WOOD SCIENCE TEACHING CURRICULA UPDATING – CASE OF WOOD MODIFICATION

Arian Kapidani

MsC., Agricultural University of Tirana, ALBANIA, kapidani.arian@gmail.com

Abstract

Because of continuous reduction of forest resources, the challenge for production of high performance wood products, which means long-lived products, is becoming more and more evident. For a better adapt to this reality, as well as for a better approach to wood processing industry requirements, the staff of Wood Industry Department of the Faculty of Forestry Sciences of Tirana has implemented in its teaching curricula the recognition and application of different methods of wood modification. Wood modification aims to improve wood properties. Among different didactic and scientific activities related to improvement of mechanical properties of wood, a comparative experimental investigation was performed with sodium chloride (NaCl) treated and non treated silver fir wood (*Abies alba* Mill.) with regard to hardness strength, based on mechanical tests performed according to standard ISO 13061-12. From 48 samples with dimensions 50×50×50 mm, 24 of them were full covered with solid NaCl for a period of 2 years. The samples were sawn from boards produced from fir logs of the area of central Albania. After treated and non treated samples were conditioned, the weight percent gain was calculated and samples were tested by means of mechanical testing machine, in the Faculty of Forestry Sciences of Tirana. The weight percent gain of treated fir resulted 17.2%. The Janka hardness parallel to the grain of treated wood resulted 19% higher than non treated one, while perpendicular to the grain resulted 22% higher. It was noted that difference of hardness referring to grain directions was smaller for treated wood than non treated one. In the framework of a quantitative and qualitative analysis, measured values of Janka hardness of non-treated wood were compared with respective values of silver fir wood from the literature. No significant variations were noted. As conclusion we might say that findings of this study are very useful for wood processing industry, making so possible the development and the application of eco friendly technologies for production of high performance wood products.

Keywords: silver fir, Janka hardness, NaCl treatment.

1. INTRODUCTION

For more than a century the world is facing with unstoppable reduction of forest resources. According to Food and Agricultural Organization (FAO), from 1990 to 2015 the World surface of forests decreased with 129 million ha, or with 1% referring to global land area (FAO, 2016, p.3). Furthermore, the future outlook is not at all optimistic, particularly for natural forest area, which will likely continue to be reduced (FAO, 2016, p.20).

One of the reasons of this decline is continuously growing demand for wood products. On the other hand, the

production of low quality and short life cycle wood products deteriorates more the situation.

In this context, the challenge for production of high performance wood products, which means long-lived products, is becoming more and more evident. The performance of wood products depends much on raw material properties. In an effort to improve its properties, wood has been modified and treated in many different ways. There are known four main categories of wood modifications; chemical, thermal, surface and impregnation modifications. Unfortunately, most of techniques can not improve all the properties of wood. Some properties become short of after treatment.

One of chemical treatment, formaldehydesation, has been recognized for a long time. It is known as a method with high anti-shrinkage efficiency and gives a small increase in weight of the timber. By the other side, it is related with negative effects, such as significant reduction of friction and tensile strength (Stamm, 1960, p.19).

Another well known chemical treatment, acetylating, has been industrially applied since 1961 in boards used in buildings (Rowell, 1985, pp.17-18). It is noted that acetyl treatment increases more than 55% the dimensional stability of wood, but reduces about 50% its tensile modulus (Ramsden, Blake and Fey, 1997, pp.97-104). It is found that Anti Shrinkage Efficiency (ASE) of acetyl treated wood arrive from 45 to 50%, and the modules of elasticity (MOE) and rupture (MOR) are reduced about 15% (Epmeier, Westin, Rap and Nilson, 2003, pp.121-142). Other studies show that Brinell hardness of acetylated pine is increased up to 20%, but Janka hardness is not significantly affected [Larsson and Simonson, 1994, pp.83-86; Papadopoulos and Tountziarakis, 2010, p.382). This treatment improves wood's resistance against biodegradation and color changes, but reduces some of wood's technological properties (ability of gluing) (Nasheri, Durbin, Singh and O'Callahan, 2005, pp.15-17; Papadopoulos, Militz and Pfeffer, 2010, pp.409-412; Mohebby and Militz, 2010, pp.41-50; Ajdinaj, Lato, Quku and Cota, 2013, pp.356-361).

Thermal treatment of wood is by far the most advanced commercially in comparison with all various wood modification processes that have been studied. During this process wood is heated under controlled conditions, increasing its dimensional stability. There is always a reduction in mechanical properties, especially of tensile and shear strength in radial and tangential directions, up to 40%. Static bending strength is reduced significantly, but there is no a significant effect on the modulus of elasticity (Finnish, 2003, pp.4/4-12/4).

Almost all modifications and treatments are expensive and present human health and environmental issues. Wood treatment has to represent a process that improves wood properties, but in the same time the material produced, at the end of its life cycle must not present environmental issues greater than those associated with the disposal of untreated wood. Although wood treatment has been the subject of many studies for many years, there are many other methods which have to be taken into consideration with regard to improvement of wood performance during its application.

For a better adapt to this reality, as well as for a better approach to wood processing industry requirements, the staff of Wood Industry Department of the Faculty of Forestry Sciences of Tirana has implemented in its teaching curricula the recognition and application of different methods of wood modification.

Among different didactic and scientific activities related to improvement of mechanical properties of wood, a comparative experimental investigation was performed with sodium chloride (NaCl) treated and non treated silver fir wood (*Abies alba* Mill.). Actually, silver fir is one of the most used wood species. Among properties which characterize its application in buildings is its hardness. In the framework of improvement of this mechanical property, as well as to find more economical and more environmental methods for wood treatment, the study was focused on assessment of the impact of sodium chloride (NaCl) treatment on Janka hardness.

2. MATERIALS AND METHOD

The study was based on comparative experimental investigation, cause-consequence (Creswell, 2014, p.48). The method consisted to quantity evaluation of a specific phenomenon caused by a provocative factor and after that, the evaluation of the same phenomenon in the situation of the factor's absence. In our case, the phenomenon was the static hardness of silver fir wood, and the provocative factor was the sodium chloride treatment of the sample.

Wood material for production of samples was selected from pieces of kiln dried boards without deformations or structure defects, which could influence on hardness strength. The boards were sawn from silver fir logs from the

area of Librazhdi region, located in central Albania.

There were produced 48 samples with dimensions 50×50×50 mm, according to standard ISO 13061-12 (ISO 13061-12, 2017, p.2). 24 of them were full covered with solid NaCl for a period of 2 years.

Together with samples selected for NaCl treatment, silver fir blocks from the same wood material, with dimensions 20×20×50 mm were covered, too. Before covering, blocks were oven dried in temperature 103ºC ± 1ºC, until they reached equilibrium state, corresponding to 0% moisture content and were weighed. The same procedure was repeated after 2 years and the Weight Percent Gain (WPG) was calculated.

The treated samples were conditioned to reach equilibrium moisture content and were tested by means of mechanical testing machine (Controlab, FRANCE) in the Faculty of Forestry Sciences of Tirana. Tests were performed according to two grain directions of wood, respectively on 12 samples for each direction.

The static hardness H_W of NaCl treated and non treated samples were calculated in Newtons, as follows:

$$H_W = K \times F$$

where F is the maximum load during the penetration of the plunger into the sample to a depth of 5,64 mm, in newtons (N), and K is the coefficient equal to 1 referring to penetration of the plunger to a depth of 5,64 mm.

3. RESULTS AND DISCUSSIONS

Mean values of weight percent gain (WPG) and Janka hardness, together with respective standard deviations are shown in Table 1.

Table 1 Results of weight gain (WPG) and Janka hardness

Samples	Weight gain [%]	Stand. Dev.	Hardness parallel to grain [N]	Stand. Dev.	Hardness perpendicular to grain [N]	Stand. Dev.
Untreated	0	-	4110	544	1638	237
NaCl treated	17.21	0.43	4891	471	1998	187

Mean value of the density of untreated silver fir wood used in our study resulted 0.40 g/cm^3, with a standard deviation 0.059. The weight percent gain of treated wood resulted 17.21%.

From examination of results can be noted that Janka hardness was influenced considerably by the treatment with NaCl. The values parallel to the grain of treated fir resulted 19% higher than non treated one, while perpendicular to grain resulted 22% higher. It is well known that hardness of wood is increased with increment of its density (Doyle, 1980, p.28). On the first sight hardness values parallel to the grain appeared to be much higher than perpendicular direction's respective values. The ratio between parallel to grain hardness values and perpendicular ones resulted 2.7 for non treated wood and 2.5 for treated one. Although it is not a significant, we can say that NaCl treatment affects positively on reduction of hardness differences referring to grain directions.

Comparable data on the effect of NaCl on hardness does not exist in the literature. However, in the framework of a quantitative and qualitative analysis, measured values of Janka hardness of non treated wood were compared with respective values of silver fir wood from the literature. No significant variations were noted.

By the other hand, such increment of density was appears to be a negative factor with regard to applications of silver fir wood in constructions. Such value was thought to be caused by the method's treatment applied. During analyses of the humidity of treated samples was noted that the salt was located only to peripheral substrates of samples. The full covering method applied did not make possible the control of the quantity of NaCl penetrated in the wood. Another issue was the revealment of a relationship between treatment time (covering time) and quantity of NaCl penetrated in wood. To avoid these issues, the NaCl solutions treatment must to be set up. This

way can provide a uniform localization of the salt in all sample's volume, as well as a control on the wood density increment. Even the time of treatment will be reduced considerably.

4. CONCLUSIONS

Based on research results obtained during this comparison study we can say that NaCl treatment of silver fir wood presents a better performance in comparison to untreated silver fir with regard to mechanical features in static hardness. The method applied full covering wood with solid NaCl for a period of 2 years, increases with 19% Janka hardness parallel to grain of silver fir and with 22% the hardness perpendicular to grain, while the weight percent gain is 17.2%. Other methods of NaCl treatment have to be studied to conceive a possible application in the future in industrial scale.

NaCl wood treatment is an ecological method which is not studied profoundly yet. We might say that findings of this study are very useful for wood processing industry, making so possible the development and the application of eco friendly technologies for production of high performance wood products.

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