MODELLING OF THE ENERGY NEEDED FOR MELTING OF THE ICE IN FROZEN WOOD ABOVE THE HYGROSCOPIC DIAPASON

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ABSTRACT

A mathematical model and an approach for calculation of the specific heat energy needed for melting of the ice in the wood above the hydroscopic diapason, q_{ice}, have been suggested. The model takes into account to a maximum degree the physics of the processes of melting of the ice, formed by both bound and free water in the wood. It reflects the influence of the temperature, wood moisture content, wood density, and for the first time also the influence of fiber saturation point u_{fsp} of each wood type on q_{ice} during wood defrosting and the influence of temperature on u_{fsp} of frozen wood.

An equation for calculation of the specific heat energy needed for melting of the frozen bound water in the wood above the hygroscopic diapason, q_{bwm}, has been derived, depending on the basic density of the wood ρ_b, on the wood moisture content u, on the fiber saturation point u_{fsp}, and on the initial temperature of the frozen wood t_0. An equation for easy determination of the specific heat energy needed for melting of the frozen free water in the wood, q_{fw}, has been derived as well, depending on ρ_b, u, and u_{fsp}. The specific heat energy q_{ice} equals to $q_{fw} + q_{bw}$.

For calculation of the q_{bwm}, q_{fw}, and q_{ice} according to the suggested model and approach, a software program has been prepared in MS Excel 2010. By means of the program, calculations have been carried out for determination of q_{bwm}, q_{fw}, and q_{ice} for frozen oak and poplar wood with moisture content from $u = 0.4\ \mathrm{kg \cdot kg^{-1}}$ to $u = 1.0\ \mathrm{kg \cdot kg^{-1}}$ at a temperature ranging from t_0 = –20 °C to t_0 = –1 °C, at which melting of the frozen water in the wood is completed.

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