Diurnal Thermal Wave Tests of Thermal Insulation and Phase-Change Materials Using Fox Heat Flow Meter Instruments

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Diurnal (i.e. the 24-hour cycle) thermal waves using commercially available FOX Heat Flow Meter instruments can be very helpful for analysis and thermal property estimation of thermal insulation materials - in addition to the routinely measured thermal conductivity, thermal resistance according to ASTM C518, ISO 8301, EN 1946-3, EN 12667, and volumetric specific heat according to ASTM C1784 standards. New formulas for the thermal properties based on thermal waves theory, and the corresponding additional option for the FOX instruments' software were now developed and verified. Heat flow through the phase-change materials during the diurnal tests also can be recorded and analyzed providing unique and very useful information about the efficiency of these materials. The FOX Heat Flow Meter instruments running in this regime imitate conditions very much the same as in buildings' walls and roofs subjected to the slow diurnal temperature oscillations at their outer surface. One of the FOX instrument's plates can be maintained at a constant, e.g. 20 ^{o}C "room" temperature, and the other plate's temperature can slowly oscillate around some mean temperature with some prescribed amplitude. Both heat flow meters' readings (heat fluxes on both sides) are being recorded during the run and provide valuable information about performance of the insulation material sample, and its average thermal properties under such conditions. Imaginary and real components of the heat flows oscillations obtained using Fourier analysis contain information about the materials' thermal properties - thermal diffusivity and volumetric specific heat – which can be calculated using the new formulas. Both the time and phase shifts between heat fluxes on both plates and the oscillating temperature also can be determined. Size of the samples can be up to 1 m wide, or up to 0.25 m thick.