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RESEARCH OF WATER VAPOUR ADSORPTION OF THERMALLY MODIFIED BEECH, SPRUCE AND POPLAR WOOD

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ABSTRACT

For use in this search, was realized thermally treatment by temperature 210ºC on spruce, beech and poplar wood in sunflower oil and glycerol environment. Thermally treated wood have some differences from natural, like colour, odor, density and other physical and mechanical properties. From this wood was produced samples with measure 30x30x10mm (last one in longitudinal direction). In parallel with this was produced control samples from same wood dried to constant weight by temperature 102±3ºC. It was determinate water vapour adsorption of samples according to BDS 16987-89.

Key words: wood, spruce, beech, poplar, water vapour adsorption, thermally modified wood

INTRODUCTION

Thermal treatment is good alternative to chemical modification for wood and guaranties good dimensional stability [2].This treatment changes the structure of cell walls in wood; the result of this is lower adsorption ability, lower density and better resistance on fungi attacks. It is useful on conifer species (softwood) and on hardwood species as well. The results of thermal treatment (190-220 °C) are destruction of hemicelluloses and separation of some extractives from wood [1]. The thermally modified wood has a soft brown colour, depends of the temperature of receiving with well-defined texture. Thermally modified wood has two standards about treatment classes: Thermo-S and Thermo-D. Thermo-S is wood received after heated to 190 ºC. Thermo-D is wood received after heated to 212 ºC (Termowood handbook 2003 www.thermowood.fi). The average tangential swelling and shrinkage due to moisture for Thermo-S class treated wood is 6–8 %. The average tangential swelling and shrinkage due to moisture for Thermo-D class treated wood is 5–6 %. The decreased equilibrium moisture content of the wood improves its stability, which in turn reduces the cracking of the wood. Thermally modified wood has possibility to be produced in different environment. Heat treatments usually take place in an inert gas atmosphere at the temperature between 180–260 °C [3]. The boiling point of many natural oil and resins are higher than the temperature required for the heat treatment of wood. This open us the option of the thermal treatment of wood in a hot oil bath. The smoke point and the tendency to polymerisation are also important for the drying of the oil in the wood and for the stability of the respective oil bath. The ability of the oil to withstand heating to a minimum temperature of 230 °C is a prerequisite (Rapp and Sailer 2001). The refined sunflower oil is a good alternative about heating environment, because its smoke point is 227 °C. Another alternative is glycerol, its smoke point is 290 °C. Water vapour adsorption of wood is one of most important characteristic of wood, which have attitude on dimensional stability of wood, respectively on exploitation potencies.

MATERIALS AND METHODS

This investigation is comparable for eight different series of modified and untreated spruce (Picea abies L.), beech (Fagus sylvatica L.) and poplar wood (Populus alba L.). The first index show wood spies in this order: spruce-S; poplar-P; beech-F. The series are consisted of 16 samples with measurement: 30x30x10 mm (last one in longitudinal direction). Untreated wood are obtained in drying kiln with temperature 103°C till constant weight. They are marked with second index N. The wood for modification is the same like untreated before treatment. The processes are organized like heat treatment in determinate temperature regime (figure 1), but with two different processing environments: sunflower oil and glycerol. The full time of processes of heating and cooling is 12 hours. The series which are obtained in sunflower oil are marked with second index S. The series obtained in glycerol environment are marked with second index G.

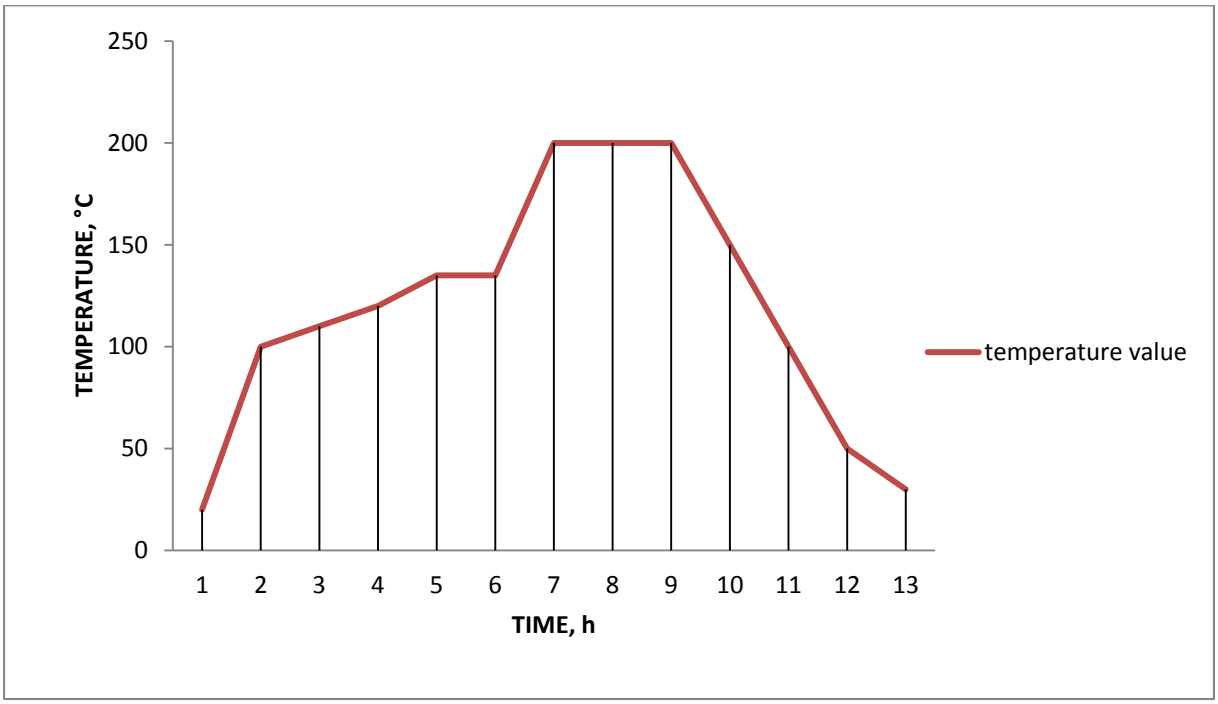

Figure 1: Thermally treatment graphic

The all samples are exposed over supersaturated solution of NaCl in water for 60 days according to BDS 16987-89. They are weight periodically on 1, 2, 3, 5, 8, 13, 20, 30, 40, 50, 60 day.

The water vapour adsorption is determinate for every measurement with next (1) formulas:

$$M_w = \frac{M_T - M_o}{M_o} 100, \% \qquad (1)$$

Where:

M_w is water vapour adsorption in %; M_T is current mass; M_o is initial mass

The kinetic of water vapour adsorption is obtained from average values for each series. The results are explained in table and graphic.

RESULTS AND ANALYSIS

The average values about water vapour adsorption are present in table 1. The results shows that poplar modification in sunflower oil has the best efficiency, its water vapour

adsorption reduce from 8.07 to 1.54 %. In other case, when poplar wood was treated in glycerol heat medium, the effect of water vapour absorption ability is opposite, its increase from 8.07 to 15.17 %. It is the same about beech wood, but the differences between values is not too drastic. Spruce wood has a different behavior, because the decrease of water vapour adsorption after heat treatment in sunflower heat medium is from 8.44 to 5.18 %. The effect on water vapour ability is not such positive like effect of poplar and beech wood modification. The treatment of spruce wood in glycerol heat medium also is negative like in the others wood, but increase of water vapour adsorption is lower than the others, from 8.44 to 13.7 %.

Table 1: Water vapour adsorption of wood series in period of 60 days

Series	1d	2d	3d	5d	8d	13d	20d	30d	40d	50d	60d
PS,%	0.72	0.83	0.91	0.93	0.99	1.04	1.08	1.18	1.35	1.43	1.54
PN,%	3.6	4.16	4.19	4.6	4.74	5.13	6.16	6.63	6.91	7.67	8.07
PG,%	3.17	4.3	5.16	6.49	7.47	9.08	10.17	12.26	13.41	14.7	15.17
FN,%	3.55	4.02	4.33	4.64	4.76	5.18	5.81	6.35	6.7	6.98	7.38
FS,%	0.79	0.92	0.98	0.98	1.04	1.09	1.23	1.37	1.51	1.67	1.76
SS,%	3.16	3.14	3.1	3.25	3.37	3.58	3.86	4.03	4.56	4.83	5.18
SG,%	6.38	6.32	6.12	6.79	7.46	8.47	9.82	11.65	12.83	13.11	13.71
SN,%	5.06	5.42	5.43	5.77	5.81	6.44	6.82	7.53	8.08	8.26	8.44

The kinetic of water vapour adsorption for different series are present in graphic (figure 2). In the bottom of graphic is series PS (poplar heat treated in sunflower oil) and FS (beech heat treated in sunflower oil). On the top of graphic is series heat treated in glycerol. The all spies untreated wood has a similar behavior in this graphic.

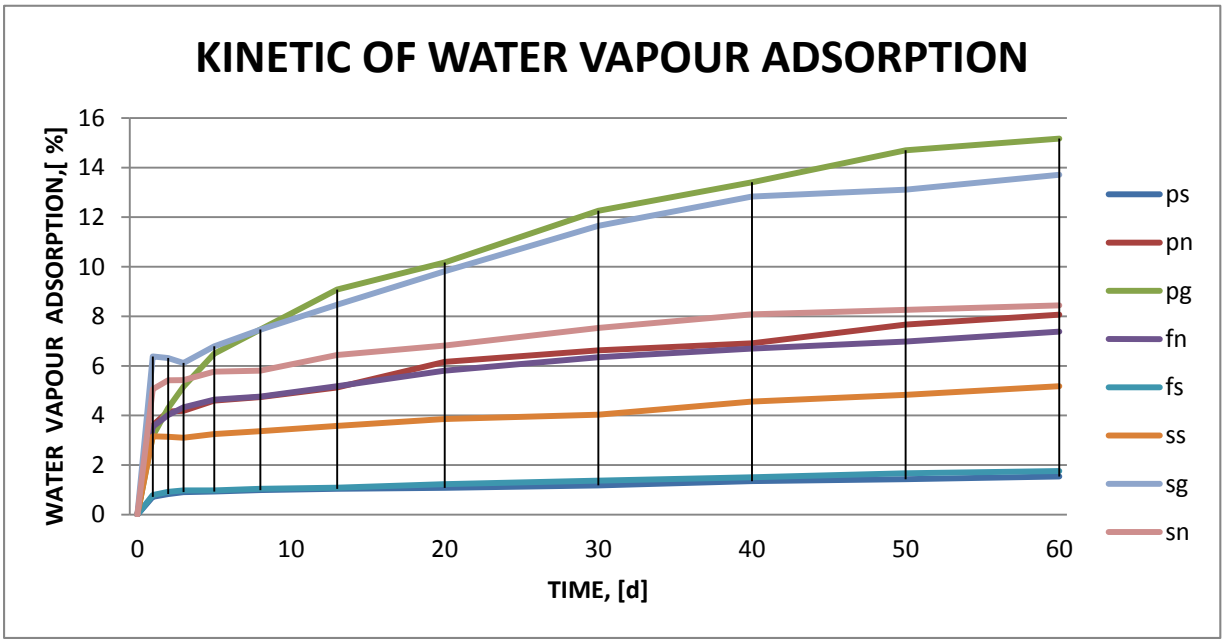

Figure 2: Graphic of kinetic of water vapour adsorption

This processes realized in oil environment have some special aspects. The first and most important thing is oil which remains in wood after processes. When it is sunflower oil it has positive influence about reducing water vapour adsorption, but when it is glycerol it is negative. The second aspect is wood spies and this study presents that the treatment effect is lower about spruce wood in comparison with beech and poplar wood. The cell walls structure of the spruce wood, prevent maximum oil adsorption in depth of wood and this decrease the effect of treatment.

CONCLUSION

Water vapour adsorption of wood is one of most important factors about wood stability. The decrease of it is our aim, which will improve wood exploitation potencies. The thermally modification is an alternative to increase it. The heat treatment in glycerol has a negative effect when it remains in wood. The technologies which use glycerol like heat medium, must extract it from wood after treatment. The thermally treatment in sunflower oil environment drastic reduce water vapour wood adsorption and therefore is a good decision for better wood dimensional stability. The heat treated wood in sunflower oil will have good possibilities for use.

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