

Influence of preservation of pine wood with selected hydrophobic treatments on its higroscopicity, absorbability and susceptibility to salts leaching

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Abstract: *Influence of preservation of pine wood with selected hydrophobic treatments on its higroscopicity, absorbability and susceptibility to salts leaching.* Research focused on preservation of pine sapwood with wax-based paste and hydrophobic treatment based on nanometric particles of fluoride derivatives dispersed in non-polar organic solvent and influence on its higroscopicity, absorbability and susceptibility to salts leaching. Obtained result were compared with reference samples, natural pine sapwood. It was found that preservative based on nanometric fluoride derivatives dispersed in non-polar organic solvent improves hydrophobic properties of wood, treated material had also lower absorbability and was less prone to salts leaching.

Keywords: środki hydrofobowe, zabezpieczanie drewna, higroskopijność drewna, nasiąkliwość drewna, wymywalność preparatów solnych z drewna

INTRODUCTION

Wood is one of the most popular raw materials used in furniture and building industries. Two of the most obvious application obstacles are low hydrophobicity and high hydrophilicity. Natural resistance of wood against water in liquid and gaseous form may be increased by impregnation and coating by paints and waxes. Again natural resistance of wood-based materials is often lowered after preservation against fungi and insects, because of treatments based on hydrophilic salts. Application of substances increasing hydrophobicity and lowering hydrophilicity aims and increased dimensional stability and decreased susceptibility to cracking. Such phenomena can not be eliminated, but may be significantly decreased. Furniture (especially bathroom and garden one) and wooden building structures are exposed to periodical water penetration. Hydrophobically preserved wood without significant changes of appearance widens its application area and increases its visual attractiveness.

Presented work aims at preservation of pine sapwood with wax-based paste and hydrophobic treatment based on nanometric particles of fluoride derivatives dispersed in non-polar organic solvent and influence on its higroscopicity, absorbability and susceptibility to salts leaching.

MATERIAL AND METHODS

Pine sapwood samples of 10 x 50 x 120 mm dimensions were used for testing. Part of the samples were saturated with water soluble sodium nitrite (NaNO₃). Saturated and control samples were then dried in laboratory drier at 100 °C ± 5°C. Five series of samples were prepared for the experiment:

1. Control samples (untreated),
2. Preserved with wax-based paste,
3. Salt-saturated and preserved with wax-based paste,

4. Preserved with hydrophobic treatment based on nanometric particles of fluoride derivatives dispersed in non-polar organic solvent,
5. Salt-saturated and preserved with hydrophobic treatment based on nanometric particles of fluoride derivatives dispersed in non-polar organic solvent.

Before wetting or soaking in water, fronts of the samples were sealed by 2 layers of waterproof lacquer. Parameters of the samples before testing:

1. Average amount of salt in the test sample - 3,3 g.
2. Average amount of wax paste for salt-saturated samples– 0,85 g.
3. Average amount of wax paste for regular samples – 0,85 g.
4. Average amount of nano treatment for salt-saturated samples – 0,05g.
5. Average amount of nano treatment for regular samples – 0,21 g.

Such prepared samples (dried down to constant mass) before soaking in water were weighted, and normalized in laboratory conditions by 3 months, until samples reached equilibrium moisture content. Mass gain was measured in 1 month increments. After reaching equilibrium moisture content, samples were dried down to constant mass, weighted and soaked in water. Soaking was made within 24, 48, 72, 96 and 120 hours. After each stage samples were weighted.

RESULTS AND ANALYSIS

Experiment results are presented in tables 1 and 2.

Tab. 1 Average mass of water contained in pine sapwood, gathered in the process of 3 months conditioning for various types of preservation .

Time [month]	Airborne water in wood for various test variants [g]				
	Natural	Wood+salt	Wood+salt + wax paste	Wood+salt + nano treatment	Wood+nano treatment
1	1,4	1,6	1,5	1,3	1,1
2	1,8	2,2	2,0	1,7	1,7
3	2,0	2,4	2,2	1,9	1,8

Tab. 2 Average mass of water contained in pine sapwood with various protection gathered in the water soaking process versus water held by natural unprotected wood[%]

Variant	Average mass of water in soaked preserved wood versus water in natura wood [%]				
	24 h	48 h	72 h	96 h	120 h
Natural	100	100	100	100	100
Wood + salt	126,6	125,3	117,6	118,0	117,1
Wood + salt + wax paste	82,8	83,9	77,9	74,7	77,8
Wood + salt + nano treatment	82,3	79,6	75,3	71,2	69,5
Wood + nano treatment	31,7	40,6	48,6	61,6	64,5

In salt saturated samples preserved with wax paste, after 120 hour soaking in cold water, 84% of salt remained, again with preservation with nano treatment, remaining salt

averaged at 91%. With salt saturated and unprotected samples, salt residues after 120 hour soaking averaged at 80% level. ,

Higroscopicity test results for samples with various type of preservation in relation to unprotected samples were as follows: wood + salt - 114,3 %, wood +wax paste – 107,1 %, wood + salt + nano treatment – 92,8 % and wood + nano treatment – 78,6 %.

Higroscopicity test results for 2 months water-soaked samples with various type of preservation in relation to unprotected samples were as follows: wood + salt 122,2 %, wood +wax paste – 111,1 %, wood + salt + nano treatment and wood + nano treatment – 94,4 %.

Higroscopicity test results for samples after 3 months of conditioning with various type of preservation in relation to unprotected samples were as follows:: wood + salt 120 %, wood +wax paste – 110 %, wood + salt + nano treatment – 95 % and wood + nano treatment – 90 %.

Dynamics of absorbability against time for wood + salt and wood + salt + wax paste and wood + salt + nano treatment was declining. In wood + nano treatment variant however, showed inclining character. Best protection against water was shown by treatment based on nanometric particles of fluoride derivatives dispersed in non-polar organic solvent, in both with and without the salt cases. Because of high higroscopicity of salt used, absorbability of water was increased in all applications.

CONCLUSIONS

Numerical results obtained within the framework of the experiment allow to conclude:

1. Hydrophobic treatment based on nanometric particles of fluoride derivatives dispersed in non-polar organic solvent was best in protection of pine sapwood against moisture and liquid water.
2. Hydrophobic treatment based on nanometric particles of fluoride derivatives dispersed in non-polar organic solvent has better anti-leach properties with salt in pine sapwood than treatment based on wax-paste, sealing salt-saturated wood.

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Streszczenie: *Wpływ zabezpieczenia drewna sosnowego wybranymi środkami hydrofobowymi na jego higroskopijność i nasiąkliwość oraz wymywalność soli.* W ramach badań określono wpływ zabezpieczenia drewna sosnowego (bielu) pastą na bazie wosku oraz środkiem hydrofobowym na bazie fluoropochodnych nano cząstek rozproszonych w niepolarnym rozpuszczalniku organicznym na jego higroskopijność, nasiąkliwość oraz wymywalność soli. Otrzymane wyniki przedstawiono w porównaniu z wynikami dla naturalnego bielastego drewna sosnowego. Stwierdzono, że środek hydrofobowy wytworzony na bazie fluoropochodnych nano cząstek rozproszonych w niepolarnym rozpuszczalniku organicznym lepiej chronił pokryte nim drewno przed działaniem wody w formie wilgoci z powietrza, w formie wody ciekłej oraz lepiej chronił przed wymywaniem soli z drewna.

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