Accurate Transient Heat Flow Meter (THFM) Method for Express Tests of Thermal Effusivity

Dr. Akhan Tleoubaev

Abstract

Few years ago, author presented* new express procedure to evaluate vacuum super-insulation panels. Thermal effusivity (square root of the product of thermal conductivity x volumetric specific heat) can be quickly estimated using lower plate of the FOX Heat Flow Meter instruments (ASTM C518, ISO 8301, etc.). After placing flat sample on the warm (typically, 50-55C) constant temperature plate, heat flux between the plate and the flat sample sharply jumps up, and later becomes inversely proportional to the square root of time. It also is proportional to thermal effusivity of the sample's core material, and to difference between the plate's temperature and the sample's initial room temperature. If the heat flow meter's signal is being multiplied by the square root of time, then a ~stable value of the thermal effusivity can be made visible in about a minute or two, which makes this new express procedure the fastest one for thermal effusivity estimation, and especially useful for quality control of vacuum super-insulation panels, helping quickly to identify and discard defective panels with poor insulation property (i.e., with poor or no vacuum).

Now new, accurate formula for the Transient Heat Flow Meter (THFM) method's heat flux versus time, and thermal effusivity calculations (where approximate values of the heat flow meter's properties are now used in the calculations), is obtained, numerically verified, and presented. This new formula makes possible to get the flat sample's thermal effusivity value almost immediately after placing it on the warm heat flow meter plate maintained at constant temperature.

This new Transient Heat Flow Meter (THFM) method has obvious advantages because it is many times faster compared to the well-known Modified Transient Plane Source (i.e., flat heater) MPTS method, which inevitably needs long waiting time between tests for its heater to cool. The new THFM method can produce accurate thermal effusivity value practically immediately, and its heat flow meter is always ready for the next flat sample's test, because its plate is permanently kept at constant temperature.

Currently, prototype of the new automated device, where this new accurate formula will be used, is under development. Its heat flow meter (and its thermal resistance's) will be calibrated using NIST 1453 Standard Reference Material and special procedure.

*) A. Tleoubaev and P. Scotto. "Vacuum Insulation Panels Express Tests Using FOX Heat Flow Meter Instruments." Presented at the 13th International Vacuum Insulation Symposium - IVIS2017. September 20-21, 2017, CSTB, Paris, France