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German Sheep Wool - Insulation Material with a Future ?

For thousands of years sheep wool has been used for making clothing. The major part used for that is imported from abroad, because the wool is cheaper than that produced in Germany. For this reason German shepherds have problems selling their wool. Part of the problem is that shearing costs are not covered by the selling price. A possibility for improving income could come from marketing wool which is not suitable as cloth fibre. It can be used for insulation material, because sheep wool has good insulation properties.

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Keywords

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Insulation materials from sheep wool have beeen already for a long time on the market. Because of their good insulation abilities these products (mainly fleeces) often belong to the thermal conductivity group (WLG) 040. Therefore they are comparable with conventional insulation materials. In comparison with these products they have a better behaviour in the resorption and the release of moisture *(Fig. 2)*, due to the better ability of moisture storage (*Fig. 1*). This leads to a positive influence on the room climate. For this usage, mainly high manufactured fibres were used which must go through an expensive cleaning process. Additionally they need a special protection, because of their different chemical structures unlike to insulation materials made from plant fibres. They consist of polypeptides, not of polysaccharides. As it is known , textiles made of sheep wool are vulnerable to moths and beetles; the same is valid for insulation materials made of sheep wool or mixtures out of it. Fore this reason, the legislation prescribes a test for moth security. To avoid the destruction of the insulation material, the use of an insecticide e. g. Mittin-FF is necessary.

The consequence is a much higher price in comparison with other insulation materials, as well as with conventional products and products made of renewable and recycled raw materials like flax, hemp or cellulose. Flocks of cellulose (blow-in insulation materials) can be bought for 50 to 60 € per m^3, whereas sheep wool insulation materials only can be received for up to 180 € per m^3. However the price has an important influence on the behaviour of the buyer as shown in the results of the study on „Prospects of renewable materials in the insulation materials market.“ This has an negative influence on the market of insulation materials from sheep wool, in spite of the growing environmental consciousness.

A possible starting point could be the reduction of the processing of the sheep wool which leads to a significant reduction of the costs. The idea is the use of raw sheep wool only cleaned from dirt. In this way sheep wool from sheep races can be used which

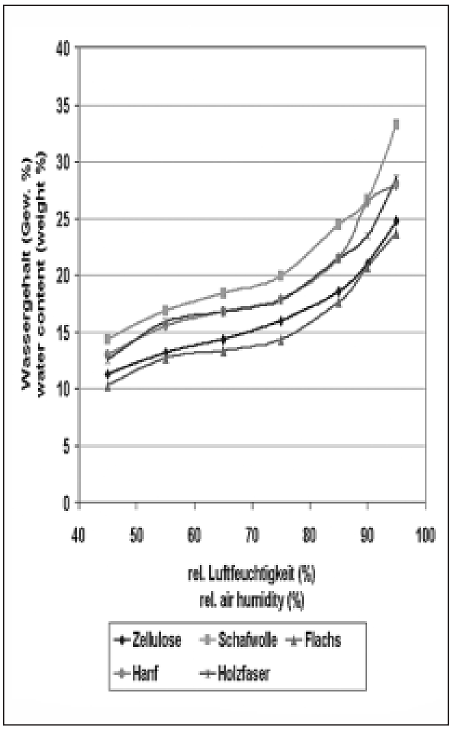

Fig. 1: Moisture content of sheep wool dversus temperature and humidity in comparison with other natural or recycled materials

otherwise could not be taken for the production of textiles.

Investigations on thermal conductivity

In co-operation with a company, working in the field of insulation materials and restoration, first investigations on the use of raw sheep wool were made. One possibility is the use of this wool as a blow-in insulation material in connection with short fibres from plants e. g. hemp and flax. Because of this component mixture the properties (e. g. thermal conductivity, density, reaction to moisture , blow-in abilities) can be changed and improved.

First experiments were made on the mixtures influence on the thermal conductivity. For this, different mixtures of sheep wool and hemp fibres were investigated. The measuring was executed following the DIN 52 612. The thermal conductivity of the samples (in wet conditions ($\lambda_{10;\,f.}$)) was measured first. After drying, the thermal conductivity of the dry material ($\lambda_{10;\,tr.}$) was calculated. At the end, a general surcharge of 20 % on the thermal conductivity (λ_Z) is added. This leads to the assignment of the material to the thermal conductivity group (WLG). The results showed that there will be a decrease in the thermal conductivity by a raising portion of the sheep wool. With the same density of 30 kg/m^3 (not dried conditions) a mixture of 50/50 weight % (λ_Z = 0,055 W/mK) showed a thermal conductivity 18 % higher than a mixture of 60/40 weight % (λ_Z = 0,047 W/mK). This correlates with the result that insulation materials made out of pure sheep wool have a lower thermal conductivity than insulation materials made from plant fibres (e. g. hemp and flax) at the same density.

Another point of research was the influence of the density on the thermal conductivity. The first samples which were tested have a mixture of 50 % sheep wool and 50 % hemp fibres. The thermal conductivity decreased from a value of $\lambda_{10;\,tr.}$ = 0,047 W/mK with a density of 22,3 kg/m^3 (dry weight) to 0,032 W/mK at 62,5 kg/m^3 (dry weight). Already with a density of 40 kg/m^3 (dry weight), a value of 0,037 was reached (*Fig. 3*). Thus this material can be put into the thermal conductivity group 045. Densities over 60 kg/m^3 (dry weight) lead to the group 040, comparable with products made out of pure sheep wool (like fibre mats). Depending on the used materials a lower price can be calculated.

For the usage of sheep wool/plant fibres mixtures as blow-in insulation materials the fibres were mixed and milled together to reach the necessary fineness of the fibres. By this way the elasticity and the setting behaviour of the product can be influenced. This is an important point concerning on the influence of the density on the thermal conductivity.

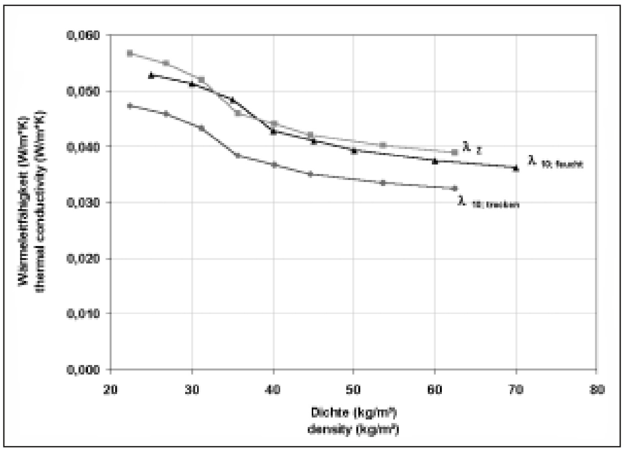

Fig. 3: Thermal conductivity versus density of a „blow-in" insulation materia,l made from 50 % sheep wool fibre and 50 % hemp fibre

Another possibility of the usage of sheep wool is the supply of cleaned long fibres as an insulation string (for wall insulation or gap insulation for doors and windows), without any addition of plant fibres. For insulation strings, the sheep wool is drilled together with a strong string to get stability. A sample of this material made from pure raw sheep wool was tested on it's insulation properties. At a density of nearly 35 kg/m^3 (dry weight) a thermal conductivity of $\lambda_{10;\,tr.}$ = 0,034 was measured. That means that this materials belongs to the thermal conductivity group 040. The thermal conductivity was lower at a lower density than the measured blow-in insulation material, but this material needs more sheep wool per m^3.

Conclusions

Based on the fact that there is no market for German sheep wool as material for textiles and a resulting low price, there is a good raw material source for insulation materials. By the use of this raw materials there should be a rise of production of materials which can fulfil the demands of the market, concerning quality and price. The portion of sheep wool products at the insulation market (total volume 3,3 million m^3/year) is currently 0,2 %. Sheep wool is a very good insulation material which can be manufactured, in combination with plant fibres, to low price and competitive products. First investigations on the thermal conductivity of the different manufactured forms (blow-in insulation; insulation strings), as well as the results concerning the humidity behaviour of the sheep wool, show that this is a possible way for using more native raw material. An additional opening up for the sale of sheep wool would support the shepherds in Germany. Products can be developed, which have a good eco-balance due to the reduction of the processing to the only necessary steps, a good energy saving effect and a positive CO_2 balance during production and lifetime.

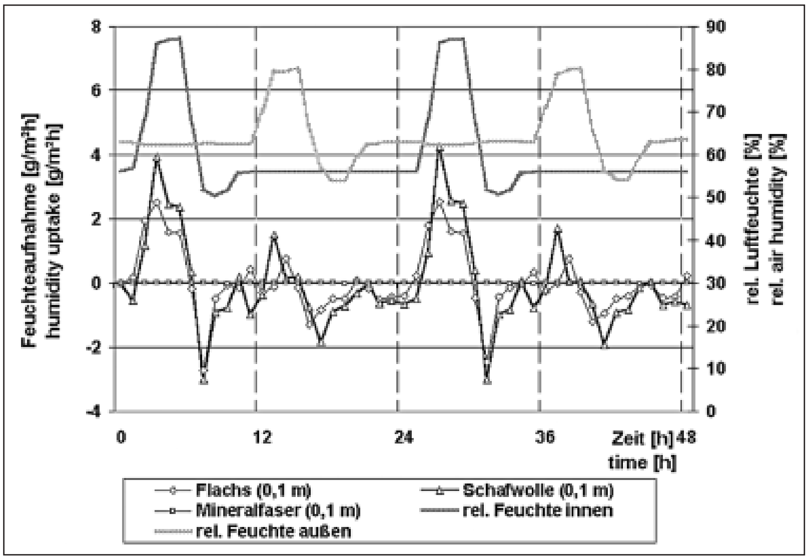

Fig. 2: Moisture absorption and moisture diffusion of sheep wool in comparson with insulation materials made from a flax product and a mineral wool product

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