

Title: Improvement of emissivity measurements on reflective insulation materials

Abstract

Standard EN16012 stipulates that the external face emissivities of reflective insulation products must be measured to calculate thermal resistance. However, high discrepancies (0.06 for emissivity < 0.1) were found in a comparison study performed under CEN/TC 89/WG 12. The results of this comparison showed that the technique of measurement is not reliable when the emissivity is believed to be less than 0.05. CEN/TC 89/WG 12 has decided to review the methodology for emissivity measurement in order to improve existing primary techniques, ensure traceability and get uncertainties about 0.02 for calibration of reference samples and to allow end-users to perform measurements with uncertainty no more than 0.03

Keywords

Reflective, insulation, low emissivity, total hemispherical emissivity, thermal resistance.

Background to the Metrological Challenges

The principle of reflective insulation is based on the high sensitivity to emissivity, of the radiant heat power, exchange between two facing surfaces; the lower the emissivities of the surfaces, the lower the exchanged radiant power. Insulation systems based on this effect are usually said to be “reflective” or having “low emissivity”. This is because emissivity and reflectance are related (low emissivity = high reflectance). For efficiency, the two surfaces should either be separated by an empty gas space (a vacuum as in a Dewar) or filled with a low thermal conductive and static gas (air, argon). Knowing the emissivity of surfaces is therefore a crucial parameter for modelling the heat transfer coefficient between two surfaces. The parameter required for modelling radiant heat flux is the “total hemispherical emissivity” which is the emissivity integrated in all wavelengths and directions. A recent comparison of measurements techniques, on some reflective products, has shown high discrepancies (emissivity varying from 0.02 to 0.08 on the same product). The comparison was performed under CEN/TC 89/WG 12 and involved integrating spheres and commercially available portable instruments. The results of this comparison showed that the technique of measurement is not reliable when the emissivity is believed to be less than 0.05. This set a limitation in the CEN standard EN 16012 that any 'measured' value of emissivity less than 0.05 be rounded upwards to 0.05. This limitation is a limitation to product development and market innovation since a manufacturer cannot launch products with claimed superior emissivity below 0.05. As a result CEN/TC 89/WG 12 has decided to review the methodology for emissivity measurement so that, if or when an alternative and accurate method is developed, this can be incorporated into a revision of EN 16012.

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 the improvement and traceable measurement of total hemispherical emissivity low values from external faces of reflective insulation materials in response to the demand from CEN/TC 89/WG 12 on the EN 16012 standard.

The specific objectives are

1. To analyse and test the different techniques and instruments used by laboratories to characterise reflective insulations, describing the sensitivity of these techniques in relation to the specularity, transparency, spectral radiative properties and thermal inertia of the materials to be tested.
2. To improve and validate primary techniques of measurement from at least two NMIs in Europe. The primary, ideally independent, techniques must be able to measure total hemispherical emissivity below 0.1 with an uncertainty below 0.02. The primary techniques should also be applicable for materials with different ratios of specular reflectance/diffuse reflectance.
3. To establish calibration procedures for end-users by performing emissivity measurements on reflective insulations and to validate these procedures by comparing the techniques. Results should be in agreement within 0.03 for emissivity below 0.1.
4. To produce appropriate calibrated reference samples for instruments used by testing laboratories and producers of reflective insulations materials.
5. To contribute to a revision of EN 16012 and possibly of EN 15976 via the production of procedures, guidelines and recommendations to CEN/TC 89 WG 12 and CEN TC 254/WG 14 respectively.

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 project goes beyond this.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 0.4 M€, and has defined an upper limit of 0.5 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 deviation from this must be justified.

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,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Transfer knowledge to the insulation production industry.

You should detail other impacts of your proposed JRP as specified in the document “Guide 4: Writing a 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

This topic is in response to needs identified by CEN/CENELEC published at http://msu.euramet.org/pre_norm_2015/index.html#stage1-orientation (priority 12: Thermal emissivity of low surface emitting reflective insulation products).