EMRP Call 2010 – Industry & Environment

Topic number: SRT-27i

Title: Thermal conductivity metrology for high-temperature insulation

Abstract

The implementation of advanced, high-performance insulation and refractory products for high temperatures are essential for European process industries to increase their competitiveness by reducing losses of high-quality energy. However, international intercomparisons on high-temperature thermal conductivity measurement have reported 12 % disagreement. There is an urgent requirement to resolve existing metrological issues, develop new reference materials and to achieve European equivalence of 5 %. Improved performance data will enable industrial users to select the highest performing products, optimise thermal control of processes, and meet mandatory requirements for traceability and compliance with recently issued EU regulations.

Conformity with the Work Programme

This Call for JRPs conforms to the EMRP 2008, the need for appropriate determination of thermal transport properties, specifically mentioning insulation, is addressed on page 12 of the EMRP 2008 under the “Thermometry” section.

Keywords

Traceability infrastructure, thermal conductivity, advanced insulation materials, European regulation, European equivalence

Background to the Metrological Challenges

Temperatures in many industrial processes are being raised in order for them to operate with increased efficiency. In the case of energy production the trend of higher temperatures is being addressed within the previous EMRP call on Energy. However, the issues seen in industrial processes (e.g. heating, drying, cooking) are focused on different types of materials that require different measurement techniques and a more regulation based approach.

Insufficient knowledge of the thermal conductivity of insulation materials has lead to the obligation to make more full-scale tests during the development of process plants, furnaces and factories. This resource hungry approach increases the time and cost taken to implement the production of new technologies. Today’s thermal modelling capabilities provides an opportunity to design industrial systems far more efficiently. However, accurate thermal properties of materials is the main limit on the predictive power of thermal modelling and high quality data must be available to allow designers to precisely engineer these systems, rather than just adopting a costly over-engineering approach.

A new demand for thermal properties data is also emerging in the field of fire engineering for buildings, industrial facilities and transportation. Ensuring that the load-bearing capacity of structures is maintained for a long enough time to allow evacuation of people, depends upon the application of multifunctional materials that are able to both reduce energy consumption during normal use, but also act to protect structural integrity during a fire situation. This application will require thermal characterization of a wide range of new materials from room to high temperatures.

Significant progress in the measurement of low thermal conductivity materials has been made in the last twenty years, but most of the effort has been focused on those used in buildings/construction and driven by regulation. Until the recent issue of new CEN product standards for industrial insulation products, there has not been an infrastructure in which manufacturers of insulation materials could get

EURAMET, EMRP-MSU
National Physical Laboratory
Hampton Road, Teddington,
Middlesex, TW11 0LW, UK

Phone: +44 20 8943 6666
emrpA169@npl.co.uk
www.euramet.org

EMRP
European Metrology Research Programme
Programme of EURAMET

The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union

significant commercial advantage by developing advanced products or investing in improved measurement capability. This situation has meant that industrial designers and other end users do not have access to adequate performance data. Now that infrastructure is to be provided through the mandatory requirements of the new product standards, the science underpinning the measurement standards will quickly needs to improve.

Existing measurement standards (e.g. ISO 8302:1991 or EN 12667:2001) for measuring the thermal conductivity of insulating materials do not adequately account for the metrological and materials issues that are involved with making measurements at temperatures above ambient. A CEN consultative committee (TC 89) has a working group (WG11) that is looking at developing a new measurement standard (CEN/TS 15548-1:2007) to address the limitation of existing techniques/standards, but large gaps in technical knowledge and a lack of common understanding need to be tackled to allow this initiative to deliver impact to manufacturers and industrial end users.

The current agreement between reference laboratories of 12 % is not adequate to facilitate the development of improved insulation products or provide sufficiently accurate data for end users to enter into their process models. European equivalence needs to be improved to 5 % or better through improvements in metrology being standardised and through traceability being provided through new European certified reference material (none is currently available worldwide for this temperature range).

Scientific and Technological 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 JRP protocol.

The overall aim of the JRP is to develop metrological methods and tools addressing heat transfer in high temperature insulation as relevant for industrial applications. The JRP should provide validated and reliable measurements/methods with traceability wherever it is practicable to do so.

The specific objectives are:

1. Improved metrology for thermal conductivity of materials/products including modelling of radiant heat transfer, lifetime of high emissivity coatings thought thermal cycling, long-term stability of temperature sensors
2. Temperature measurement suitable for regions of heat flux; including thermal guarding systems
3. Measurement of the mechanical stability of components subject to temperature cycling
4. Certified reference materials for thermal conductivity in the ranges 0.02 $Wm^{-1}K^{-1}$ to 1 $Wm^{-1}K^{-1}$

Proposers shall give priority to work that meets documented industrial needs and that which supports transfer into industry e.g. by cooperation and/or by standardisation.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this. Proposers must ensure that they are familiar with the existing EURAMET funded Joint Research Projects (link below); you must explain how the project is different from the previously funded work, and describe the scientific and technological steps beyond the state of the art.

- ENG06 POWERPLANTS http://www.euramet.org/index.php?id=a169jrps

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community. This may be through the inclusion of unfunded JRP partners or collaborators, or by including links to industrial/policy advisory committees, standards committees or other bodies. Evidence of support from the “end user” community (eg letters of support) is encouraged.

Where a European Directive or Regulation is referenced in the proposal, the relevant paragraphs of the Directive identifying the need for the project should be quoted and referenced. It is not sufficient to quote the entire Directive per se as the rationale for the metrology need. Proposals must also clearly link the identified need in the Directive with the expected outputs from the project.

In your JRP submission please detail the impact that your proposed JRP will have on the regulation in this field.

You should also detail other Impacts of your proposed JRP as detailed in the document “Guidance for writing a JRP”

You should detail how your JRP results are going to:

- feed into the development of urgent standards through appropriate standards bodies E.g. CEN ISO etc
- transfer knowledge to the industrial sector.
- link to and build on the existing EMRP funded project ENG06 POWERPLANTS, and the related EMRP researcher grants.

You should also detail how your approach to realising the objectives will further the aim of the EMRP to develop a coherent approach at the European level in the field of metrology. 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 Member States and countries associated with the Seventh Framework Programme whose metrology programmes are at an early stage of development to be increased
- outside researchers & research organisations other than NMIs and DIs to be involved in the work

Time-scale

The project should be of 3 years duration.

New mandatory requirements for traceability to national standards and to EU regulations for high-temperature insulation products were published in November 2009 and the industry must comply within a period of thirty-three months. These requirements will not be able to be fully met without a significant improvement in the current level of metrology within Europe and without the availability of traceable reference materials. Therefore substantive progress is a matter or urgency and prospers should address the approach to enable early research findings to be transferred to the appropriate communities during the project lifetime.