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Relations between Varnish Type and Color Changes of Wood Material

E.Seda Erdinler[1]–Tuncer Dilik [2]–Ender HAZIR[3]–Emel Öztürk[4]*

[1] Assistant Professor E.Seda Erdinler, Istanbul University, Faculty of Forestry, Department of Forest Industry Engineerig, 34473 Istanbul – Turkey
* *Corresponding author*
seda@istanbul.edu.tr
[2] Associate Professor Dr, Istanbul University, Faculty of Forestry, Department of Forest Industry Engineerig, 34473 Istanbul – Turkey
tuncerd@istanbul.edu.tr
[3] Research Assistant, Istanbul University, Faculty of Forestry, Department of Forest Industry Engineerig, 34473 Istanbul – Turkey
ender.hazir@istanbul.edu.tr
[4] Research Assistant, Istanbul University, Faculty of Forestry, Department of Forest Industry Engineerig, 34473 Istanbul – Turkey
emelozt@istanbul.edu.tr

Abstract

Wooden material takes an important place in life with its natural structure and psychological effect. Color is an important parameter to emphasize the aesthetic appearance of the material and the surface. One of the important stages is varnishing. As known, varnish provides prevention as well as good appearance for wooden materials. Several varnish types are used in industrial applications with respect to the developing technology and the structure of the materials becomes more important with the environmental awareness. Varnish types may cause positive or negative effects on the color of wooden material. For this reason, determination of color changes of wood by investigating the changes in varnish types on wood according to their utilization is important. Varnish applications may have both positive and negative effects on natural wood color. Determination of these effects would be important to meet the expectations according to the utilization fields. In this frame, background for necessary information for appropriate application in the industry will be provided. The results from this study will be supported by future studies to determine varnish type and wooden material sufficiency. Appropriate varnish selection occurs by the determination of the effects of varnish types on different wooden materials. In the study color values are in accordance to TS 6611 EN ISO 3668 and ASTM D 2244-3.

***Keywords*:** A. Color change, B. Wooden, C. Surface color, D. Varnish type, E. Surface treatment

Introduction

Wooden and wood based materials are one of the most widely used product groups. With their both industrial use and furniture and decoration use, wood based products directly affect the

quality of life. The basic reasons why wood based materials are used for industrial purposes can be listed as obtaining economic and wide surfaces, being used as a filling or bearing purpose and being able to be equipped with technological needs required by the setting. For the end-consumer use, wooden materials are preferred as first option due to their visual quality, warm life experience feeling and acoustic characteristics. The most important characteristic reflected by the wooden material in industrial use or end-consumer use is the rich natural color and appearance it offers. It's been endeavored to protect, feature or make this richness permanent in industrial applications. As is known, the natural beauty and live appearance of wooden material is affected more or less during the surface treatments. The color of the material changes after it is exposed to natural atmospheric conditions for a long time, changes. For example, the color of oak, walnut and mahogany under natural use becomes darker, while the color of maple and ash tree turns pale [1-7]. Coloring treatment is applied for changing the specific color of the wooden material, guaranteeing a unified appearance in mass production and removing the lines and spots arising from the natural appearance of the material. While color is a very positive characteristic when it can be taken under control and remain between esthetic lines, it can also cause undesired situations due to lack of application, method and material. Therefore, color measurements can be used in various fields in various industries such as food [8-11]. Considering the limited amount of studies carried out on the wooden materials, aging related color difference has always been an important study topic. The color of the wooden material may change due to various chemicals used in the production of surface treatment materials, and the color difference effect of varnish is also inevitable due to its own color. In this regard, the varnishes with highest color difference effect are the synthetic and polyurethane varnishes. Therefore, the expected color effect must be taken into account in all surface layer treatments [1, 3, 5, 6, 12].

Materials and Methods

Materials: Massive Abies is used in the study. Cellulosic and water based transparent varnish is selected as the surface treatment material to see its effect on the natural color system.

Method: Test applications take the national and international standards into account. Test design and sample pattern are as shown in Table 1. During the study, minimum 2 and maximum 4 layers of surface treatment is applied including the filling layer. In this context, the layer thicknesses obtained have been measured with PosiTector Probe 200 and color measurements have been carried out with HunterLab MiniScan EZ at $D65/10^0$ according to CIEL* a*, b* basis [13-15].

Table 1: Test design and sample pattern used in the study (*)

Wooden material	Varnish type	Application	No. of samples	Treat. 1	Treat. 2	Treat. 3	Treat. 4
Abies (*Abies bornmılleriana* Mattf.) (Massive wood prepared in calibrated 18x100x1000 mm size)	Cellulosic Varnish	2 layers	5	Filling	Filling		
		3 layers	5	Filling	Filling	Finish	
		4 layers	5	Filling	Filling	Finish	Finish
	Water Based Varnish	2 layers	5	Filling	Filling		
		3 layers	5	Filling	Filling	Finish	
		4 layers	5	Filling	Filling	Finish	Finish

(*) All applications are carried out with spray gun according to the instructions of the company with the varnishes produced by the same company.

Results

The layer thicknesses obtained in the study and the color values measured are provided in Table 2. Based on these findings, the layer thickness and color correlation of different varnish types on color difference effect is illustrated in Figure 1. In the assessments, the color system of the non-varnish part is taken as the basis for natural color system as control sample. Therefore, it's been ensured that the varnished and non-varnished surfaces of the same part are subjected to the same preliminary preparation treatments before the application. Thus, the comparisons are made between the color systems of varnished and non-varnished surfaces of the same part and it's been tried to determine the effect of varnishes on color difference.

Table 1: Results related to layer thickness obtained in the study and color systems.

Varnish type	Application	Layer Thickn. (micron)	Natural Color System L* a* b*	Color difference (ΔE)1	Varnished Color System L* a* b*	Color difference (ΔE)2	Color Difference[(1)] (ΔE)*
Cellulosic Varnish	2 Layers	76	90,88 - 2,61 - 18,48	90,81	86,11 - 2,61 - 20,95	88,25	2,56
	3 Layers	107	87,85 - 2,87 - 18,99	89,58	83,85 - 3,70 - 23,66	86,82	2,76
	4 Layers	120	89,20 - 2,88 - 18,81	90,89	86,21 - 2,02 - 20,14	88,13	2,76
Water Based Varnish	2 Layers	69	89,34 - 2,29 - 17,13	90,59	86,16 - 2,72 - 20,57	88,34	2,25
	3 Layers	73	90,31 - 2,30 - 17,59	91,54	87,35 - 2,89 - 20,01	89,07	2,47
	4 Layers	98	88,62 - 2,68 - 18,43	90,06	86,76 - 2,99 - 21,16	88,89	1,17

[(1)] (ΔE)* = (ΔE)1 - (ΔE)2

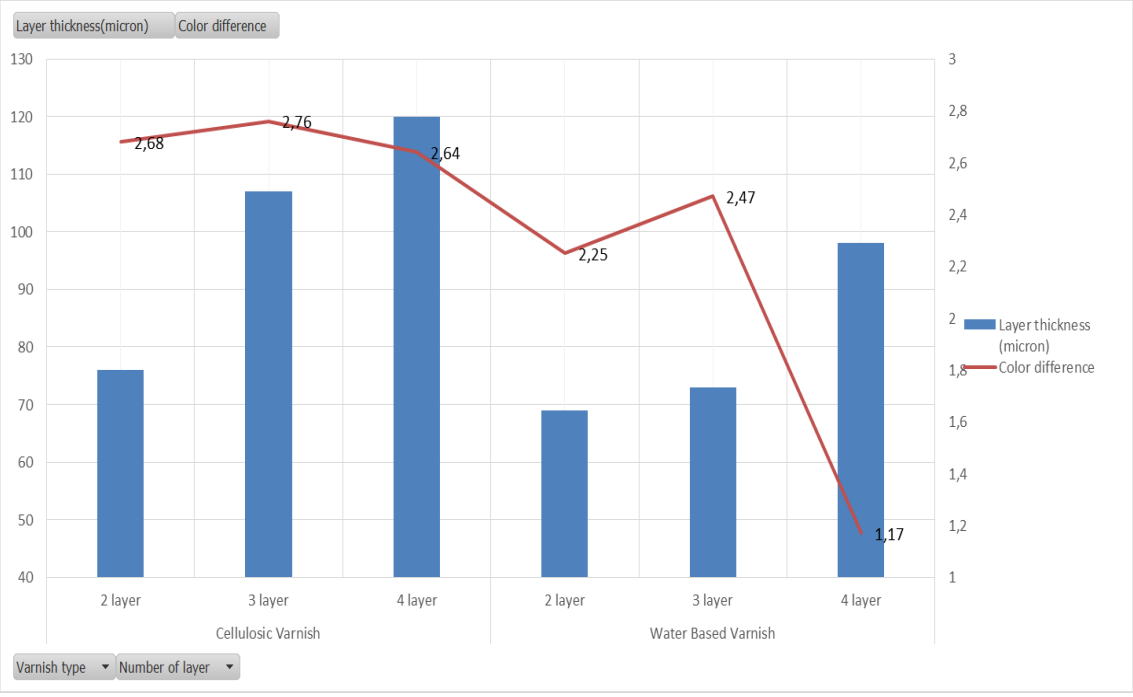

Figure 1: Layer thickness and color correlation in varnish application

As it can be seen from the examination of the values in the table and the graphics in the figure, for the color difference effect **(ΔE)*** of the varnishes on the natural color system, the highest value of 2,76 in cellulosic varnish is obtained in 3-layer and 4-layer applications, while the highest value of 2,47 in water based varnishes is obtained in 3-layer application. On the other hand, it's clearly seen that the varnish types have a changing effect on L* (color brightness value), a* (red color tone value) and b* (yellow color tone value) constituting the color system. As it can be seen in various studies [2, 7], this study also reveals the important effect of different layer thickness application on L*, a* and b* values. For the effect of varnish on color brightness, the highest value of 87,35 is determined in water based varnish with 3-layer application, while the lowest value of 83,85 is obtained in cellulosic varnish with 3-layer application. For the effect of varnish on red color tone, the highest value of 3,70 is obtained in cellulosic varnish with 3-layer application, while the lowest value of 2,02 is obtained in cellulosic varnish with 4-layer application. In water based varnish, the values are determined between 2,72 and 2,99. For the effect of varnish on yellow color tone, the highest value of 23,66 is obtained in cellulosic varnish with 3-layer, while the lowest value of 20,01 is obtained in water based varnish with 3-layer application. This allows observing the changing effect of varnish type and layer thickness on the natural color system and also reveals that cellulosic varnishes have higher color changing effect compared to water based varnishes on the same material. However, it's seen that color changing effect is more obvious in finish applications in cellulosic varnishes and more effective in filling layer applications in water based varnishes.

Conclusions

As a result, an evaluation, even partially, has been obtained on the degree the varnish type and number of layers, commonly used in the industrial application, meets the natural color appearance of the wooden material. It's been found out that the changing effect of the varnish type and layer thickness on the natural color system for the same material studied in this context is higher in cellulosic varnishes compared to water based varnishes. However, it's seen that color changing effect is more obvious in finishing applications of cellulosic varnish. In this case, the number of layers (layer thickness) in finishing applications of cellulosic varnish appears as a matter that should be taken into account. For the water based varnish application, it's seen that color changing effect is more effective in filling layer applications compared to finishing applications. Accordingly, the thing that should be taken into account in water based applications is the filling layer application. Thus, it's been considered that the results submitted would be effective in solving the problems and meeting the expectations related to coloring and appearance frequently encountered in protective surface layer treatments in the wood industry. However, it would be better to perform more detailed studies and control the layer thickness and color changing correlation in order to establish a complete numerical and parametric correlation.

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