WORKSHOP/TRAINING SESSION FOR STAKEHOLDERS AND END-USERS FROM INDUSTRY - 26TH NOVEMBER 2018

PRESENTATION OF THE EMIRIM PROJECT

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LABORATOIRE NATIONAL DE MÉTROLOGIE ET D'ESSAIS

Use of low emissivity to increase the thermal resistance of an insulation system

$$R_{air\ space} = \frac{1}{\frac{1}{R_{cond}} + \frac{1}{R_{rad}}}$$: Thermal resistance of the air space

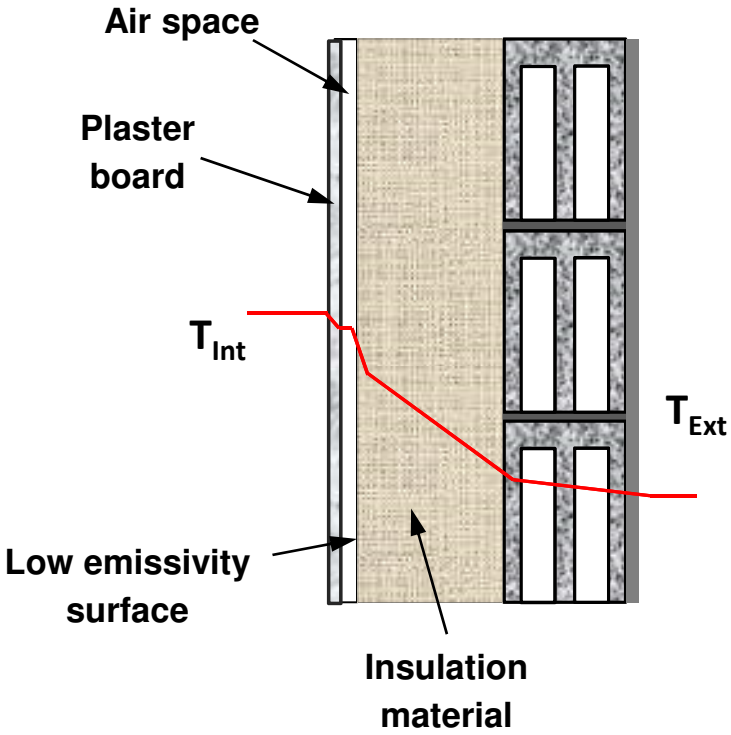
$$\Phi_{rad\ air\ space} = \frac{\sigma\ \left(T^4_{board} - T^4_{insul.}\right)}{\frac{1}{\varepsilon_{board}} + \frac{1}{\varepsilon_{insul.}} - 1}$$

$$R_{rad} = \frac{\left(T_{board} - T_{insul.}\right)\left(\frac{1}{\varepsilon_{board}} + \frac{1}{\varepsilon_{insul.}} - 1\right)}{\sigma\ \left(T^4_{board} - T^4_{insul.}\right)}$$

Calculation of thermal resistances of air spaces in building walls is described in ISO 6946 (Annex D).

Manufacturers of insulation products wanting the gain in thermal resistance due to the low emissivity and an air space to be considered must declare a total hemispherical value for their products.

Emissivity shall be measured in conformity with standard EN 16012.



Air space not too wide to not induce thermal convection in the space

Need for the project

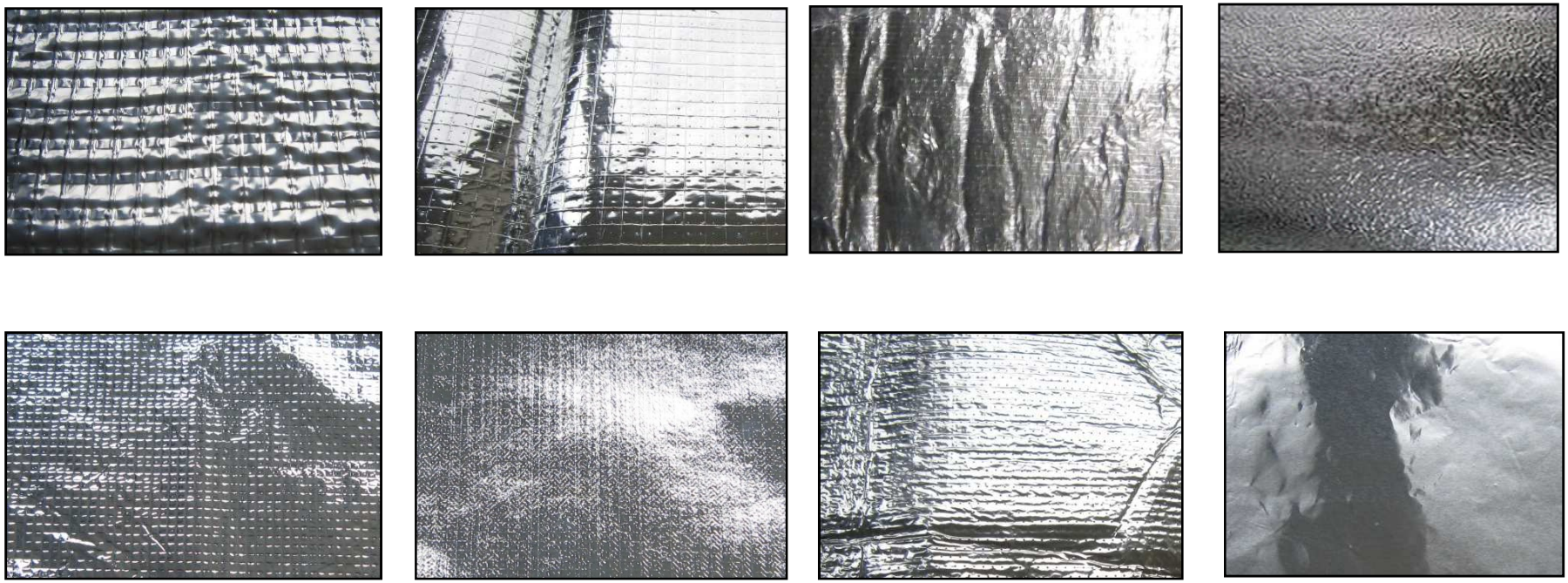
CEN/TC 89/WG 12 is responsible for defining test methods and declaration rules for the thermal performance of reflective insulation products to be marketed in EU.

A comparison managed by CEN/TC 89/WG 12 showed in 2013 high discrepancies between total hemispherical emissivity results obtained on 3 reflective foils (external foils of thermal insulations).

Laboratory	Test method	Sample A	Sample B	Sample C
1	TIR 100-2	0.02	0.08	0.02
2	TIR 100-2	0.02	0.08	0.02
3	TIR 100	0.02	0.08	0.03
4	FTIR + Int. sphere + calc	0.08	nm	0.06
5 (LNE)	Calorimetric total hemispherical emissometer	0.07	0.10	0.07
6	D&S emissometer	0.05	0.11	0.04
7	?	0.06	0.12	0.04
	Dispersion of results (max – min)	0.06	0.04	0.05

Low Emissivity Foils : high variety of structures of surfaces

High diversity of morphologies of surfaces



Specificities of reflective foils used in insulation products

- Low emissivity → Polyethylene (PE) foils aluminized overcoated with a thin PE layer for protection over the metal layer → desired characteristic = high IR reflectance of the apparent surface

- Aspect of surfaces = shiny → reflection quite directional locally (radiation reflected around specular direction) but they are not flat mirrors (not perfectly specular).

  - Foils often loosed and crumpled when tested in emissivity
  - High diversity of structures of surfaces
  - Reflective layer often overcoated (particular spectral reflectance curved with absorption bands).
  - Low areal density → Low thermal inertia.
  - Non planar surface

Need for the project

Sources of discrepancies were not identified at the end of the comparison.

Sources suspected : type of references used for calibration of instruments; sensitivity of instruments to the angular distribution of the reflected radiation, wrong procedures for calibration and/or measurement.

Result : CEN/TC 89/WG 12 set a limitation in the standard EN 16012 that any 'measured' value of emissivity less than 0.05 has to be rounded upwards to 0.05.

This situation is not satisfactory for manufacturers wanting to sell thermal insulation products with declared total hemispherical emissivity below 0.05.

CEN/TC 89/WG 12 expressed the need for improvement of total hemispherical emissivity of thermal insulation products with low emissivity .

Need expressed in the frame of the "**EUROPEAN METROLOGY PROGRAMME FOR INNOVATION AND RESEARCH (EMPIR)".**

EMPIR is the main programme of EU for European research on metrology. (https://www.euramet.org/research-innovation/research-empir/).

Project proposed : Consortium

A consortium of 10 partners submitted in 2016 (EMPIR Normative call) a proposal for a research project aiming to improve emissivity measurements on external surfaces of low E thermal insulation products for buildings.

Short Name	Full name	Country	Type of organisation
LNE	Laboratoire national de métrologie et d'essais	France	NMI
Aalto	Aalto-korkeakoulusäätiö sr	Finland	NMI
DTU	Danmarks Tekniske Universitet	Denmark	NMI
PTB	Physikalisch-Technische Bundesanstalt	Germany	NMI
FIW	Forschungsinstitut fuer Waermeschutz e.V. Muenchen - FIW Muenchen	Germany	Certification of thermal insulation products
IG	Istituto Giordano SPA	Italy	Certification of thermal insulation products
IPK	Fraunhofer Gesellschaft Zur Foerderung der Angewandten Forshunhg E.V.	Germany	Research Institute (techniques for production)
ZAE Bayern	Bayerisches Zentrum für Angewandte Energieforschung ZAE e.V.	Germany	Research in thermal sciences and use of energy
ACTIS	Actis S.A	France	Manufacturer of low E insulation materials
INGLAS	INGLAS GMBH & CO. KG	Germany	Manufacturer of emissometer TIR100-2

Project proposed : Technical objectives

1. **To understand why the techniques of measurement usually used can give non coherent results**. To analyse and test the main techniques and instruments used by end-users. The sensitivity of these techniques in relation to the specificities of the reflective foils (specularity, angular diffusion, transparency, spectral properties, thermal inertia and non-flatness of surfaces) will be investigated to enable the definition of the most appropriate types of reference samples for ensuring traceability.

2. **To improve and validate reference techniques** based on different principles of measurement from at least two NMIs in Europe. The reference techniques will be able to measure total hemispherical emissivity below 0.1 with an uncertainty below 0.02. They will be applicable to materials with different ratios of specular reflectance/hemispherical reflectance.

3. **To build new competencies in NMIs/DIs in order to produce appropriate calibrated reference samples** for characterising end-users instruments and for ensuring traceability of measurements, via calibration and measurement procedures developed in the project. Calibrated reference samples will also be produced for partners involved in the measurement techniques characterisation.

4. **To establish calibration and measurement procedures** enabling the end-users to perform emissivity measurements on reflective foils with an uncertainty below 0.03 for emissivities below 0.1.

5. **To participate to the revision of EN 16012 and EN 15976**, via the provision to CEN/TC 89WG12 and CEN/TC254/WG14 of amendments based on the technical results of the project. To communicate technical reports and guidelines on the calibration and use of end-users techniques to CEN/TC89WG12 and CEN/TC254/WG14. To disseminate the technical results of the project to the wider scientific and industrial community.

Structure of the project

WP 1 : Reference samples and reference techniques

- Improvement, adaptation of ref. techniques in NMIs → **uncertainty < 0.02** for low emissivity (total hemispherical emissivity).
- New methods for production of reference samples with same angular diffusion as reflective foils.
- Production of calibrated reference samples for WP2

WP 2 : End-users techniques and good practice guides

- Investigation of industrially used measurement techniques (characterization, uncertainty sources).
- Calibration and measurement procedures for end-users → **Uncertainty < 0.03**
- Validation of improved procedures by comparison
- Draft of improved sections of EN16012 and EN15976

WP 3 : Impact

Diffusion of knowledge gained in the project to end-users

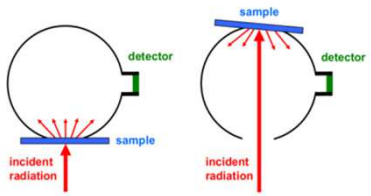
WP 3 : Management

Instruments used by end-users and tested in the project :

- TIR100-2 emissometer manufactured by INGLAS GmbH & Co. KG (Bermatingen – Germany)

  - Technique of measurement recommended by standard « EN 16012 : Thermal insulation for buildings — Reflective insulation products — Determination of the declared thermal performance".
  - Instrument used in EU by several organisations involved in certification of thermal insulation materials and by produceurs of those materials.
  - End-users using TIR100-2 satisfied for control of stability of a production.→ good fidelity.

- Infrared Integrating spheres associated to FTIR spectrometers



  - Technique of measurement recommended by standard « EN 16012 : Thermal insulation for buildings — Reflective insulation products — Determination of the declared thermal performance".
  - Instrument used in EU by several research institutes, by some organisations involved in certification of thermal insulation materials and by some produceurs of materials.

Partners :

Website : **http://projects.lne.eu/jrp-emirim/**

Thank you for attention

Questions ?