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Fire Protection with Insulation Materials made from Renewable Raw Materials

The Influence of Fire Protection Compounds on Thermal Conductivity and Moisture Behaviour

Within the framework of a cooperative project sponsored by the FNR, the influence of fire protecting compounds for insulation made from renewable raw materials on thermal conductivity and moisture behaviour is being tested. The goal is to better assess the exact concentrations required, with the goal of maintaining the natural character of the insulation materials.

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The projekt is part of a cooperative project sponsored by the FNR (Fachagentur für nachwachsende Rohstoffe) with finance of the BMELV (Bundesministeriums für Ernährung, Landwirtschaft und Verbraucherschutz). Further partners in this cooperative project are the Institut für Baustoffe, Massivbau und Brandschutz (IBMB) of the TU Braunschweig, the Institut für Holztechnik (Ihd) in Dresden as well as the Fraunhofer Institut für Bauphysik (IBP) in Holzkirchen, what also has the project coordination

Keywords

Renewable raw materials, insulating material, fire protection, thermal conductivity, moisture characteristics

Insulation materials from renewable raw materials as all other building materials underlie the regulation of the legislation. These regulations guaranty security for the user. Especially for building materials from renewable raw materials two aspects must be regarded, on the one hand the fire protection and on the other the moisture behaviour.

The raising of moisture in the materials can be avoided if the materials are handled professionally, i.e. damages by the growth of fungi did not occur. In the case of fire it is different. The insulation material must have a protection before it is used in the building. The main products which are used are borate compounds. The question which is raised here is a question about the used concentrations. Are they necessary and how is their influence on the thermal conductivity, the moisture behaviour and how is this connected with the possible growth of fungi.

Thermal conductivity and fire protection

The investigations were started with the measuring the thermal conductivity of different insulation materials from renewable raw materials with different kinds of fire protection salts and different concentrations of them. The insulation materials were made from different raw materials like flax, hemp, wood fibre, wood wool, sheep wool and cellulose. All products from the list of the market installation program of the BMELV. Also prototype materials were investigated (e.g. mixtures from sheep wool and hemp fibres). The measurements were made on a new bought instrument („lambda-Meter EP-500 following EN 1946-2") (*Fig. 1a and 1b*). Samples up to a thickness of 200 mm can be measured with this instrument. Materials like pouring and plugging material were measured in a frame made of PU-foam with a thickness of 100 mm to avoid possible inhomogeneity of the materials. To get comparable results, a uniform density (approximately 65 kg/m^3) was used; otherwise the data of the manufacturers were used. The samples were measured in non-dried conditions, because this way the handling is better as if the materials must be packed into hermetically closed bags to avoid the uptake of humidity after drying. After the measure the samples were dried at 70 °C in a drying furnace with fresh air (DIN EN ISO 12570) and the estimated water content was used to calculate the thermal conductivity for the dry material (DIN EN 12667).

The samples were supplied with different fire protection salts with different concentrations and mixtures (borax, boric acid, ammonia phosphate, silicate and soda). Mainly borate compounds were used (*table 1*). Under the investigated materials products made from cellulose/waste papers were present. Based on a relative homogeneous raw material the different products showed changing thermal conductivity, depending on the content of fire protection salts (*Fig. 2*). The results of these measures show that the used borate compounds influences the thermal conductivity of the materials in different ways. The results for sample 1, consisting of 22 % fire protection salt and 78 % waste papers, showed the lowest thermal conductivity in comparison with the two other tested materials (sample 2 /18 % fire protection salt and sample 3 /11 % fire protection salt). Additionally the material had the highest moisture content. The reason for this can be found in the hygroscopic character of the used salts. If this behaviour is typical for all materials from renewable raw materials or especially for waste papers must be evaluated in further investigations with other fibre materials.

Result

It could be proven that the fire protection salt concentration in insulation materials from renewable raw materials has different influences on the building physical properties of the materials. This result contains courses of

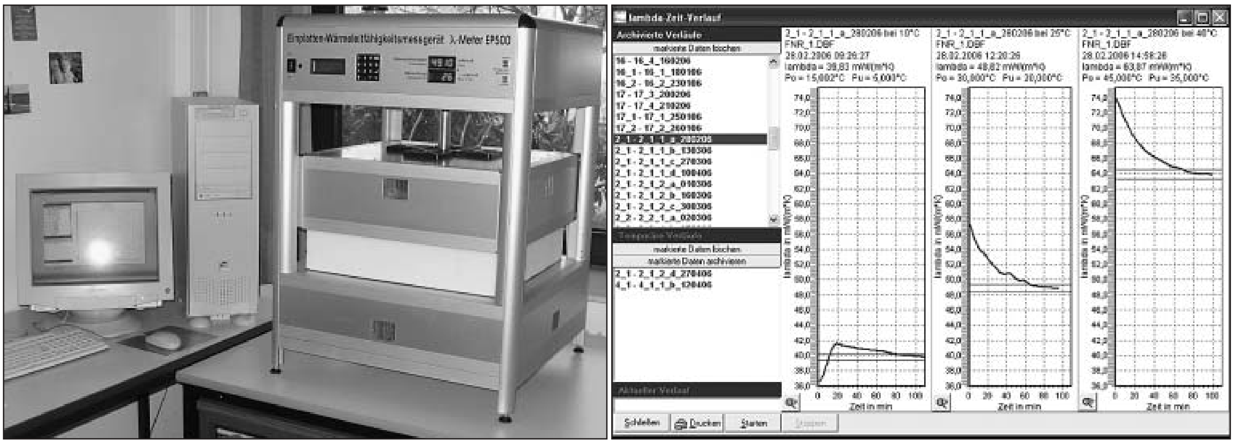

Fig. 1a and 1b: Instrument for measuring the thermal conductivity with the running control program

action for the variation of the fire protection salt concentration in the direction to a still more pollution free handling with additives to natural insulation materials for the maintaining their positive character.

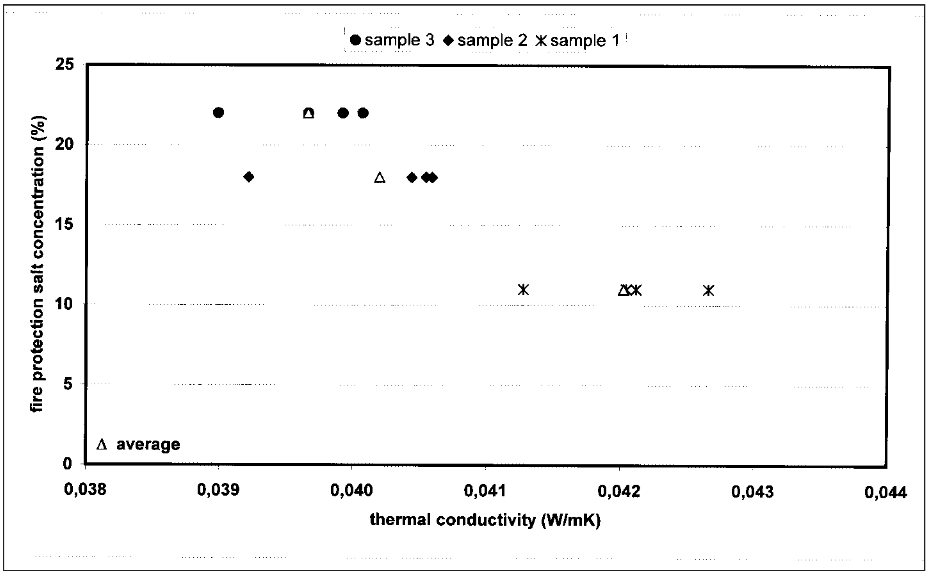

Fig. 2: Influence of the concentration of the fire protection salts on the thermal conductivity

Table 1: Results of the preliminary experiments

materials				λ_{10}						
kind of product	**composition**	**apparent density [kg/m³]**	**dry density [kg/m³]**	**moist [W/(m·K)]**	**dry [W/(m·K)]**	**SD**	**minus for moisture content**	**mass refering moisture content [%]**	**volume refering moisture content [%]**	**measures**
flax mat	flax, binding fibres, borate	63,2	57,9	0,0342	0,0322	0,0003	0,06	6,20	0,36	2
hemp mat	hemp, binding fibres, borate	53,5	50,8	0,0364	0,0350	0,0002	0,04	4,09	0,21	2
cellulose, blow in insulation	89 % Papier, 9 % Borsäure, 2 % Borax	69,8	64,7	0,0453	0,0420	0,0006	0,08	7,74	0,49	4
cellulose, blow in insulation	82 % paper, 7 % boric acid, 11 % borate	69,7	63,4	0,0440	0,0402	0,0007	0,09	9,39	0,59	4
cellulose, blow in insulation	78 % paper, 16 % boric acid, 6 % borate	69,9	62,8	0,0440	0,0397	0,0005	0,11	11,02	0,69	4
sheep wool, blow in insulation	100 % sheep wool	69,6	63,9	0,0394	0,0363	0,0006	0,08	8,45	0,54	4
sheep wool, blow in insulation	60 % sheep wool, 40 % hemp	66,6	61,2	0,0423	0,0391	0,0016	0,08	7,96	0,49	4
sheep wool, blow in insulation	50 % sheep wool, 50 % hemp	69,5	64,2	0,0475	0,0442	0,0009	0,07	7,43	0,48	4
sheep wool, blow in insulation	30 % sheep wool, 70 % hemp	69,5	64,3	0,0487	0,0452	0,0014	0,08	7,68	0,49	4
mat from cloth	fibres from cloth	42,0	40,5	0,0297	0,0287	0,0007	0,03	3,38	0,14	2
wood fibre plate	wood fibres	148,9	136,4	0,0392	0,0364	0,0002	0,08	7,68	1,05	2
cork plate	baked cork particles	113,4	109,6	0,0405	0,0395	0,0006	0,03	2,52	0,28	2