

Title: Thermal resistance measurement at high temperatures using the guarded hot plate method

Abstract

The current ambiguity surrounding the standardised measurement of thermal resistance in insulation products is especially pertinent at high temperatures. CEN/TC89/WG14 has highlighted the need for the CEN Technical Specification 15548-1:2014 to be converted into a new EN standard and has established the areas of thermal resistance measurement that require further research to enable the development of the new standard. Proposals addressing this SRT should compare existing measurement standards for thermal resistance, carry out thermal resistance measurements in agreement with the new standard and perform a EURAMET intercomparison.

Keywords

Guarded Hot Plate, Thermal Conductivity, Thermal Resistance, Thermal Insulation Products, High-Temperature Protection Materials

Background to the Metrological Challenges

The European Construction Product Regulation (305/2011) recently issued harmonised product standards (EN 14303 to EN 14309, EN 14313, EN 14314 and EN 15501) from a regulatory framework, which requires proper certification of thermal insulation products before being marketed in the EU. In regards to the declaration of thermal conductivity/thermal resistance values of products, the level of agreement between reference laboratories is currently three times worse than the required level of 5 %, especially for measurements at elevated temperatures. To overcome this issue a new EN standard is being developed by CEN/TC89/WG14, which will build on the revision of CEN/TS 15548 1:2014 'Thermal insulation products for building equipment and industrial installations - Determination of thermal resistance by means of the guarded hot plate method – Measurements at elevated temperatures from 100 °C to 850 °C'. Further investigations are required to justify the selected mandatory limits for equipment and test conditions and reach the agreement among laboratories in different European countries.

Thermal conductivity and thermal resistance measurements around ambient temperatures are fulfilled via standards ISO 8302, EN 12667, EN 12939 and ASTM C177 with a level of accuracy and reliability adequate to meet the requirements of European regulations. However, these standards do not satisfactorily provide the basis for measurements at elevated temperatures (above 100 °C) and much work is still needed before the mandatory measurement requirements of European regulations for high-temperature thermal protection materials can be delivered through NMIs.

Wide discrepancy in the way data are reported has resulted from European material manufacturers, test laboratories and industrial end users of thermal protection materials being unclear about the relative equivalences of obligatory measurement standards from different standard organisations. A thorough comparison of the different measurement standards is therefore needed.

Furthermore, the current measurement standards do not provide a satisfactory basis for measurements at elevated temperatures (above 100 °C) and much work is still needed before the mandatory measurement requirements of European regulations for high-temperature thermal protection materials can be delivered through NMIs.

The EMRP project SIB52 Thermo is currently developing a European framework for characterising the performance of thermal protection materials at temperatures up to 800 °C, including many technical advances in measurement technology and capability. The High-Temperature Guarded Hot Plate technique is being improved or introduced at participating NMIs and the first European high-temperature thermal conductivity

reference materials for insulation are being developed based on a limited intercomparison. Further intercomparisons involving wider European laboratories are required to achieve European equivalency. SIB52 Thermo has also put together a comprehensive list of factors contributing to uncertainties in the measurement enabling the closer comparison of measurement capabilities among different laboratories but the comprehensive uncertainty assessments have not yet been disseminated to wider EU industry and test laboratories.

Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the protocol.

The JRP shall focus on metrology research necessary to support standardisation in the measurement of thermal resistance in insulation products at elevated temperatures.

The specific objectives are

1. To revise and establish the performance limits of high temperature guarded hot plates and test conditions relevant to the new EN standard being developed by CEN/TC89/WG14. The relative uncertainty of thermal resistance measurements carried out in agreement with the new standard must be $\leq 5\%$.
2. To carry out a EURAMET regional intercomparison of thermal resistance measurements at temperatures up to 850 °C using available reference materials developed within the EMRP project Thermo.
3. To develop calibration methods for temperature sensors installed within guarded hot plate apparatus, especially for centre-guard imbalance sensors up to 850 °C.
4. To undertake a comparison of different methods from documented measurement standards published for thermal resistance measurements by means of the guarded hot plate technique, including those published by ISO, CEN and ASTM.
5. To contribute to the standards development work of the working group CEN/TC89/WG14 to ensure that the outputs of the project are aligned with their needs, communicated quickly to those developing the standards and to those who will use them (e.g. European material manufacturers, test laboratories and industrial end users of thermal protection materials) and in a form that can be incorporated into the new standard being developed.

The proposed research shall be justified by clear reference to the measurement needs within strategic documents published by the relevant Standards Developing Organisation or by a letter signed by the convenor of the respective TC/WG. EURAMET encourages proposals that include representatives from industry, regulators and standardisation bodies actively participating in the projects.

Proposers should establish the current state of the art, and explain how their proposed research goes beyond this. In particular, proposers should outline the achievements of the EMRP project SIB52 Thermo and how their proposal will build on those.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 0.6 M€, and has defined an upper limit of 0.8 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 30 % of the total EU Contribution to the project.

Any industrial partners that will receive significant benefit from the results of the proposed project are expected to be unfunded partners.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the “end user” community (e.g. letters of support) is also encouraged.

You should detail how your JRP results are going to:

- Address the SRT objectives and deliver solutions to the documented needs, in particular CEN/TC89/WG14,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Transfer knowledge to the industrial sector e.g. building and materials industries.

You should detail other impacts of your proposed JRP as specified in the document “Guide 4: Writing Joint Research Projects (JRPs)”

You should also detail how your approach to realising the objectives will further the aim of EMPIR to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. Specifically the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased
- organisations other than NMIs and DIs to be involved in the work

Time-scale

The project should be of up to 3 years duration.

Additional information

CEN/CENELEC identified this topic as one of their priorities. Details are available at http://msu.euramet.org/current_calls/pre_norm_2016/documents/CEN_priorities/cen_priority_05.docx.