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THICKNESS HUMIDITY CHANGE OF SAW-TIMBER AT WARMING UP IN THE UNSATURATED ENVIRONMENT

Moisture content change of surface and inner layers of pine wood at warming up in the unsaturated environment ($\varphi < 1$) was studied. Internal tensile stresses arising on the surface of assortments being warmed up were calculated. Conclusion about the warming up process safety for the wood entirety was made.

Introduction. Drying of preliminary non-warmed up saw-timber can result in the surface layers crippling. Therefore the first technological operation before drying is initial warming up.

Modern drying technologies assume the modes usage of initial warming up at which the degree of the processing environment saturation is $\varphi < 1$, and the indications difference of psychrometer (hygrometer) Δt does not exceed 5°C. Warming up duration should not be less than 6 hours and is set depending on the saw-timber species and thickness. It should be noted that the initial warming up duration is defined now without taking into account the initial wood humidity, stacks width, temperature rise speed in the chamber and other factors.

The initial warming up in the unsaturated environment assumes the usage of the temperature not exceeding the drying temperature at the mode first stage. As a rule it is not more than 70°C. Under such conditions the moisture evaporation intensity from the assortments surface and its moving from the internal more humid layers to external ones is much lower than directly in the saw-timber drying process. And though it does not exclude completely the occurrence of humidity strains, their value is considerably lower than the allowed value.

Wood warming up process in the unsaturated environment is characterised by non-uniform moisture thickness distribution of saw-timber. As a result of moisture evaporation from the surface layers there is a thickness humidity difference of the assortment which is the reason of the internal humidity strains appearance.

Objective. Character determination of the saw-timber humidity thickness change at warming up in the unsaturated environment and also value estimation of thus arising internal strains was the aim of this work.

Research technique. Researches were carried out under production conditions of "Pinskdrev-Adriana". Drying shop of the enterprise is equipped by the drying chambers CATHILD of the French production with capacity of 75 m^3.

At the chamber loading by saw-timber the check samples were put in the central, top and bottom parts of the stack, they used pine edged boards with the thickness of 40 and 50 mm, width of 120 mm and length of 5,500 mm (Fig. 1, *a*) as the check samples. In the middle of each check sample they put detectors for wood humidity measurement (Fig. 1, *b*). The detectors for humidity measurement of the surface layers were placed on the depth of 3–4 mm, of internal – on the depth equal to half the thickness of the check sample.

Similarly the humidity meters were put at the check samples edges on the distance of 4*S* from the ends.

Before being loaded into the drying chamber the saw-timber was exposed to atmospheric drying and consequently the initial wood humidity is 32–34%. At the initial warming up period the temperature of the processing environment was kept at the level of $t = 58$°C, and saturation degree –$\varphi = 0.78$. The initial warming up process duration for saw-timber with thickness of 40 mm is $\tau = 6.0$ h, and for thickness of 50 mm is $\tau = 7.5$ h.

The measurement results received from the humidity detectors were transferred into the controller memory card of the automatic system of drying process control. Than this information was fed into the computer of the drying chambers operator.

Current values of the wood humidity were registered with periodicity of 30 minutes. Throughout all the drying period the processing environment temperature was also monitored. The resulting information about the measurements results was given in the form shown in Fig. 2.

Research results. The graphic dependences showing the wood humidity change on the surface and inside assortments are given in Fig. 3.

The received results analysis shows that the inside layers humidity remains constant and equal to the initial humidity throughout all the initial warming up period. Inside layers humidity decreases with the course of time, reaches the values of 15% then does not change. It is easy to notice that the humidity stabilisation on the surface of warmed up assortments happens at the level of steady humidity value at desorption, corresponding to the set-up parametres of the processing environment. Thickness humidity difference of the saw-timber changes from 5-7% at the process beginning to 24% – in the end. It is necessary to pay special attention that humidity of the surface wood layers humidity is less than the hygroscopicity limit W_g = 26%, and inside layers humidity is more than this value.

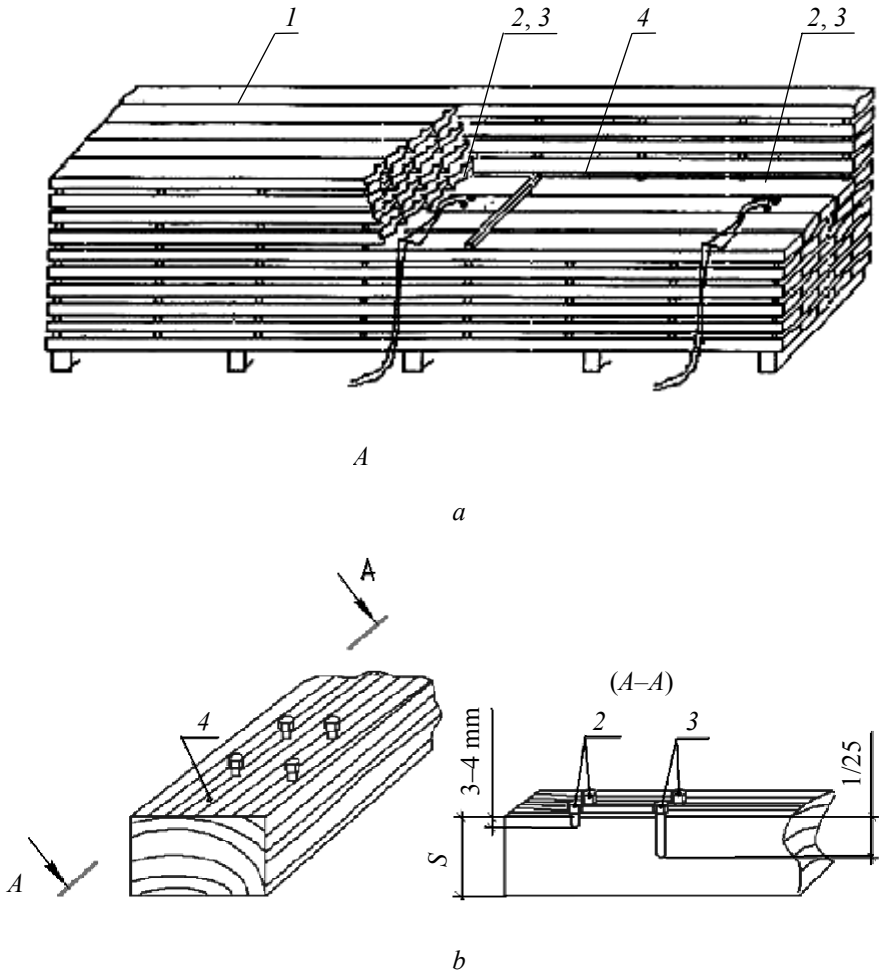


Fig. 1. The experiment scheme in the drying chamber CATHILD:
a – samples layout in a stack; *b* – humidity detectors installation scheme in the sample;
1 – saw-timber stack; *2* – humidity measurement detector on the sample surface;
3 – humidity measurement detector inside the sample; *4* – check sample.

It is known that if humidity of the surface wood layers is less than humidity of the cell walls saturation limit they feel stretching deformations. As the inside wood layers humidity is more than this value, shrinkage does not take place and compressing internal stresses occur in them. For the described humidity condition of wood B.N. Ugolev offered the formula for value calculation of humidity internal stresses [1, p. 63].

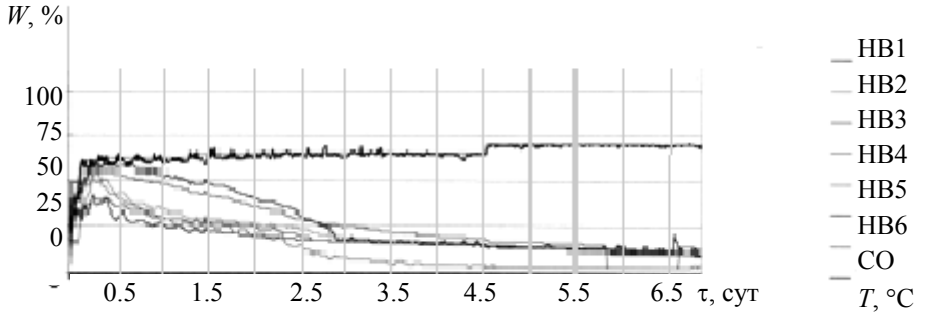
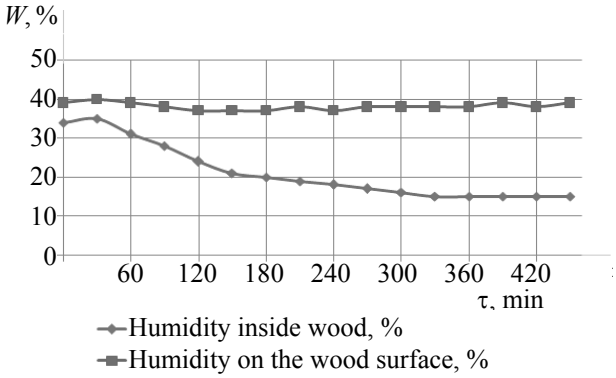
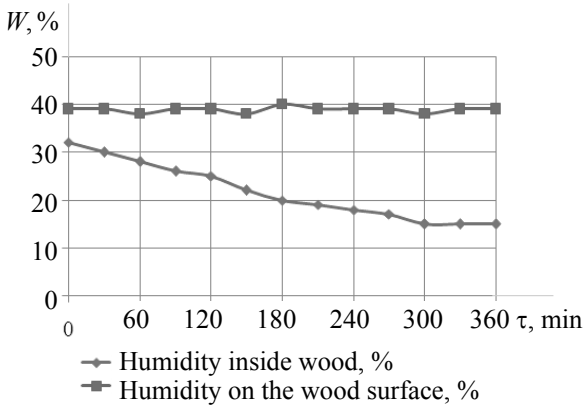


Fig.2. Experimental data presentation form
HB-HB6 – wood humidity measured by detectors № 1-6;
CO – saturation degree of the processing environment; *T* – temperature
of the processing environment



a



b

Fig. 3. Wood humidity change of the surface and inside layers:pine board with the thickness of 50 mm (*a*) and 40 mm (*b*)

Using the given formula the value calculations of the internal stresses ocurring at the wood warming up in the unsaturated environment were done. Stresses value behaviour for the pine saw-timber with the thickness of 50 mm and 40 mm turned out to be identical. The value determination results of the internal stresses for saw-timber with the thickness of 50 mm are shown in the Table.

Internal stresses value

W_{inside}, %	$W_{surface}$, %	ΔW, %	σ, MPa
37	28	9	0.016
37	24	13	0.06
37	21	16	0.15
38	20	18	0.043
37	19	18	0.057
38	18	20	0.097
38	17	21	0.091
38	16	22	0.12
39	15	24	0.14
38	15	23	0.13
39	15	24	0.13

As it is clear from the Table, in the course of warming up in the unsaturated environment the stretching internal stresses occur on the wood surface. However, they do not exceed the allowed value σ = 5.4 MPa and, moreover, is dozens of times less. It means that there is a possibility to bring the temperature value and the processing environment saturation degree as close as possible to the drying mode parametres, keeping the internal stresses value on the safe level. This processing method will permit to reduce the general process duration of wood drying and to make lower power inputs.

Conclusion. Research of humidity change nature of the surface and inside layers of pine wood is carried out while warming up in the unsaturated environment ($\varphi < 1$). The stretching internal stresses arising on the surface of assortments being warmed up were calculated. The conclusion about the warming up process safety for wood integrity was drawn.

References

1. Уголев, Б. Н. Деформативность древесины и напряжения при сушке / Б. Н. Уголев. – М.: Лесная пром-сть, 1971. – С. 63–64 с.

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