Influence of cyclic influences of temperature and humidity of the environment on durability of a lignotsellyulozny composite

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Abstract. Composite slabby material of low density with a filler from irrevocable waste of processing of flax and cotton and a matrix from thermoreactive binding can be used as heat-insulating material. Results of durability of material after cyclic tests are given.

1. Introduction
Increased requirements to durability aren't imposed to heat-insulating composite materials of construction appointment. However, it should be noted that heat-insulating materials as an element of building constructions are affected by changes of temperature and humidity. In practice to any change of temperature there corresponds change of humidity of air. At the same time owing to the proceeding processes of sorption desorption of water vapor the material of low density having a quantity of an open time periodically absorbs and gives moisture. Development of temperature and moist tension is a consequence of these processes that leads to decrease in durability of a composite.

2. Discussion of results
For heat-insulating plates, unlike constructional moisture resistant, durability and swelling on thickness after cyclic tests aren't normalized. But, in relation to use conditions, they have to keep operational indicators at the changes of temperature and humidity caused by atmospheric actions. In practice it is difficult to predict precisely duration and size of change of temperature and humidity of the environment in which composite material will be operated. Different time of moistening and drying, distinction in temperature and other factors significantly influence indicators of material and complicate their comparative analysis. Therefore, for comparison of results the standard method of cyclic tests of material [1] gives the most objective data.

Composite components differently react to fluctuations of temperature and humidity.
The lignotsellyulozny filler in these conditions a long time is rather resistant. According to E. Pokrovskaya, "IR spectrums of samples of wood of various age have shown lack of chemical changes in woody substance in time. There is only a quantitative change of components, and a lignouglivodny complex in the conditions of variable moisture … shows stability in time" [2].
So, J. Zhu notes that the sensitivity of lignocellulosic composites to humidity is still a problem, the properties of composite materials made of fibers of flax largely depend on the type of binder (thermoplastic, thermosetting materials or biomaterials) [3]. Use as a filler of fibres of linen and cotton ensures high strength characteristics of composite materials, the strength of the composites is inversely proportional to the fraction of lignocellulosic filler [5, 6].

The strength of the composite with lignocellulosic filler is determined by the strength matrix of a thermostet binder. Materials made using thermosetting resin, to a greater or lesser extent (this depends on the type of polymeric material) are subject to aging, which affects their operational performance. To evaluate the resistance of the material to the operating conditions allow the results of the cyclic temperature and humidity tests.

3. Experimental part

In the laboratory of the Department of Logging and wood industries (LDP) is investigated for resistance to temperature and humidity influences composite Board materials on the basis of the fillers from waste production of cotton and flax fiber based on the matrix of synthetic and inorganic adhesive [4].

The binder plates were selected: liquid glass (LGL) – Na₂O(SiO₂)n, (module n = 1.6 … 3.75), a phenol-formaldehyde resin (SFG-314) and homographische binder (AHF) CrAl₃(H₂PO₄)ₙ (n = 8.8 … 9.6) [4]. Composite material insulation purpose is manufactured of medium density 375 kg/m³, binder consumption 20 % by weight of the filler. The samples were dried at 80°C.

Cyclic temperature and humidity tests were carried out according to GOST 33121-2014 [1]. One cycle of temperature and humidity effects on the sample includes the following: the stay of the samples in water at 20°C for 20 hours, the freezing of wet samples at -20°C for 6 hours, thawing at 20°C for 16 hours and heating at 60°C for 6 hours.

The results of determination of physical-mechanical characteristics of the material are presented in the table. Figure 1 shows the variation of ultimate strength in static bending for plates from the waste of flax, made on the basis of different binder figure 2 – plates of cotton waste.

![Figure 1](image-url)

**Figure 1.** The ultimate strength for plates from waste flax in static bending, MPa after cycles of temperature and humidity influence: 1 – SFG-314; 2 – LGL; 3 – AHF
Figure 2. The ultimate strength for plates from waste cotton under static bending, MPa after cycles of temperature and humidity influence: 1 – SFG-314; 2 – LGL; 3 – AHF

| Material | A control sample | After the test cycle |
|----------|------------------|---------------------|
|          |                  | 1                   | 2           | 3           | 4           |
| SFG-314  | 0.203            | 0.164               | 0.134       | 0.137       | 0.121       |
| LGL      | 0.430            | 0.426               | 0.386       | 0.333       | 0.306       |
| AHF      | 0.285            | 0.218               | 0.189       | 0.159       | 0.145       |
|          | 0.462            | 0.371               | 0.350       | 0.290       | 0.280       |
|          | 0.356            | 0.306               | 0.275       | 0.185       | 0.171       |
|          | 0.491            | 0.429               | 0.420       | 0.344       | 0.318       |

4. Conclusions
Composites from waste cotton has lower than from the waste of flax, the strength at a static bend, and a big loss of strength after cycles of testing. The pattern observed for plates in thermosetting binder SFG-314 and materials for the inorganic binder – liquid glass and alumacraft.

The control samples for AHF have higher strength at a static bend in comparison with the plates on SFG-314 and liquid glass. However, after the first test cycle, higher values of residual strength shows a matrix of a phenol-formaldehyde binder for both types of lignocellulosic filler.

The residual strength after four cycles of testing for composites on the SFG-314 filled with cotton waste – 60 %, waste of flax 71 %.

Thus, the composite plate material of the irrevocable waste of the production of flax fibers on the basis of thermosetting phenol-formaldehyde binder has a high resistance to cyclic temperature and humidity effects and can be used as an insulating element for building structures.

References
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