Heat capacity determination of low density insulation materials by calorimetry

INTRODUCTION

Maintaining acceptable temperatures in buildings (by heating and cooling) uses a large proportion of global energy consumption, leading to a high R&D interest in more efficient insulation materials. Among others, aerogels are interesting low density, low conductivity materials in which the liquid component of the gel has been replaced with a gas. Cp of such an insulation material is a key parameter that describes its aptitude to accumulate heat. As large sample masses are preferred for accurate Cp determination, the CALVET calorimeter is perfectly adapted for the measurement.

Figure 2 – Spaceloft® is a flexible, nanoporous aerogel blanket insulation in residential and commercial building applications.

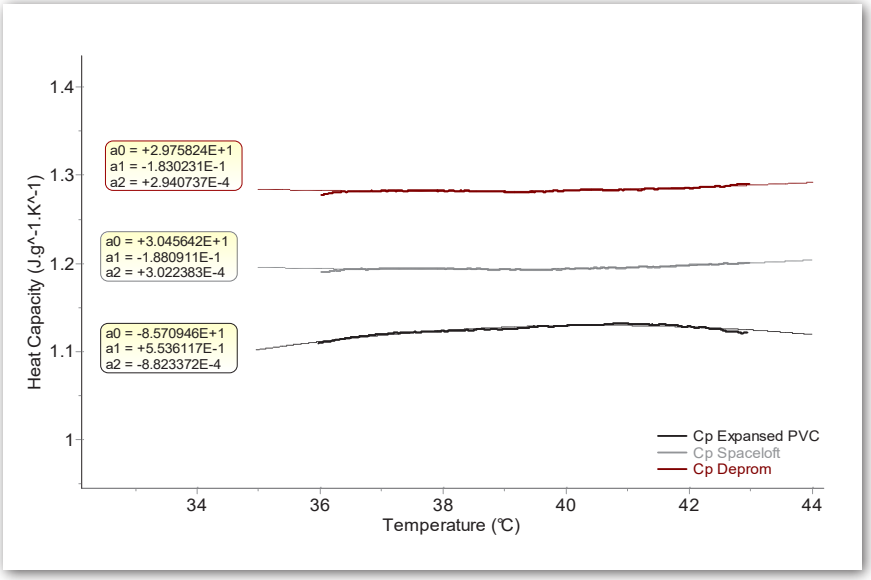

Figure 1 – Heat Capacity of the tested samples as a function of temperature

EXPERIMENT

Three materials were tested. Spaceloft® has a low density (150kg.m^{-3}) and extremely low conductivity (14mW/m.K at 40°C). Deprom is a common thermal insulator based on extruded polystyrene and with an extremely low density (40kg.m^{-3}) and low conductivity (27mW/m.K). Expansed PVC is relatively dense. Sample masses ranged from 300mg to 4g. All samples were heated from 30°C to 45°C at 0.15 °C.min^{-1}. A blank test with empty vessels was run using the same procedure.

RESULTS AND CONCLUSION

Heat Capacity is calculated from eq.1, where Ab and As are the HeatFlow signals for blank and sample tests respectively, and β is the instantaneous heating rate (see document TN149).

$$C_p = \frac{A_s - A_b}{m_s \times \beta} \qquad \text{Eq.1}$$

A polynomial regression can be obtained from the experimental data, in order to extrapolate to higher or lower temperatures. Here, the benefit of CALVET vessels is that they allow testing large sample volumes, meaning that samples masses are significant even with low density materials. Heat capacity differences as high as 0.1 J.g^{-1}.K^{-1} between Deprom, Spaceloft®, and expanded PVC samples are easily measured.

INSTRUMENT

CALVET

Ambient to 300°C

HIGHEST HEAT MEASUREMENT ACCURACY
3D sensor based on thermocouples with Joule effect calibration.

ISOTHERMAL OR TEMPERATURE SCANNING MODES
for increased flexibility and replication of real life conditions

CONVENIENT INTERCHANGEABLE CRUCIBLES AND CELLS
to perform even the most demanding experiments using one instrument :
- high pressure (500bar) and high vacuum
- pressure measurement and control
- mixing/stirring experiments.

EXTERNAL COUPLING CAPABILITY
designed to increase your research options including manometry, BET instrumentation, gas analyzers, humidity controllers and gas panels