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PHYSICAL AND MECHANICAL PROPERTIES OF WOOD THERMALLY MODIFIED IN ORGANIC OILS

In this paper, the following values of the physical and mechanical properties of thermally modified wood in organic oils of: water absorption, deliquescence, the maximum shrinkage, the MOR in static bending, compression and shear parallel to grain, the MOE in static bending. Raising the temperature and time of thermal modification leads to a deterioration of the mechanical and physical properties of the wood better. It is concluded that the operation of a suitable timber under low mechanical stress, or in their absence, as well as in conditions of high humidity.

Introduction. Modern synthetic materials with more advantageous properties are inferior to wood in terms of some characteristics, for example cheapness, ecological and aesthetic qualities, which determines a separate area of investigation – wood modification.

At the beginning of the 30th of the last century German scientists were puzzled for the first time with unique feature of wood under the influence of high temperatures to gain new properties [1]. Development of this direction by 90th was expressed in creation of new production technology of thermal updating of wood.

The wood received on this technology, details of furniture and the sanitary equipment use as facing materials, for restoration works, manufacturing of musical instruments. Today the most popular application of thermally modified wood is the flooring of floors.

For thermally updating in Europe mainly use fast-growing soft species (88%): spruce, pine, birch and aspen.

Process of thermal updating of wood consists of three main stages: 1) drying in the chamber at temperature 130–150°C to absolutely dry condition; 2) heat treatment at raised to 180–240°C to temperature in the protective environment (in order to avoid ignition); 3) a hardening, i.e. decrease in temperature to 80–90°C and wood conditioning to optimum humidity of 4–7%.

As the protective environment can act: water vapor (Thermowood, Plato and Le Bois Perdure technologies), inert gas (the Retification technology where nitrogen), vacuum (the technology developed in Estonia), organic oils (the Oil Heat Treated (OHT) technology where vegetable oils) or their combinations are used is used.

The analysis of references showed that the longest process of receiving thermally modified wood is updating in vacuum, and the fastest is in organic substances. Advantage of use of technology of thermal updating of wood in liquid environments, unlike gaseous, is lack of need of removal of the gases which are forming at decomposition of components of wood.

Today offers on sale of the house-building elements made of thermally modified wood meet. In this regard there is a lawful question of compliance of durability of such wood to special requirements to construction materials.

At an assessment of influence of thermal updating on mechanical properties of wood there are some disagreements. So, as some sources [2] affirm that procedure of thermal updating on durability of wood of influence doesn't render, except for some decrease in durability at chipping.

On the basis of the aforesaid for researches the technology of receiving thermally modified wood in organic oil was used. Depending on various modes of updating properties of the received material were investigated.

Main part. For tests commercial wood species were selected which are most widespread in the Republic of Belarus: pine and birch. Pine is a coniferous species known for the expressed layered structure. Birch is a deciduous species having homogeneous structure.

As the protective environment used organic oil which at temperature 23°C has viscosity 34 with on VZ-4 and density of 923 kg/m^3.

Processing of wood was carried out to three stages. The first stage is drying. Samples were placed in a drying cabinet and dried up to constant weight at temperature 103±2°C. The second stage is high-temperature processing. Samples right after drying were immersed in the organic oil which had been heated up to the set temperature where maintained during time, defined by a mode. The final stage is cooling. After endurance in oil samples were taken, cooled under room conditions, placed in an exsiceator where maintained during 14 days before achievement by wood of equilibrium humidity of 7–9%.

For high-temperature processing (the second stage) used four modes:

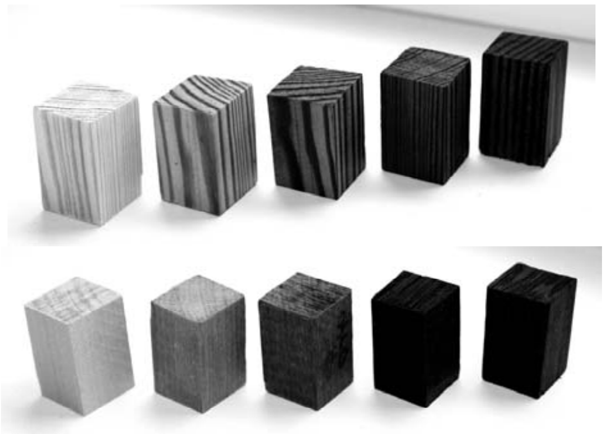
mode 1. Endurance during 1.5 h at temperature 185°C;

mode 2. Endurance during 3 h at temperature 185°C;

mode 3. Endurance during 1.5 h at temperature 215°C;

mode 4. Endurance during 3 h at temperature 215°C.

After processing wood gets a caramel shade: changes the color to more dark at increase in temperature and processing time (Fig. 1).



a *b* *c* *d* *e*

Fig. 1. Photos of samples of wood pines (the top number) and birches (the bottom number) after thermal processing: *a* – raw samples; *b, c, d* and *e* – samples processed in 1, 2, 3 and 4 modes accordingly

After conditioning to operational humidity on samples of thermally modified and control wood defined the following mechanical properties were obtained: strength at a static bend [3]; conditional strength at a static bend [4]; the elasticity module at a static bend [4]; strength at compression along fibers (GOST 16483.10-73); strength at chipping along fibers (GOST 16483.5-73). Physical properties of wood were defined also: (GOST 16483.20-72) water absorption, moisture absorption (GOST 16483.19-72) and (GOST 16483.37-88) shrinkage.

Mechanical tests were carried out by means of explosive cars R-5 and R-05. Results of these tests are presented in Table 1 and 2. Indicators of mechanical properties are brought as the percentage to indicators of the control (raw) wood.

Table 1

Results of definition of mechanical properties of thermally modified wood of a pine

Properties of wood	Modes			
	I	II	III	IV
Strength at a bend, %	71.58	47.98	43.22	43.03
Conditional strength at a bend, %	72.18	65.81	63.83	59.52
The elasticity module at a bend, %	67.77	59.79	56.24	55.87
Strength atcompression, %	99.87	92.21	85.77	84.05
Strength atchipping, %	79.37	68.13	50.08	45.48

Results of definition of moisture absorption are presented by diagrammes in Fig. 2 and 3, and water absorptions – in Fig. 4 and 5.

Table 2

Results of definition of mechanical properties of thermally modified wood of a birch

Properties of wood	Modes			
	I	II	III	IV
Strength at a bend, %	68.50	64.68	56.95	51.72
Conditional strength at a bend, %	83.77	83.63	83.51	83.51
The elasticity module at a bend, %	95.00	89.67	89.32	86.88
Strength at compression, %	99.97	99.38	86.29	83.17

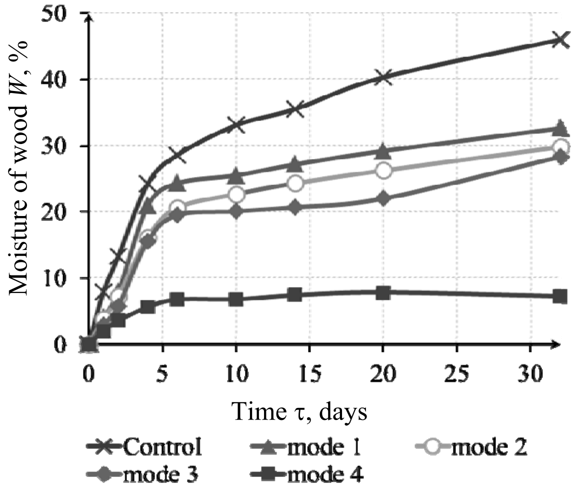


Fig. 2. Moisture absorption thermally the processed wood of a pine

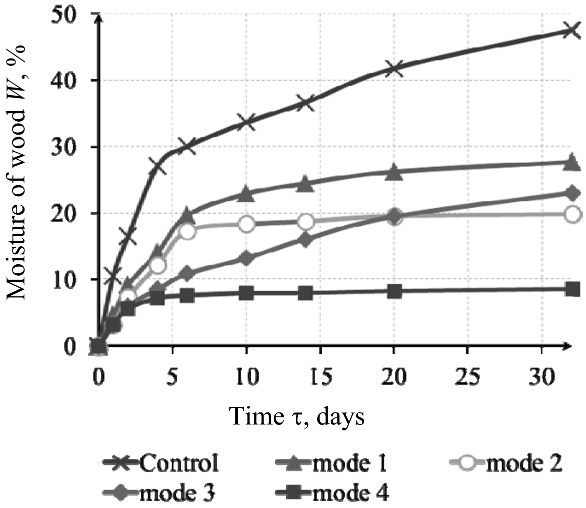


Fig. 3. Moisture absorption thermally the processed wood of a birch

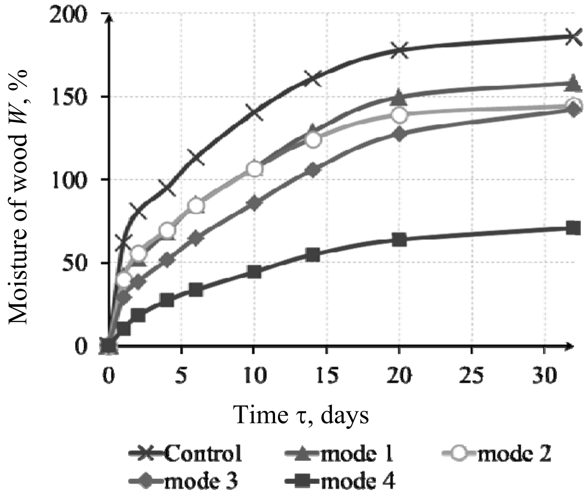


Fig. 4. Water absorption thermally the processed wood of a pine

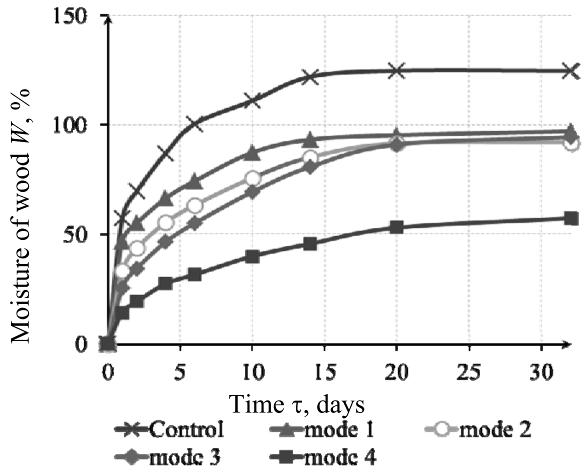


Fig. 5. Water absorption thermally the processed wood of a birch

Results of definition of shrinkage are presented in Table 3.

Table 3

Results of definition as much as possible volume shrinkage

Species ofwood	Control	Mode			
		I	II	III	IV
Pine	13.77	13.48	11.00	9.63	9.26
Birch	16.71	16.16	15.32	13.47	10.16

Conclusion. Having analyzed the obtained data, it is possible to argue that durability of thermally modified wood at a bend, compression and chipping and also the elasticity module at a bend with increase in temperature of processing decrease. At high-temperature processing the birch reduces the elastic properties from 5.0 to 16.5%, and a pine – from 27.8 to 44.1%. Durability at a bend decreases for a birch from 31.5 to 48.3%, and for a pine – from 28.4 to 57.0%. Durability at compression both for a birch, and for a pine decreases from 0 to 16.8%. The greatest decrease in durability occurs at a chipping and makes from 20.6% to 54.5%.

When updating wood on the most rigid mode (4th) maximum moisture absorption for a pine decreases for 83.1%, and for a birch – for 82.0%. Thus absorption of water decreases for 62 and 54.1% respectively, and the maximum volume shrinkage – for 32.8 and 39.2% respectively

In conclusion, thermally modified wood is worth applying in the conditions of the lowered mechanical loadings or at their absence, and also for operation in the conditions of the increased humidity.

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