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RESISTANCE OF WOODEN LACQUERED SURFACE TO ABRASION

Anastasija Temelkova

Ss. Cyril and Methodius University in Skopje, Republic of North Macedonia,
Faculty of Design and Technologies of Furniture and interior – Skopje
e-mail: temelkova@fdtme.ukim.edu.mk

ABSTRACT

In this study, the resistance of lacquered wood surfaces to abrasion was analyzed. The samples for varnishing were previously prepared by the second level and third level of grinding. Further, the samples were surface treated with 2K polyurethane coating and modified 2K alkyd-urethane coating. This study aims to determine which of the used coatings will give better resistance to abrasion. The test results show that surfaces treated with modified 2K alkyd-urethane coating give greater resistance to abrasion compared to the surfaces treated with 2K polyurethane coating.

Keywords: surface, resistance, abrasion, grinding, 2K polyurethane coating, 2K alkyd-urethane coating.

1. INTRODUCTION

Surface treatment of wood is the last phase in production of final products. The basic functions of the appropriate surface treatment are protection of the surface from mechanical and chemical influences, decorative surface treatment, increase of the use-values of the product (material and conceptual values) and protection of the surface during use in the external environment in the form of physical and chemical protection on the wood. (Jaić, Milan., Palija, Tanja, 2010)

One of the most important factors that determine the quality of wood surface treatment is the choice of substrate and its preparation. It is important for the substrates not to have too high or too low humidity, the surface to be treated to satisfactory quality and the ingredients of the substrate not to affect the coating. Grinding has a direct impact on the spillage and consumption of the coating material. It also affects the connection between the coating and the substrate, the coverage, and also the properties of the formed dry film (adhesion, gloss, thickness). (Манева, Анастасија, Манев, Трајче, 2007)

The materials used for wood surface treatment must be mutually compatible and adapted. They must not act aggressively on each other or influence the change of composition, both the substrates and the coatings. Attention should also be paid to the properties of the substrate, so as not to overlook some components of bonding and hardening of surface treatment materials. (Jaić, Milan.,Živanović-Trbojevći Rajka, 2000)

After drying and hardening of the coating, the surface should remain dry film in quantity, actually thickness, sufficient for the coating to realize its basic function - protective and aesthetic. (Jaić, Milan.,Živanović Rajka, 1993)

Coatings must be elastic enough to follow the movement of the wood due to hygroscopicity, as well to withstand smaller deformations due to mechanical impacts that occur during exploitation, and at the same time must be hard and resistant to scratching, wear, etc. (Ljuljka, Boris 1990)

In this research, the resistance of lacquered surfaces to mechanical impact expressed through abrasion resistance will be examined. All samples are varnished with two layers of polyurethane basic

coating, while two different types of coatings were used for the final varnish: 2K polyurethane coating and 2K alkyd-urethane coating.

2. MATERIAL AND METHODS

2.1. Sample preparation

Samples of two wood types were used in the study: spruce (Picea abies Karst.) and oak (Quercus robur L.). The samples had dimensions 200X100X15 mm and were obtained by cutting planks with tangential cross-section, without errors. The humidity of the spruce samples was 7.76%, and the humidity of the oak samples was 9.24%. To obtain flat and smooth surfaces of the samples, the samples were ground on the upper side of a wide-band grinding machine (manufacturer Casolin, Italy) with a pressure beam. The grinding speed was 17 m/s, and the accessory movement speed was 20 m/min. Grinding was performed using a grinding paper numbered $N^0$80. Then half of the samples were processed with I grinding system (second level of grinding with numbering $N^0$120+ $N^0$150), and the other half with II grinding system (third level of grinding with numbering $N^0$120+ $N^0$150 + $N^0$200). After grinding, the samples were varnished with a basic 2K polyurethane coating (manufacturer „Zorkacolor“, Skopje), applied in two layers by air spraying, applying a pressure of 3 bar. The basic coating was prepared by mixing components A and B immediately before application in ratio of mixing 2:1. The diameter of the gun nozzle was 1.2 mm. During spraying, a constant distance of the gun from the object of 250 mm was maintained. The spraying was performed in controlled conditions of the working room with an air temperature of 21 ^{0}C and relative humidity of the air of 60%. After hardening of the basic coatings and before applying the final coating, intermediate grinding was performed manually with grinding paper numbering N^0 240. Two types of final coating were used, 2K polyurethane coating and 2K alkyd-urethane coating (manufacturer „Zorkacolor“, Skopje). The final coatings were applied in one layer, following the same procedure as the basic coating, and were prepared by mixing components A and B immediately before application. The basic parameters of the application of the final coatings are shown in Table 1.

Table 1. *Basic parameters of application of the final coatings*

Parameter	**Type of final coating**	
	2K polyurethane coating	*2K alkyd-urethane coating*
Viscosity of coating	20s (F4/20 ^{0}C)	22s (F4/20 ^{0}C)
Terms of mixing A:B	2:1	1:1
Temperature of coating	20 ^{0}C	20 ^{0}C
Amount of alluvium	180 g/m^2 ± 5%	170 g/m^2 ± 5%

2.2. Determination of resistance to abrasion

The determination of the property of abrasion resistance was performed by a method of rotation of abrasive wheels, in practice recognizable and known by the device that works on this principle the so-called Taber Abraser (Figure 1). The device consists of a sample carrier that has a circular shape and a central shaft to which the sample is attached, and above it there is a horizontal shaft with abrasive wheels. Abrasion is performed by rotating the sample carrier at a speed of 60 c/min under rotating wheels acting with a force of 5.5 N on a sample. The sample was exposed to abrasion until a predetermined number of cycles was reached or grinding all coating. The number of cycles is read and adjusted on the device counter.

Abrasion resistance can be expressed based on a recommendation of individual methods of instrument manufacturers, through several cycles, wear index, mass loss, volume loss, number of cycles per unit thickness and wear thickness. The number of cycles was taken as a measure up to complete grinding of the coating to the substrate, or visual assessment of the obvious changes in the appearance of the surface.

The test result is taken as a change in the mass of the samples for the range of cycles from 0 to 700, which removes the film layer that is a characteristic of coating in terms of abrasion resistance.

Figure 1. *Test Instrument for resistant of abrasion – Taber Abraser*

Figure 2. *Testing resistance of abrasion on Taber Abraser*

3. RESULTS AND DISCUSSION

Table 2 presents the results of testing the film of coating resistance to abrasion of the lacquered surfaces of spruce and oak samples.

Table 2. *Results of the examination of the resistance of the coating film of abrasion*

Nr	Wood base/ grinding system	Sample mass (g)	Ord. numb.	Wood base/ grinding system	Sample mass (g)
Number of cycles: 0					
Basic polyurethane coating *2x* + *Final* polyurethane coating *1x*					
1.	Spruce / I	55.89	5.	Oak / I	111.89
2.	Spruce / II	63.91	6.	Oak / II	109.24
Basic polyurethane coating 2x + Final alkyd-urethane coating 1x					
3.	Spruce / I	66.57	7.	Oak / I	112.63
4.	Spruce / II	57.41	8.	Oak / II	110.39

Number of cycles: 100					
Basic polyurethane coating *2x + Final* polyurethane coating *1x*					
1.	Spruce / I	55.79	5.	Oak / I	111.79
2.	Spruce / II	63.81	6.	Oak / II	109.17
Basic polyurethane coating 2x + Final alkyd-urethane coating 1x					
3.	Spruce / I	66.51	7.	Oak / I	112.58
4.	Spruce / II	57.26	8.	Oak / II	110.33
Number of cycles: 200					
Basic polyurethane coating *2x + Final* polyurethane coating *1x*					
1.	Spruce / I	55.71	5.	Oak / I	111.70
2.	Spruce / II	63.72	6.	Oak / II	109.09
Basic polyurethane coating 2x + Final alkyd-urethane coating 1x					
3.	Spruce / I	66.45	7.	Oak / I	112.52
4.	Spruce / II	57.21	8.	Oak / II	110.27
Number of cycles: 300					
Basic polyurethane coating *2x + Final* polyurethane coating *1x*					
1.	Spruce / I	55.63	5.	Oak / I	111.62
2.	Spruce / II	63.64	6.	Oak / II	109.01
Basic polyurethane coating 2x + Final alkyd-urethane coating 1x					
3.	Spruce / I	66.39	7.	Oak / I	112.47
4.	Spruce / II	57.15	8.	Oak / II	110.21
Number of cycles: 400					
Basic polyurethane coating *2x + Final* polyurethane coating *1x*					
1.	Spruce / I	55.54	5.	Oak / I	111.50
2.	Spruce / II	63.55	6.	Oak / II	108.92
Basic polyurethane coating 2x + Final alkyd-urethane coating 1x					
3.	Spruce / I	66.33	7.	Oak / I	112.41
4.	Spruce / II	57.09	8.	Oak / II	110.15
Number of cycles: 500					
Basic polyurethane coating *2x + Final* polyurethane coating *1x*					
1.	Spruce / I	55.41	5.	Oak / I	111.36
2.	Spruce / II	63.44	6.	Oak / II	108.81
Basic polyurethane coating 2x + Final alkyd-urethane coating 1x					
3.	Spruce / I	66.25	7.	Oak / I	112.35
4.	Spruce / II	57.03	8.	Oak / II	110.08
Number of cycles: 600					
Basic polyurethane coating *2x + Final* polyurethane coating *1x*					
1.	Spruce / I	55.26	5.	Oak / I	111.23
2.	Spruce / II	63.32	6.	Oak / II	108.68
Basic polyurethane coating 2x + Final alkyd-urethane coating 1x					
3.	Spruce / I	66.14	7.	Oak / I	112.26
4.	Spruce / II	56.96	8.	Oak / II	110.00
Number of cycles: 700					
Basic polyurethane coating *2x + Final* polyurethane coating *1x*					
1.	Spruce / I	55.12	5.	Oak / I	111.10
2.	Spruce / II	63.18	6.	Oak / II	108.55
Basic polyurethane coating 2x + Final alkyd-urethane coating 1x					
3.	Spruce / I	66.02	7.	Oak / I	112.17
4.	Spruce / II	56.86	8.	Oak / II	109.91

With analysis of the obtained results, it can be seen that the choice of the type of applied coating affects abrasion. By removing a layer of the coating after a certain number of cycles, the initial mass of the coating is reduced. In this research, the maximum number of cycles was 700 cycles. The size of the removed coating layer indicates the property of the coating which refers to abrasion resistance. Of the two types of coatings applied, the final 2K alkyd-urethane coating showed better abrasion resistance, in both wood species and for both grinding systems. The mass loss of the coating on spruce substrate was 0.55 g and on oak substrate 0.48 g. The final 2K polyurethane coating showed lower abrasion resistance than the final 2K alkyd-urethane coating and the mass loss of the coating on spruce substrate was 0.77 g and on oak substrate 0.79 g.

The samples treated with 2K alkyd-urethane coating showed better protection of the surfaces under mechanical loads. Previous studies have shown that the application of 2K alkyd-urethane coating in the final layer leads to greater resistance to mechanical influences expressed through greater adhesion, compared to the application of 2K acrylic-isocyanate and 2K polyurethane coating. (Jaić, Milan., Palija, Tanja, 2012)

The results of determining the resistance of lacquered surfaces to abrasion are shown graphically in Figures 3,4,5 and 6.

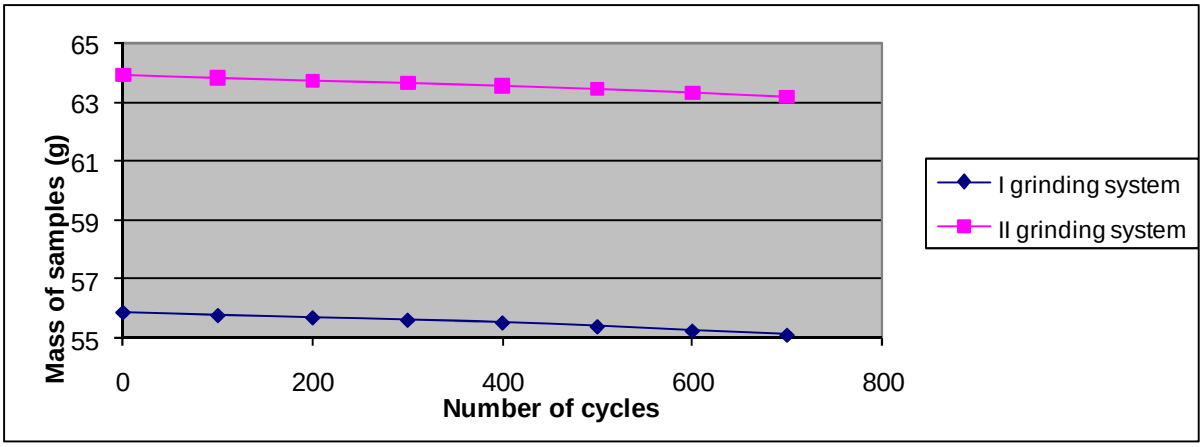

Figure. 3. *Resistance of abrasion of samples of spruce lacquered with 2K final polyurethane coating*

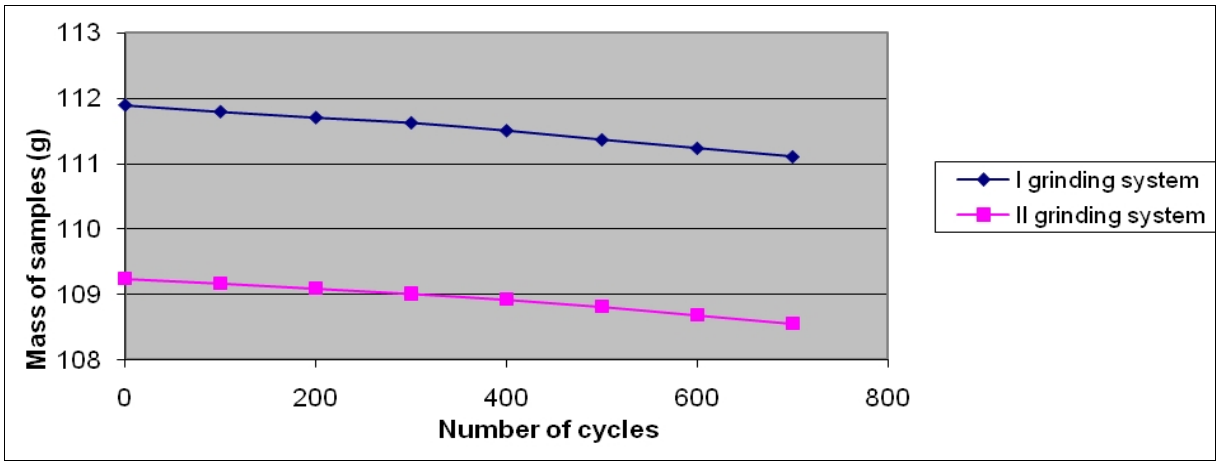

Figure 4. *Resistance of abrasion of samples of oak lacquered with 2K final polyurethane coating*

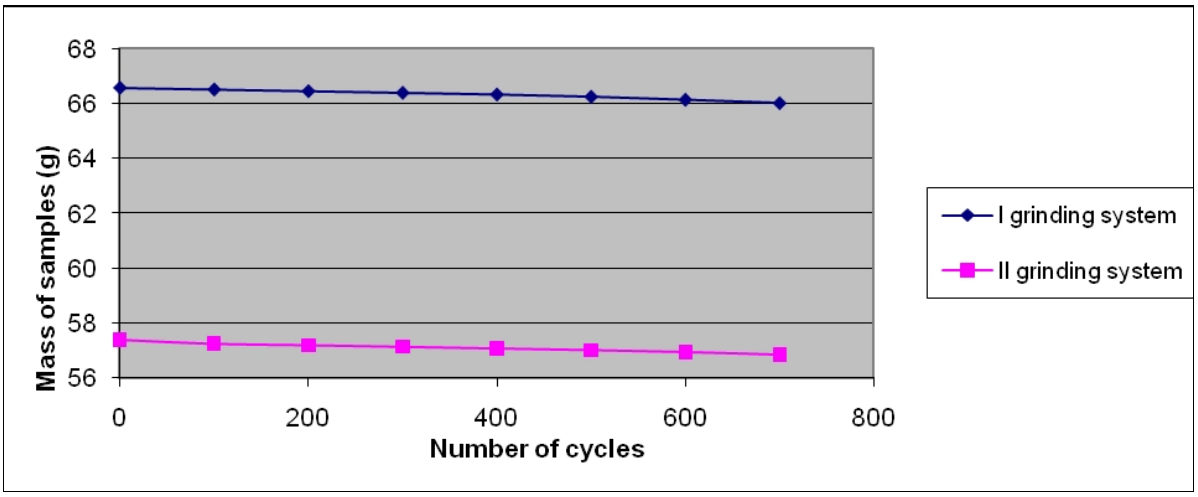

Figure 5. *Resistance of abrasion of samples of spruce lacquered with 2K final alkyd-urethane coating*

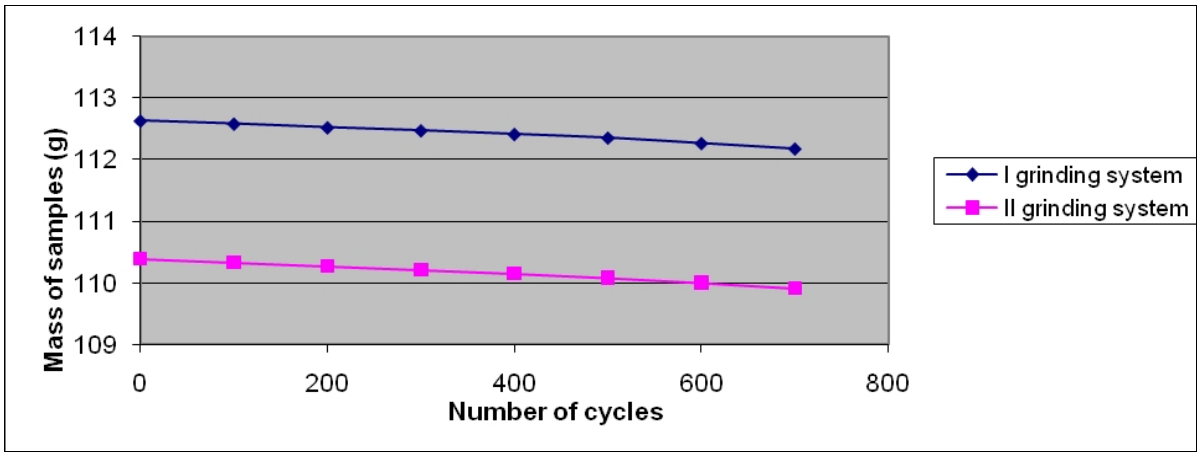

Figure 6. *Resistance of abrasion of samples of oak lacquered with 2K final alkyd-urethane coating*

4. CONCLUSION

The results of the research showed that the type of wood, as well as the grinding system, do not have a significant impact on abrasion resistance.

From the aspect of the surface treatment system, it can be concluded that a greater loss of mass of the coating after abrasion is obtained when for varnishing 2K polyurethane coating is applied, which indicates bad abrasion resistance.

Samples varnished with 2K alkyd-urethane coating showed higher abrasion resistance.

Based on the above, it can be concluded that by modifying the type of coating in the finished layer, higher abrasion resistance can be achieved. Modified systems of polyurethane coatings provide the necessary resistance of varnished surfaces to mechanical influences.

REFERENCES

[1] Jaić, Milan., Palija, Tanja. „Uticaj vrste drveta i sistema površinske obrade na adheziju premaza", *Zaštita materijala*, (2012): str. 299-303.

[2] Jaić, Milan., Palija, Tanja. „Dosadašnji razvoj u trend površinske obrade drveta". XII YuCorr International Conference *COOPERATION OF RESEARCHERS OF DIFFERENT BRANCHES IN THE FIELDS OF CORROSION, MATERIALS PROTECTION AND ENVIRONMENTAL PROTECTION*, Tara, Srbija,18-21. May (2010): str. 36-37

[3] Jaić, Milan.,Živanović Rajka. Površinska obrada drveta-Svojstva materijala, kvalitet obrade. Beograd: SITZAMS, 1993.
[4] Jaić, Milan.,Živanović-Trbojevći Rajka. Površinska obrada drveta-Teorijske osnove, tehnološki procesi, Beograd:, 2000.
[5] Ljuljka, Boris. Površinska obrada drveta. Zagreb:1990.
[6] Maneva, Anastasija, Manev, Trajce. „Vlijanie na brusenje i bajcuvanje na kvalitetot na furnirani povrsini", *Medgunaroden simpozium, Zbornik na trudovi*, Ohrid, 24-26 Oktomvri, (2007): str. 428-431.(in Macedonia).