"THERMAL PROPERTIES OF POLYURETHANE (PUR) BASED MATERIALS"

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Introduction

Thermal behaviour properties of materials represent subject of high scientific interest at the present [1] due to a critical demand for optimal energy handling and utilization. The latter is motivated not only from financial point of view, but also from point of view of lowering carbon footprint of individual processes and products. Furthermore, the wise, effective and sensitive approach on sustainable production and behavior is also in agreement with valid EC policies focused on energy consumption and carbon footprinting in polymer processing industry and its supply chain [2]. For that reason, the aim of this paper was focused on interrelation between thermal behavior of polyurethane based materials (PUR) represented by means of thermal conductivity coefficient, thermal resistivity and materials micro structure, such as porosity, pore size distribution and density. As a tested PUR materials, the commercially available systems supplied by Gumotex, a.s., Břeclav, Czech Republic were: MOLITAN® - typy H1830, MH23, N2542, HR3836, H3543 cellular foams.

Thermal Conductivity, Program NeReg02

Thermal conductivity λ is physical property of material as well as it is constant of proportionality in Fourier law. In fact it is not in reality a constant. Practically in all materials thermal conductivity is a function of temperature (when we omit non-homogeneous materials, where as an addition the spatial position in the material structure will be added as another parameter). In many cases we need to assume, that thermal conductivity λ is constant. This assumption is simplifying our calculations. If this assumption is possible and correct or not depends on kind of material applied and especially on temperature interval in which latter material body is conditioned. Due to the fact, that the thermal conductivity of an air is four magnitudes lower than e.g. for copper or aluminium. Based on this came the knowledge, that gas presence in the solid materials is creating good insulators from them (polystyrene, cork wood, PUR etc.). Higher the thermal conductivity material has, lower the resistance for heat transfer from one side to another it exhibits (for simplification we can suppose planar wall). It means, if through such a wall one would like to transfer certain heat flow, e.g. 100 W, the relatively small temperature difference between both sides of the wall will be required. In the imaginary case when the thermal conductivity will be infinite the required temperature difference will be equal to zero. On the contrary, lower the thermal conductivity of the wall higher temperature gradient will be required for transfer of the same thermal heat flux of 100 W. The wall interpose higher thermal resistivity.

Program NeReg02 allows evaluation of the parameter a_3 and other statistical data in the first step of its processing. In the second step it is possible to evaluate correctness of the measurement by determination of the time dependence of the temperature and by the temperature dependence of the residual scattering. Next in the processing of data, it is possible to eliminate from the calculation outlier data which do not correspond to the mathematical model. Finally the calculation of the thermal conductivity proceeds on bases of the knowledge of the parameter a_3. Program NeReg02 allows evaluation of the data from the point of view of residual graphical analysis.

Experimental

Sample preparation

Cellular PUR materials were purchased in the form of blocks. From each material 5 samples were prepared for measurements repetition. Samples were cut in the form of cylinders having diameter of 90 mm. For testing commercial available materials purchased from Gumotex, Břeclav, Czech Republic were used. The latter materials are used in automotive, aerospace and building construction industries. The basic physico-chemical properties of the materials under study are given in Table 1. Studied samples were of polyether type as well as of polyester type of resin.

Table 1. *Porosity of studied materials.*

Material	*Solid material content (w. %)*	*Porosity (%)*
H1830	1,5086	98,49
MH23	1,8456	98,15
N2542	2,0076	97,99
HR3836	3,1316	96,87
H3543	2,8898	97,11
PUR foam	16,3256	83,67
PUR winter	32,2307	67,77

Results and discussion

Main results of thermal properties of selected materials are given in the Table 2. There is evident that the lowest thermal conductivity exhibit PUR material denoted as PUR winter. In detail correlation between physical properties and structural and chemical composition will be given during oral presentation.

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Material	*λ* $(W.m^{-1}.K^{-1})$	*R* $(m^2.K.W^{-1})$	*a* $(m^2 s^{-1})\times10^{-7}$
H1830	0,0247	0,208	9,12
MH23	0,0325	0,173	9,82
N2542	0,0246	0,232	6,81
HR3836	0,0269	0,196	4,78
H3543	0,0288	0,399	5,56
PUR foam	0,0222	0,294	7,48
PUR winter	0,0222	0,362	3,79

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Table 2. *Thermal properties of studied materials.*

Table 3. *Pore size distribution of studied materials.*

Pore diameter (mm)	*H1830*	*MH23*	*N2542*	*HR3836*	*H3543*	*PUR foam*	*PUR winter*
0,001-0,05	41	11	18	52	18	33	3
0,051 - 0,100	42	14	28	43	20	30	4
0,101-0,150	20	17	14	20	16	10	2
0,151-0,200	21	7	9	7	7	7	2
0,201-0,250	1	8	3	1	8	2	2