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RESEARCH UPON ALDER VENEERS UNDER VISIBLE LIGHT INFLUENCE

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Abstract: *The present research work presents the sunlight influence upon the colour of veneers made of alder wood (Alnus glutinosa) exposed indoor, behind a window glass, during summer and autumn, respectively for 1, 3 and 5 months. The colour of veneer samples was determined by using a Chroma Meter Konika Minolta CR-410 device. The colour coordinates L^*, a^* and b^* were recorded before and after the exposure according to Standard ISO 7724-2. All colour coordinates supported variations with the exposure time. Alder veneers exposed to sunlight under indoor circumstances suffered a colour change, highlighted, generally, as a colour darkening and a tinge changing phenomenon.*

Key words: *colour, discoloration, veneers.*

1. Introduction

The wood of hardwood species used for decorative purposes is selected according to diverse criteria that are empirical and traditional.

The colour of wood represents an important aesthetic problem for all customers of wooden products.

Light-coloured wood species are preferred in wood industry nowadays, due to their pleasant appearance (ash, beech, maple, alder and birch).

Many researchers have studied the colour changes occurred on the surfaces of light-coloured wood species, due to the phenomenon of timber drying [19], [23], [4], [9], [10], [11] and natural weathering of wood [6], [5], [2], [17] or artificial weathering [21], [1] as well as the methods for preventing the discolorations by chemical treatments [8], [22], [3].

1.1. Discoloration Occurring On Veneer Surfaces

The colour of wood species and the colour variations among them represent a natural feature of wood which confers an attractive and pleasant appearance when compared to all substitutes of wood. It is impossible to keep the colour of wood as it appeared during cutting.

When the surface of wood is exposed to sunlight for a long period or under indoor circumstances, colour changes occur. These changes occur in the case of clear finishes as well.

In order to obtain a colour marker of the clear finishing effect, a simple wetting test of a small area can be done and thus the colour evaluation is rapidly obtained.

In the case of veneers, the colour changes are caused by influencing factors, such as: chemical reactions between the

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extractible substances and the adhesive components or the reaction with the material that the tools are made of and the exposure to sunlight.

The exposure to sunlight produces a gradual discoloration of dark wood species and the yellowing of light-coloured wood species. This type of modifications is limited to the surface layers of wood and the original colour may be obtained by planning.

UV inhibitors can be used in order to reduce the yellowing effect of timber made of light-coloured wood species.

Typical and common discolorations of veneers are to be mentioned: reddish and pink discoloration of cherry and beech; white discoloration of thermally treated beech; iron spots discoloration of oak; reddish discoloration of maple, ash and beech; pinkish discoloration of alder.

Under visible light all wood species change their colour. Veneers made of alder, cherry, birch and maple gradually darken while the colour of other wood species becomes highly darker (sapele veneers) and in the case of others a slow discoloration may be produced (jarrah veneers) [14].

1.2. The Motivation of Measuring the Colour of Wood

Wood industry remained behind the industry of food and fabrics, cosmetics and cars both in what the colorimetry approach is concerned. To depict wood as timber or veneer under colorimetric approach seems suitable and useful in order to classify the wood species and this would help to study the colour changes occurring on the wood surfaces by photo-oxidation or when drying but to suit the parts of furniture within the furniture set.

The colour is very important when furniture is acquired, in most cases it is more important than the nature, name and location of wood species.

All the reasons why the price of wood species is highly increased nowadays are well-understood when evaluating the aesthetic features of wood [7]. The colorimetric approach both on wood and veneers would facilitate a better understanding of their physical properties. The colour coefficients allow the classification of wood species and their location within a hierarchy of prices according to their colour.

This evaluation presents accuracy comparing to the visual one. All defects of wood and veneers may be recorded and located by using colorimetric coefficients, the elaboration of cutting patterns and its optimization may be also performed. Colour references are to be expected when agreed contracts as well.

1.3. Research Regarding the Colour Changes of Alder (Wood and Veneer)

The colour modification of alder wood under artificial light exposure was studied by Temiz [21]. Under UV radiations the surfaces of wood without protection became darker; it was established that the lignin depolymerisation on the exposed surfaces facilitated this phenomenon. Some treatments of colour preservation by using CCA and ACQ 1900 were used, they delayed the gradual photo-oxidation of lignin when compared to the fast-speed process occurred on non-treated pieces.

Oltean [13] performed research studies on the discoloration of some European wood species due to artificial light exposure under indoor circumstances. After 120 hours of exposure, a detailed classification of wood species was achieved according to CIELab system.

The redness coefficient for alder wood increased after 120 hours of exposure, a red colour appeared when reaching 600 hours of exposure. There were recorded colour differences lower than 3 units.

The colour changes of alder veneers were studied by Nowaczyk [12] in Poland and Aydin [2] in Turkey.

Aydin focused on colour reactions which occurred due to high drying temperatures and sunlight exposure under indoor circumstances as well as chemical treatments for preventing this discoloration.

The temperature caused the darkening of veneers colour and their roughness was also influenced by it.

As a result of the documentary research presented above, it is worth noticing that the colour changes occurring on the surfaces of timber or veneer represent an important economic problem requiring accurate scrutiny.

The profit in wood industry may be increased when knowing discolorations and the responsible factors.

2. Objective

The paper has as main objective to highlight the final results of the experimental research studies upon colour changes that appeared on the surfaces of alder veneers exposed to sunlight under indoor circumstances for 1, 3 and 5 months of exposure.

Experimental research studies upon colour of alder veneers exposed to direct sunlight influence under indoor circumstances were performed by the author as part of the PhD paper exclusively focused on *Alnus glutinosa* wood species.

Some preliminary results of these experiments were already published [16] as a comparative study on alder and cherry veneers due to their similar appearance:

- black alder presents a pale pinkish-brown colour, darkening somewhat when exposed to light;
- when suitably stained and finished, it is almost indistinguishable from cherry.

3. Material and Method

3.1. Wood Material

Veneers made of black alder (*Alnus glutinosa*) were used as materials.

The veneers were cut at LOSAN Company from logs after performing their thermal treatment at the temperature of 60-70 ºC for 10-12 hours.

Alder veneers were cut by half-round slicing method (Figure 1) and were dried at temperatures of 90-100 ºC.

Fig. 1. *Half-rounded slicing method*

The dimensions of the veneer samples used for this study were: 250 mm × 150 mm × 0.55 mm.

Five veneer samples were exposed to sunlight under indoor circumstances behind a window glass in order to evaluate the changes occurred after sunlight influence, for 1, 3 and 5 months during summer (June, June-August) and autumn (September and October).

3.2. Exposure Conditions

The exposure conditions (temperature and air-relative humidity) were daily recorded during these periods (Figure 2).

All data are presented in the following chart.

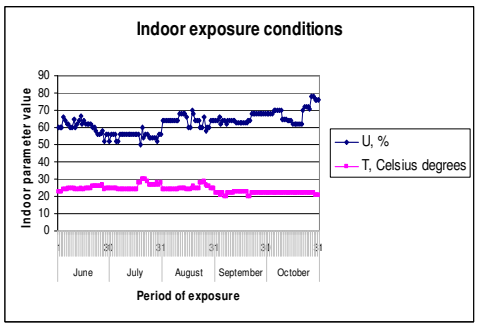

Fig. 2. *Indoor exposure conditions*

3.3. Colour Measurement

CIELAB colour-space has a unique location (see Figure 3) defined by its cartesian coordinates: L^*, a^* and b^*, where:

- L^* is the degree of lightness, ranging from white (100) to black (0) along a grey scale;
- a^* is the degree of redness and greenness;
- b^* is the degree of yellowness and blueness.

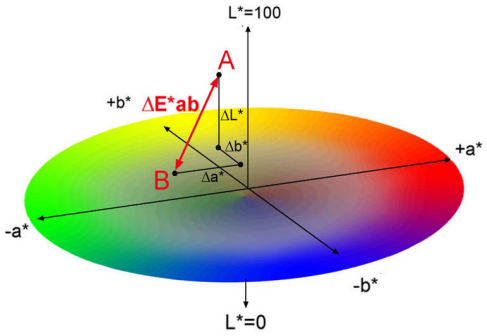

Fig. 3. *CIE L^* a^* b^* colour space*

In the present study, a Chroma Meter Konika Minolta CR-410 was used for colour measurements performed according to *ISO 7724-2*.

The device is presented in Figure 4.

On each veneer sheet 5 distinct circular areas (50 mm) were defined in order to record the colour parameters as presented in Figure 5.

Fig. 4. *Chroma Meter Konika Minolta CR-410*

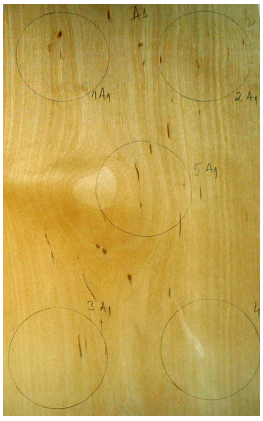

Fig. 5. *Circular areas defined on veneer sheets*

L^*, a^* and b^* colour coordinates were determined before and after the exposure under indoor circumstances.

The colour differences and the total colour changes ΔE^* were determined according to the following relations:

$$\Delta L^* = L^*_E - L^*_i, \quad (1)$$

$$\Delta a^* = a^*_E - a^*_i, \quad (2)$$

$$\Delta b^* = b^*_E - b^*_i, \quad (3)$$

$$\Delta E^* = \sqrt{\left((\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2\right)}. \quad (4)$$

Given that the subscript E and i indicate the values for the exposed samples and the control references, respectively.

A colour difference ΔE^* of 1-3 units is the smallest difference that can be discerned by the human eye [18].

4. Results and Discussions

All the $L^*a^*b^*$ colour space values obtained for alder veneers are presented within the following figures using the average values determined before and after the exposure for 1, 3 and 5 months.

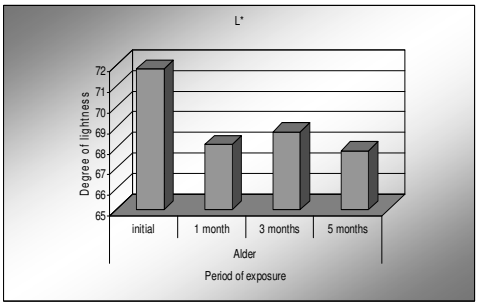

Fig. 6. *Degree of lightness L^* recorded before and after the sunlight exposure for 1, 3 and 5 months, under indoor circumstances, behind a window glass for veneers made of black alder*

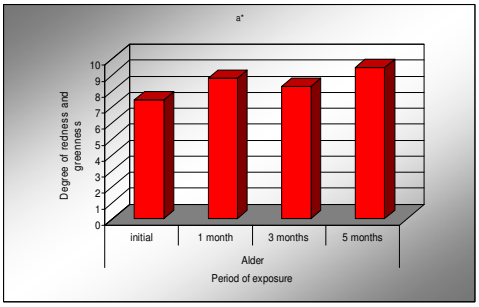

Fig. 7. *Degree of redness and greenness a^* recorded before and after the sunlight exposure for 1, 3 and 5 months, under indoor circumstances, behind a window glass for veneers made of black alder*

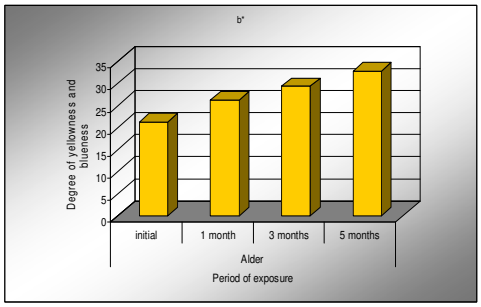

Fig. 8. *Degree of yellowness and blueness b^* recorded before and after the sunlight exposure for 1, 3 and 5 months, under indoor circumstances, behind a window glass for veneers made of black alder*

The colour differences and the total colour changes determined for alder veneers after the sunlight exposure for 1, 3 and 5 months of exposure are pointed out in Table 1.

Colour differences Table 1

Colour differences		ΔL^*	Δa^*	Δb^*	ΔE^*
Exposure	*Alnus glutinosa*				
	1 month	–3.67	1.36	5.00	6.35
	3 months	–3.05	0.85	8.07	8.67
	5 months	–3.97	2.03	11.54	12.37

The colour changes during the exposure period are presented in Figure 9.

The obtained results may be resumed as follows:

• A decrease of L^* values indicates the surface brownish, while their increase is specific to some lighter surfaces. The study results show that alder veneers presented a decrease of lightness within the exposure period, this being significantly pronounced after the first month of sunlight exposure.

The values of lightness L^* ranged from 71.82 as initial state to 67.85 after five months of sunlight exposure.

Fig. 9. *Colour differences of alder veneer*

• A decrease of a^* colour values means a passing tendency through the greenish tinge, while their increase corresponds to a reddish intensification. As resulted from the presented data, a^* values lightly and almost linearly increased with the exposure period. The surfaces of all veneers suffered a colour darkening with a reddish tendency. Significant colour differences were determined after five months of exposure when reaching a maximum of about 9.46 after five months of exposure.

• A decrease of b^* colour values shows the relation with a mauve tinge within the colour-space and their increase suggests a colour darkening. This colour coordinate increased with the exposure period, starting from 21.24 as the initial state up to 26.24 after the first month of exposure, being finally located within the colour-space as a maximum value of about 32.78 after the entire period of exposure.

• Total colour changes ΔE^* were highlighted right after the first month of exposure when reaching a value of about 6.35 units. As expected, the total colour changes were determined after five months of sunlight exposure, the maximum value being of about 12.37 units.

• When compared with the results obtained for cherry veneers [16], it is worth noticing that under sunlight influence, cherry veneer reacted more powerfully within the colour-space than alder did, recording the maximum colour differences of about 10.87 after one month of sunlight exposure.

• Under the same conditions and exposure periods (1 and 3 months), the two veneer species reacted differently: under sunlight influence, cherry veneer darkened much more than alder did.

Similar results on colour measurements were achieved by other researchers on different wood species.

Popa [15] focused on natural colour of alder, poplar and black locust and for natural alder wood the values recorded were: $L^* = 76.48$; $a^* = 12.59$ and $b^* = 23.84$.

Aydin [2] achieved interesting results after indoor exposure of alder and beech veneers and he obtained the total differences ΔE^* for alder veneers exposed for 1, 3 and 6 months as follows: 4.10 and 8.75 and 8.83 respectively.

5. Conclusions

The veneers exposed to sunlight under indoor circumstances suffered a colour change, highlighted, generally, as a colour darkening and a tinge changing phenomenon. Wood is capable to absorb all wavelengths of electromagnetic radiation to initiate photochemical reactions that may lead to wood discolorations. Because of its biological nature and sensitivity to light, unprotected wood is susceptible to weathering and photo-oxidative degradation.

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