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# Changes of surface brightness of MDF boards

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**Abstract:** *Changes of surface brightness of MDF boards*. The darker color of surface of MDF made of pine wood depends on technological parameters, e.g. production of fibers, drying, pressing in high temperature. There are two main ways to have a lighter color of panels. One of them is to reduce the temperature of selected production steps, which can result in decrease of efficiency. Second is to treat the wood fibers and/or panels surface by chemicals. In this work the results of application of four different chemicals to wood fibers and MDF panels are presented.

*Keywords:* fiber, fiberboard, brightness, color, surface

## INTRODUCTION

Customers of MDF often require a bright color of surfaces of raw board. This is due to the fact that a significant part of these boards is coated with laminates, thin layer of lacquers or paints, etc. with bright colors. Dark surface of raw boards make it difficult to obtain adequate color.

In Poland, the MDF boards are produced mainly from fibers of pine wood *(Pinus sylvestris.)*. This raw material has a quite bright color compare to many different wood species. The wood components change its color to much darker in the panels' production process. In polysaccharides, lignin and extractive substances changes occur as a result of exposure to high temperature, steam, air and others (Bekhta and Niemz 2003, Hsu et al. 1988). These changes occur during storing of raw material, chips refining process, fibers drying process and mats pressing in a hot press.

During storing of wood some physical and chemical changes can happen i.e. the evaporation of water, oxidation of the extractive substances, emission of volatile extractives, the initial process of enzymatic degradation (Ferrero et al. 2011). Color change depends on the conditions and time of storage of wood.

A major part of the color change occurs during pulping of wood chips, fibers drying and mat's pressing, because these operations are carried out at high temperatures (120 - 220$^0$C). At these temperatures and in the presence of water, the acetyl and formyl groups are separated from hemicelluloses and the organic acids (acetic and formic) are formed. Hemicelluloses are partially (5 - 10%) hydrolyzed under these conditions (Roffael et al. 2008).

The extractive substances, such as terpenes, can be emitted during heating of wood up to 200$^0$C (Roffael and Uhde 2012). It is also possible that some de-esterfication of fats and waxes occurs with further degradation. The substances such as resins can migrate to the surface of the fibers and cause a color change to darker (Spalt 1977).

Noticeable changes in the structure of lignin are initiate at temperature around 120$^0$C and with rising temperature the changes increase (Wartermark et al. 1995). The lignin at this temperature in the presence of steam is plasticized, and degradation process begins, mainly, ß-ether linkages are cleavage and degradation products are formed (Gierer 1982). These products (phenolic compounds, aldehydes, hydrocarbons and other) can be reactive with low molecular lignin parts (Lucia et al. 2001). These compounds (phenolic compounds,

carbohydrate, de-esterified waxes and fats) are reactive, since they have active groups such as: hydroxyls (-OH), carbonyls (-C=O), carboxylic groups (-COOH). As a result these secondary reactions colored compounds are formed (Chai et al. 2003, Gärtner et al.1999).

As mentioned, a brownish of the fibers surface can be observed during drying process. Probably some color reaction products are formed as a result of a low molecular carbohydrates and nitrogen components (Sj□str□m 1993).

Brighter color of MDF boards can be obtained, at least, two ways:
- selecting of technological parameters,
- treating the wood fibers by chemicals.

The selection of process parameters may consist in the application of appropriate temperatures, for example, during the defibration of wood chips. It is known that every $10^0$C a of temperature reduction, decreases chemical reaction rate 2 to 3 times. Thus, the fibers obtained at temperature of $130^0$C will undoubtedly have a lighter color than $150^0$C, but the efficiency of the production line drops down.

The second method – treatment of cellulosic and lignocellulosic fibers by suitable chemicals to improve their whiteness; this method is used in the paper industry. The experiences of this industry were used in this research.

The aim of research was to increase the brightness of the surface of the MDF through chemical treatment of fibers and surface of the panel.

## MATERIALS AND METHODS

Pulps and raw MDF boards for this study were obtained in two MDF factories. The samples were treated with one of four chemical agent mentioned below:
1. oxalic acid – mainly used to improve the surface brightness of solid wood,
2. sodium hydrosulfite ($Na_2S_2O_4$) - used to bleach solid wood,
3. hydrogen peroxide ($H_2O_2$) with concentration 30% - used to bleach cellulose fibers,
4. hydrogen peroxide and sodium hydroxide (NaOH to adjust the pH) – also used to bleach cellulose fibers.

The wood fibers were soaked in an aqueous solution of one of above mentioned agent for 15 - 30 min. and then washed with water to pH 7. On the surface of the boards the chemicals were distributed manually using a brush. To every kind of modification a untreated fiber/panels were used.

Numerals (1,2,3,4) of chemicals were used in the description of results; the number "0" indicates the sample not treated chemically.

The brightness measurements were performed with an X-Rite 500 series spectrophotometer. To compare the lightness measurement results, a CIELab color model system, which include “L” component – lightness, was applied. The range of this component is from 0% (darkest black) to 100% (brightest white).

## RESULTS AND DISCUSSION

The brightness of pulps and the surface of the boards are shown in Figure 1 and Figure 2.

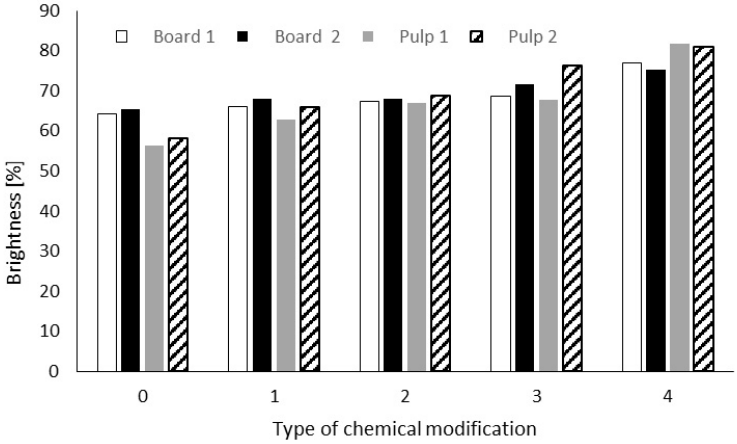


**Figure 1.** The brightness of the pulps and panel surfaces after treatment of various chemicals

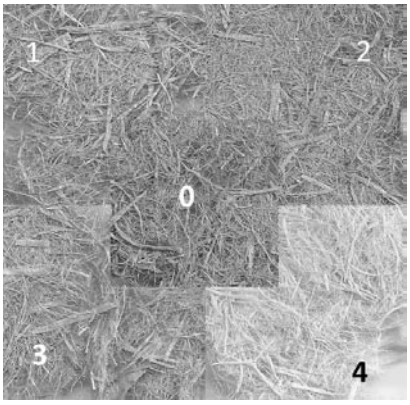


**Figure 2.** The brightness of the pulps after treatment of various chemicals (courtesy of R. Auriga)

The presented data show that by using chemical compounds the brightness of the fibers increase, both, in the form of pulp, and on the surface of boards. Slightly better results were obtained when acting with chemicals on the fibers than on the surface of boards.

In the tested chemicals least effective chemical proved oxalic acid (1). Under its influence, the brightness of all tested samples increased of about 2 - 8%. The most effective chemical agent was hydrogen peroxide with sodium hydroxide (4). Under the influence of these chemicals, the brightness of pulp increased from 56 - 58% to 80 - 82% and the brightness of the panel surface from 64 - 66% to 75 - 77%. The intermediate results of the brightness of all samples were achieved using sodium hydrosulfite.

It is worth to mention that in the samples treated with chemicals, there has been no reversion of color after 3 months of storage.

CONCLUSION

1. The studies have shown that fibers for production of MDF boards can get a lighter color using chemicals treatment.
2. From the tested chemicals, the most effective was hydrogen peroxide acting on fibers. The lightness of pulp treated with this agent increases over 45 percentage points.
3. The highest influence on the panel surface was for oxalic acid. In this case over 19 percentage points increase of lightness was found.
4. With the use of composition of hydrogen peroxide and sodium hydroxide the brightness of wood fibers increased from 56.2% to 81.9%.

REFERENCES


1. BEKHTA P, NIEMZ P. 2003: Effect of high temperature on the change in color, dimensional stability and mechanical properties of spruce wood. Holzforschung 57: 539–546
2. CHAI X-S., HON Q.X., ZHU J.Y. 2003: Carboxyl groups in wood fibres. Industrial and Engineering Chemistry Research 42 (22): 5440-5444
3. FERRERO F., MALOW M., NOLL M. 2011: Temperature and gas evolution during large scale outside storage of wood chips. European Journal of Wood and Wood Products 69 (4): 587 – 595
4. GÄRTNER A., GELLERSTEDT G., TAMMINEN T. 1999: Determination of phenolic hydroxyl groups in residual lignin using a modified UV –method. Nordic Pulp and Paper Research Journal 14 (2): 163-170
5. GIERER J. 1982: The chemistry of delignification. A general concept. Part 1. Holzforschung 36 (1): 43-51
6. HSU W.E., SCHWALD W., SCHWALDJ., SHIELDS J.A. 1988: Chemical and physical changes required for producing dimensionally stable wood –based composites. Part I. Steam pretreatment. Wood Science and Technology 22, 281-289
7. LUCIA L.A., Goodell M.M., Chakar F.S., RAGAUSKAS A.J. 2001: Breaking the oxygen delignification barrier: Lignin reactivity and inactivity. In oxidative delignification chemistry. Angelopoulos D.S. Editor ACS Symposium Series 92-107
8. LUNDQUIST K. 1976: Low molecular weight lignin hydrolysis products. Journal of Applied Polymer Science 28, 1393-1407
9. ROFFAEL E, BÄR G, BEHN C, DIX B. 2008: Einfluss der Aufschlusstemperatur auf die morphologischen Eigenschaften von TMP aus Kiefernholz. European Journal of Wood and Wood Products 67: 119–120
10. ROFFAEL E., UHDE M 2012: Influence of storage on the emission of volatile acids from wood chips. European Journal of Wood and Wood Products 70: 763–765
11. SJ□STR□M E. 1993: Wood chemistry. Fundamentals and Application. Academic Press: Orlando
12. SPALT H.A. 1977: Chemical changes in wood associated with wood fiberboard manufacture. In: Goldstein, I.S. ed. Wood technology: chemical aspects. Washington, DC: American Chemical Society 193-219
13. WESTERMARK W. 1999: The content lignin on pulp fiber surface. In Preceding of the 10th International Symposium of Wood and Pulping Chemistry. Yokohama, Japan 40-44

**Streszczenie:** *Zmiany jasności powierzchni płyt MDF*. W pracy przedstawiono rezultaty prób modyfikacji włókien drzewnych oraz powierzchni płyt MDF wybranymi związkami chemicznymi w celu uzyskania jaśniejszej powierzchni płyt. Stwierdzono, że z wykorzystaniem niektórych związków, jak np. perhydrolu można rozjaśnić barwę włókien drzewnych o ponad 45 punktów procentowych. Nie zauważono rewersji koloru po 3 miesiącach obserwacji.

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