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 hygroscopic diapason, \( q_{\text{ice}} \), 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 \( u_{\text{fsp}} \) of each wood type on \( q_{\text{ice}} \) during wood defrosting and the influence of temperature on \( u_{\text{fsp}} \) 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, \( q_{\text{bwm}} \), has been derived, depending on the basic density of the wood \( \rho_b \), on the wood moisture content \( u \), on the fiber saturation point \( u_{\text{fsp}} \), 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, \( q_{\text{fw}} \), has been derived as well, depending on \( \rho_b \), \( u \), and \( u_{\text{fsp}} \). The specific heat energy \( q_{\text{ice}} \) equals to \( q_{\text{fw}} + q_{\text{bw}} \).

For calculation of the \( q_{\text{bwm}}, q_{\text{fw}}, \) and \( q_{\text{ice}} \) 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 \( q_{\text{bwm}}, q_{\text{fw}}, \) and \( q_{\text{ice}} \) for frozen oak and poplar wood with moisture content from \( u = 0.4 \) kg \( \cdot \) kg\(^{-1} \) to \( u = 1.0 \) 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.

REFERENCES


