paint and varnish coating was varnish colloxylin, which is not very resistant to the action of water and formed a stain on the surface of the coating. For wood samples treated with melamine varnish Plastofix 96 RF, there are no traces of the presence of water.

The obtained results have certain limitations in determining the staining due to the unpredictability of the inhibition of the process of destruction of the polymer shell formed by nitro-urethane varnish SU-29 on wood. Taking this process into account is possible provided that the stability of the polymer shell formed during the oxidation of the paint and varnish coating is guaranteed.

Such uncertainty is difficult to resolve within the framework of this research, since it is necessary to conduct additional experiments to obtain more data. For example, this requires the availability of data necessary for a sound study of the process of destruction of the polymer film and establishing the time at which the drop in stability begins. Such a manifestation will allow to establish the transformation of the coating itself, that of the polymer film. And also, to establish those differences that change the transformation of the process of wood protection.

4. Conclusions

During the research, it was found that when assessing the adhesion of the surface of wood finished with nitro-urethane varnish SU-29, after lattice cuts, a slight delamination (no more than 5% of the surface) in the form of small scales is observed at the intersections of the lattice lines. In contrast, on the wood sample finished with melamine varnish Plastofix 96 RF, there are no signs of delamination for all squares of the lattice, which indicates better adhesion to the wood.

According to the results of evaluating the surface of the finished wood for staining, no visible changes in the surface were found for both varnishes. The results of determining the water resistance of the wood sample treated with nitro-urethane varnish SU-29 showed a visible trace left by water with a diameter of about 20 mm, while on the wood sample treated with melamine varnish Plastofix 96 RF, there are no traces of the presence of water.

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Conflict of interest

The authors declare that they have no conflict of interest regarding this research, including financial, personal, authorship or other nature, which could influence the research and its results presented in this article.

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Data availability

The manuscript has no linked data.

Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies in the process of creating the presented work.

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