

Quality of wood surface finished with polyurethane coating

Comparative analysis of some properties of various wood coatings is performed in this paper. A special attention is paid to polyurethane coating and several different types were taken into consideration. Their properties are compared with those of nitrocellulose and acid curing coatings. Resistance to liquids, heat resistance and scratch resistance were examined.

Key words: wood coatings, polyurethane coatings, resistance to liquids, heat resistance, scratch resistance

1. INTRODUCTION

There are various types of coatings at disposal, for final wood products finishing. Which of them and when are to be applied, depends on economical and environmental factors, but first of all on the quality of finished surface. Economical factor, mostly, is not decisive, if high quality coatings are used. Environmental factors, in working and exploitation conditions, are still not decisive, too, so that in the market conventional coatings are dominant, including nitrocellulose, polyurethane, acid curing and polyester (classic) coatings. The most diffuse are polyurethane coatings [6] which are characterized by high quality. Disadvantage of polyurethane systems for wood protection is relatively high content of organic solvents, making them environmentally suitable. However, the use of polyurethane coatings has many advantages, such as: lower content of volatiles (comparing with nitrocellulose coatings), no reactive products are produced when applied, high resistance to mechanical action, high resistance to chemicals, excellent cold-check resistance, possibility of finishing all substrate types, different decorative effects can be achieved.

Two-component polyurethanes cure through the reaction between isocyanate compound and polyol. By adequate formulation of various polymers (resins) and isocyanates, the coatings of excellent flexibility, hardness, abrasion resistance and resistance to chemicals are obtained.

On the polyol side, various hydrofunctional resins can be used. In the field of wood protection, the resins based on polyesters or polyesters modified with fatty acids. So far hardly used hydroxyfunctional polyacrylate types are ever more in use, while polyether types are not used for wood coatings. In many cases, adequate alkyd resins can be applied, where usually short chain oil types are used.

The use of alkyd resins enables the coating production at reasonable price. Acrylate modified alkyds combine with aliphatic polyisocyanate. Adding copolymerizate such as cellulose ester, rapidly sandable polyurethane coatings are obtained. These are flexible, well resistant, light stable and solvent resistant. Coating of higher quality is obtained if, under two component coating on acrylate alkyd base, UV waxy-base coat.

Abrasion resistance is particularly demanded for floor finishes. The investigations showed that abrasion resistance of polyurethane coatings cannot be achieved with no other classic system. It is shown that alkyd coatings after 100 cycles on Taber-abraser lost over 100 mg, acid curing - 50 mg, and polyurethane coatings from 10 to 25 mg. This is proved in service.

In this paper, resistance to liquids - alcohol, acetone, water, coffee, coca cola; heat resistance and scratch resistance were examined. Various types of polyurethane coatings are comparatively analyzed, and then, results were compared with those obtained for nitrocellulose and acid curing coatings - the other two types of the most used classic coatings. In this way, the possibility of applying these materials in various fields of exploitation is examined.

2. METHODS AND MATERIAL

For the investigation, the following types of coatings are used: nitrocellulose transparent opaque coat, acid curing transparent glossy, polyurethane transparent opaque, polyurethane white glossy and polyurethane white opaque. The coatings are taken from different manufacturers. As substrate, MDF board of 4 mm thickness was used. The coating was applied by spraying in the system: three base coats and one top coat.

Resistance to liquids is tested according to the international and Serbian standard ISO 4211 and SRPS D.E8.218. Filter paper of 25 mm diameter is immersed in the chosen test liquids and then placed

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on the tested area, where remained the following test periods: 10 s, 2 min, 1 h and 6 h. Test periods correspond the real exploitation cases of liquid removal from the surface as shown in the Table 1.

Table 1 - Test periods

Period	Removal
10 s	Immediate removal
2 min	Immediate removal
10 min	After a short time
1 h	After a meal or similar
6 h	After work or other activity
16 h	As soon as possible next day
24 h	After one day
7 days	After one week
28 days	Long-term action

Chosen test liquids are: distilled water, ethanol, acetone, coca cola, coffee. These are chosen as the liquids in domestic use that can have considerable destructive action against coatings on wood surfaces, as some studies showed [2, 3, 4]. The changes on the

surface are rated according to the above mentioned ISO and SRPS standards from 5 to 1 after cleaning and conditioning of the surface in the period of 24 h.

The heat resistance is determined according to Serbian standard (SRPS.D.E8.220). The method applies aluminium cup filled with mineral oil. The cup was heated and placed on the surface and left for 30 min. The applied temperatures are: 100°C, 130°C, 150°C, 180°C. 24 hours after removing the cup, the surfaces were examined under the light from different angles and any change or defect on the surface was determined.

Scratch resistance was determined by hardness test rod - Erichsen (model 318) with marking stylus 1 mm diameter. The spring tension is set with the help of the slider. The assesment of the resistance is made according to the standard DIN 68861/4. The criterion is the lowest applied force which produce the scratch.

3. RESULTS AND DISCUSSION

The results of determination of resistance to liquids are shown in Table 2, scratch resistance in Table 3 and heat resistance in Table 4.

Table 2 - Results of determination of resistance to liquids

Liquid	Coating	NC transp.	SH transp.	PU transp. (1)	PU transp. (2)	PU transp. (3)	PU pigmen. (1)	PU pigmen. (2)
	Test period	Resistance to liquids (according to ISO)						
Acetone	10 s	2	5	5	5	5	5	5
	2 min	2	5	5	4	4	4	4
	10 min	2	5	4	3	4	3	3
	1 h	1	4	3	3	3	3	3
	6 h	1	4	3	3	2	3	3
Alcohol	10 s	4	5	5	5	5	5	5
	2 min	4	5	5	4	4	5	5
	10 min	3	5	5	4	4	5	5
	1 h	3	5	5	4	4	5	5
	6 h	2	4	5	4	4	4	5
Distilled water	10 s	5	5	5	5	5	5	5
	2 min	5	5	5	5	5	5	5
	10 min	5	5	5	5	5	5	5
	1 h	5	5	5	5	5	5	5
	6 h	5	5	5	5	5	5	5
Coffee	10 s	5	5	5	5	5	5	5
	2 min	5	5	5	5	5	5	5
	10 min	5	5	5	5	5	5	5
	1 h	5	5	5	5	5	5	5

	6 h	5	5	5	5	5	5	5
Coca Cola	10 s	5	5	5	5	5	5	5
	2 min	5	5	5	5	5	5	5
	10 min	5	5	5	5	5	5	5
	1 h	5	5	5	5	5	5	5
	6 h	5	5	5	5	5	5	5

Table 3 - Results of scratch resistance determination

Coating	NC transp.	SH transp.	PU transp. (1)	PU transp. (2)	PU transp. (3)	PU pigmen. (1)	PU pigmen. (2)
Applied force (N)	8.0	12.0	11.0	13.0	13.0	11.0	14.0
Class (DIN)	A	A	A	A	A	A	A

The results shown in Table 2, showed that all applied types of coating are resistant to water, coffee and coca cola, both, in short-term and long-term action, and when the liquid remains on the surface even 6 hours will not cause any damage or change on the surface. Nitrocellulose coating is much more sensitive to alcohol and acetone in opposite to acid curing and polyurethane coatings and the changes on the surface are noticed already after 10 s. Acetone even in short period causes the changes in the structure of the surface. Alcohol (ethanol) does not produce any visible changes, not even the change in lustre, on acid curing and polyurethane coatings, if removed in 2 minutes. In longer periods slight marks with change in lustre remain on the surface of some polyurethanes. Acetone, on the same coating types, after 2 min causes the change of lustre, and after 10 min slightly visible marks, but without change in the structure of the coating. According to the alcohol action, acid curing and polyurethane coatings had

similar behaviour, while according to the acetone action acid curing coating was more resistant.

According to DIN standard, all applied coatings: nitrocellulose, acid curing and polyurethane, regarding the scratch resistance, belong to, and so can be considered as high resistant coatings. If these coatings are compared, it could be noticed that nitrocellulose coatings give more resistant surfaces with similar values.

Regarding the heat action, polyurethane coatings show excellent resistance and higher one comparing with other types of coatings. Namely, the changes of surfaces are not induced neither by the temperature of 180°C. On acid curing coating, the changes are noticeable only at 180°C, as slightly noticeable marks. Slightly noticeable marks, visible from various direction, on nitrocellulose coating are observed at temperature of 150°C, what still can be considered as good resistance.

Table 4 - Results of heat resistance determination

Applied temp. (°C)	NC transp.	SH transp.	PU transp. (1)	PU transp. (2)	PU transp. (3)	PU pigmen. (1)	PU pigmen. (2)
100	-	-	-	-	-	-	-
130	-	-	-	-	-	-	-
150	3	-	-	-	-	-	-
180	3	3	-	-	-	-	-

Results of some investigations [5] showed that, generally speaking, polyurethane coatings and decorative materials have similar behaviour under the heat action, i.e. that belong to the same resistance class and that can be used in the same exploitation

conditions, where these resistances are decisive, such as for top boards. Both materials vary from medium resistant to high resistant. The highest resistance is observed at some laminates and some types of

polyurethanes. PVC foils and decorative papers are less resistant.

Polyurethane coatings on alkyd base show good properties for use in furniture finishing. Sensibility to the action of some liquids - alcohol and acetone limits them partly the use for horizontal surfaces such as kitchen tops and tables. According to [1] it comprises the furniture groups from C to F. For groups A and B, i.e. for special uses such as kitchen tops, bathroom furniture, table tops, bars etc., decorative materials - laminates or coatings as polyurethane, wherein the resin (polyol) is modified and special catalyst is applied, are to be used [5, 7,8].

4. CONCLUSION

From the investigated coatings - nitrocellulose, acid curing and polyurethane, nitrocellulose coatings, according to heat resistance, scratch resistance and resistant to acetone and alcohol show the lowest values, while acid curing and polyurethane coatings show sufficient properties for use for furniture finishing. The analysis of various polyurethane coatings deriving from different producers indicates that they do not differ a lot. For special use, i.e. in extremely severe conditions, decorative materials - laminates or specially modified polyurethane coatings are to be applied. In other, normal exploitation conditions, polyurethanes on alkyd base give good results.

IZVOD

KVALITET POVRŠINE DRVETA OBRAĐENOG POLIURETANSKIM PREMAZOM

U ovom radu ispitivana je otpornost na tečnosti - alkohol, aceton, vodu, kafu, Coca Colu; otpornost na toplotu i otpornost na grebanje. Komparativno su ispitivani različiti tipovi poliuretanskih premaza, a zatim su rezultati upoređeni sa rezultatima dobijenim za nitroceluloze i kiselinski-očvršćavajuće premaze - druga dva tipa najčešće korišćenih klasičnih premaza. Na ovaj način je ispitana mogućnost primene ovih materijala u različitim oblastima eksploatacije. Nitrocelulozni premazi pokazali su najniže vrednosti, dok su kiselinski-očvršćavajući i poliuretanski premazi pokazali zadovoljavajuća svojstva za upotrebu za obradu nameštaja.

Ključne reči: *premazi za drvo, poliuretanski premazi, otpornost na tečnosti, otpornost na toplotu, otpornost na grebanje*

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