Influence of Latent Heat on Thermal Conductivity Measurement

Frank Hemberger [C, S], Stephan Vidi, Harald Mehling and Hans-Peter Ebert
Energy Efficiency, Bavarian Center for Applied Energy Research, Wuerzburg, Germany
frank.hemberger@zae-bayern.de

Knowing a reliable value of the thermal conductivity close to a phase transition temperature region is of great importance for many technical applications. A striking example is utilizing the phase change solid-liquid for heat storage. The thermal transport properties in such a heat storage containing a phase change material (PCM) determine the velocity of the melting process and therefore the accessibility of the stored energy. The goal of this work was to study the influence of the phase change of PCM on different measurement methods for the thermal conductivity. A transient and a steady state technique were used for the measurements, respectively the hot-wire technique and a heat flow meter. The thermal conductivity in the melting range of a PCM was determined as a function of temperature. The paraffin octadecane was used as PCM with a melting range from about 25 to 27°C. To take care of the thermal expansion during the melting process a purpose-build specimen holder was used with the heat flow meter. The experimental results show a significant variation of the measured thermal conductivity values during the phase transition depending on the used measurement technique. Even changes in experimental parameters, i.e. electrical heating power for the hot-wire method, have an influence on the measured data. For the interpretation of the experimental data, numerical simulations for the different transient and steady state measuring methods were performed taking into account the temperature dependent latent heat effects from the melting process. The experimental and the simulation data are compared and the influence of the phase change is discussed. Recommendations for good measurement practice are given in order to obtain reliable values for the thermal conductivity with both methods nearby or in the temperature region of phase transition.