THERMAL CONDUCTIVITY OF SHEEP'S WOOL WITH PARAFFIN

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INTRODUCTION

The article is aimed at assessing the possibilities of modifying sheep's wool with a phase change material (PCM), which will not reduce the heat-insulating properties of sheep's wool but will improve its thermal absorption and heat accumulation.

- The addition of macrocapsules containing paraffin to sheep's wool does not cause a significant increase in thermal conductivity compared to pure sheep's wool
- The choice of PCM, which will not cause a decrease in the heat-insulating properties of sheep's wool, but will, on the contrary, improve its thermal absorption and ability to accumulate heat, is a perspective way of modifying sheep's wool for use in the construction industry.
- Modification of sheep wool using macrocapsules and microcapsules.

MATERIALS AND METHODS

Sheep wool was chosen as an insulating material because it is an ecological and renewable raw material and because of its thermal properties such as λ=0.04 W/m*K. According to literature research, paraffin waxes were chosen as PCM, which are closest to the required properties: melting point around 20 °C, latent heat (lt=160-180 kJ/kg), melting point (Tt=18-24 °C), specific heat capacity (c=2 kJ/kg*K), thermal conductivity coefficient (λ= min W/m*K). Modification of sheep's wool was carried out with paraffin macrocapsules. Macrocapsules are small containers or packages that contain PCM. A PE foil with a thickness of 0.2 mm. The macrocapsules had dimensions of 200x130 mm and were filled with 50 ml of paraffin. The individual macrocapsules were then joined by welding to form a uniform layer and thus a homogeneous structure was achieved (Fig. 2). The melting temperature of paraffin was verified on DSC (Differential Scanning Calorimetry). Subsequently, thermal conductivity was measured on a Heat flow meter. Sheep wool samples with dimensions of 600 x 600 x 60 mm were tested, in which the middle layer was formed by a paraffin macrocapsule.

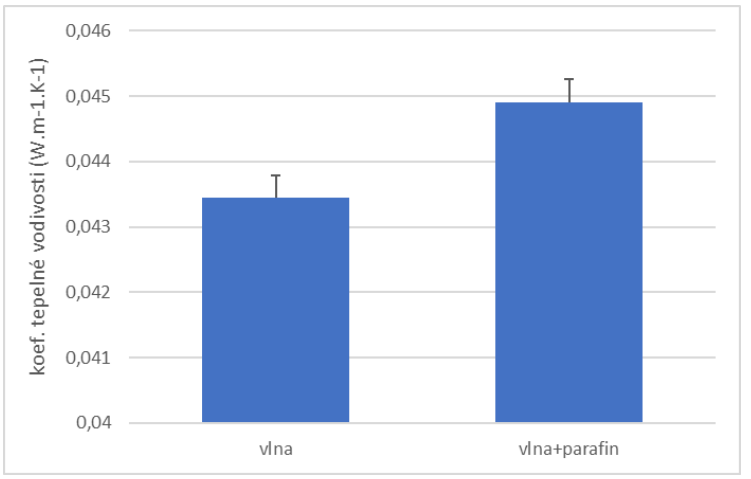

Figure 3: The figure shows a comparison of the measured thermal conductivity of pure sheep's wool and sheep's wool modified with one layer of paraffin macrocapsules. The thermal conductivity of sheep wool was 0.043441 W.m-1.K-1 (standard deviation was 0.0003 W.m-1.K-1). For modified sheep's wool, the thermal conductivity reached 0.044902 W.m-1.K-1 (standard deviation was 0.00035 W.m-1.K-1). Although the difference between the two values is statistically significant (p=0.05), the increase in thermal conductivity represents only 3.4%. The measurements showed very little variability (0.8%), the range of the sample thus roughly corresponds to the significance level of 95% and the accuracy of 99% of the results.

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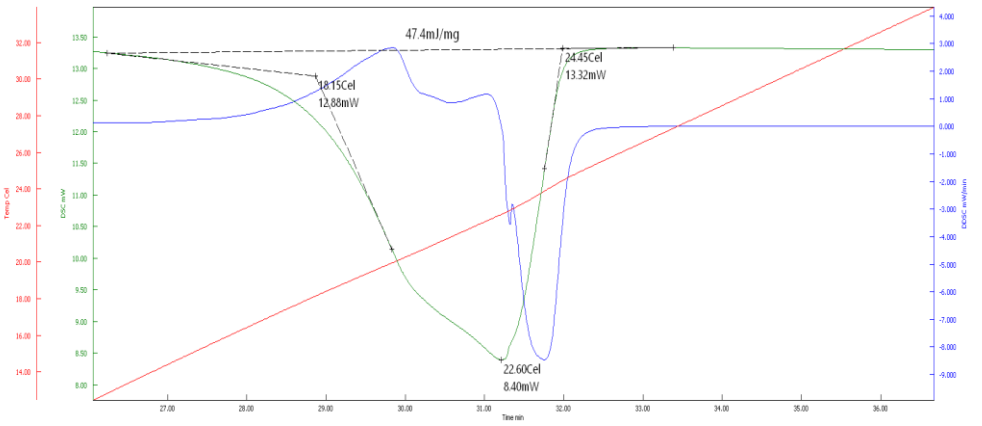

Figure 1: The thermal conductivity of pure sheep's wool and sheep's wool modified with macrocapsules was measured at an average sample temperature of 22.48 and 22.50°C.

Figure 2: To produce macrocapsules, a PE foil with a thickness of 0.2 mm was used. The macrocapsules had dimensions of 200x130 mm and were filled with 50 ml of paraffin. The individual macrocapsules were then joined by welding to form a uniform layer and thus a homogeneous structure was achieved.

RESULTS

Measurements of the coefficient of thermal conductivity of samples of sheep's wool with a layer of macrocapsules with paraffin showed that the addition of a layer of paraffin did not result in a significant increase in the coefficient of thermal conductivity. The measured values differed by 3.4% and were for pure sheep's wool 0.044902 W.m-1.K-1, respectively for modified sheep's wool with paraffin macrocapsules 0.044902 W.m-1.K-1. At the same time, we demonstrated the declared properties of paraffin, i.e. the melting point was 22-23 °C. It can be stated that one layer of paraffin macrocapsules increases the coefficient of thermal conductivity of sheep's wool by 3.4%. We consider this increase to be negligible. The results confirm that paraffin is a promising phase change material suitable for sheep wool modification without affecting its thermal properties. In the following experiments, we will therefore continue with the measurement of heat accumulation.

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