EVOLUTION OF THERMAL CONDUCTIVITY OF PU FOAMS

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In this work, we study aging process in polyurethane (PU) foams and provide framework for the assessment of their long-term heat insulation performance.

Rigid PU foams are widely used as heat insulation materials for buildings or pipes. Their excellent thermal properties derive from their low density, small cell size, and low conductivity of incorporated gas. PU foams are created by reactive foaming process, during which the foam is usually expanded by carbon dioxide, cyclopentane, or hydrofluorocarbons. However, these blowing agents gradually diffuse out of the foam and they are replaced by air. This process degrades heat insulation properties of the foam, because air has significantly larger thermal conductivity than the blowing agents.

We developed several mathematical models, which help us to predict the evolution of thermal conductivity of any PU foam. First, reconstruction algorithms based on sphere packing, Laguerre tessellation, and surface relaxation provide us with a model of foam morphology. Second, mass transfer models determine the effective diffusivity of the foam and the evolution of gas composition in the foam. Finally, conductive-radiative heat transfer model calculates the evolution of foam conductivity [1]. The models are efficiently coupled together using the MoDeNa multi-scale framework [2].

We measured the temperature dependence of solubility and diffusivity of oxygen, nitrogen, and several blowing agents in polyurethane. These properties are together with foam morphology used as inputs to the mathematical models. The validity of the model predictions was tested against a set of experimental data obtained from accelerated aging tests at elevated temperature.

[1] Ferkl, P., Toulec, M., Kosek, J., Laurini, E., Pricl, S., Fermeglia, M., Auffarth, S., Eling, B., Settels, V.: *Multi-scale modelling of heat transfer in polyurethane foams*. Submitted 2017.

[2] MoDeNa-EUProject. MOdelling of morphology DEvelopment of micro- and NAnostructures. 2015. url: https://github.com/MoDeNa-EUProject/MoDeNa.