



Publishable Summary for 20NRM04 MetrIAQ Metrology for the determination of emissions of dangerous substances from building materials into indoor air

Overview

Given that European citizens spend more than 80 % of their time indoors, it is vital to have a healthy indoor environment. To achieve this, the release of harmful substances from building materials, such as paints, flooring, and from other products used indoors, such as furniture, into the air must be minimised. Reliable, accurate, traceable measurements of the emissions are paramount to reach high level consumer protection. The overall aim of the project is to develop traceable measurement of emissions of volatile organic compounds (VOC) from such materials, by providing well-defined emission reference materials (ERM) and certified reference gas standards (gCRM), in accordance with the emission test chamber procedure described in EN 16516. The project results will support the efforts to minimise the use of building products, that emit dangerous substances, thereby ensuring improved indoor air quality.

Need

EU regulation No 305/2011/EU (Construction Products Regulation, CPR) codifies that emissions from building products must be controlled in order to meet the formulated basic requirements (BR) for construction works. This takes place either on the manufacturer side or in test laboratories accredited under ISO/IEC 17025. EN 16516 describes a mandatory test procedure for the determination of VOC emissions from construction materials in environmental test chambers whose results are used for the Declaration of Performance (DoP) demanded by the CPR demonstrating conformity with the BR. Furthermore, the test chambers results will be used for the mandatory health-related evaluation of these products, once a harmonised evaluation concept defining emission classes is available in Europe. Comparability between measurement results is fundamentally important, as such, EN 16516 demands verification of the performance of the whole method by comparing against external references and the participation in round robin tests (RRT). For this purpose, both ERM and gCRM are urgently needed.

In recent times, studies related to the development of reference materials for emission test chamber measurements have focused mainly on investigating one or two VOCs (i.e. toluene and formaldehyde). However, the findings from these studies often do not consider long-term stability over a time period > 100 hours, in contrast to the standard testing time of 28 days. In previous RRT performed with commercial materials, the relative standard deviations of reproducibility between labs varied from 46 % to 300 %. In addition, a common factor with such approaches is a decreasing emission profile, thus making it difficult to predict the emission rate, which is essential for an external reference. All of these issues highlight the need for ERMs with reproducible and homogenous emission properties. The ERMs should also be supplemented with a suitable numerical model describing the mass transport inside the material which would enable the prediction of the VOC release and allow accurate performance verification of test chambers.

Suitable ERMs, that emit a known amount of a compound are currently not available, although a first approach of an artificial one on lacquer basis was made in the former EMRP project ENV01 MACPoll. However, shortcomings in its long-term stability and reproducibility between the batches have been identified and require further development. In addition, in view of the great variety of dangerous substances occurring in indoor air, the lack of availability of a gCRM hinders progress in this area.

Objectives

The overall goal of this project is to provide reference materials to improve the traceable measurement and characterisation of emissions of VOCs from materials for interior use according to EN 16516 and to provide CEN/TC 351/WG 2 and other standardisation committees related to materials emissions testing with validation data for future revision of their standards. The specific objectives are:

1. To develop an emission reference material (ERM) that contains and releases relevant compounds typically emitted by construction products within the range of the EU-LCI list with a constant emission profile that decreases by less than 10 % over at least 14 days, in order to improve the quality assurance and quality control (QA/QC) of the emission test chamber method as described in EN 16516.
2. To develop gaseous certified reference materials (gCRM) of indoor air pollutants for compounds selected from key groups that are relevant for the health-related evaluation of building products as stated in the EU-LCI-list, such as aldehydes, unsaturated aldehydes, cyclic dimethylsiloxanes and glycol compounds.
3. To validate the newly developed ERM and gCRM by investigating the short- and long-term stability, reproducibility, and uncertainty in an inter-laboratory comparison, thereby demonstrating the benefits of the reference materials for the test procedure described in EN 16516.
4. To develop a suitable numerical model for simulating the transport processes inside the ERM and the compound release into test chamber air enabling the prediction of the emissions for each of the selected target VOC. The model should support the customised generation of the ERM. All relevant process parameters affecting the release of the compounds from the material will be determined.
5. To contribute to the standards development work of the technical committees CEN/TC351 WG2 and ISO/TC146 SC6 to ensure that the outputs of the project are aligned with their needs, communicated promptly to those developing the standards and to those who will use them (e.g., test chamber operators and gas standards manufacturers), and in a form that can be incorporated into the standards at the earliest opportunity.

Progress beyond the state of the art

Within the preceding EMRP project ENV01 MACPoll an important approach towards a candidate ERM was made with a lacquer material that was added with a selection of VOCs. However, production reproducibility was only shown within the batch of the lacquer material and the emission profile for this decreased rapidly after its application. Furthermore, colligative effects of the added VOCs in terms of miscibility, volatilisation or chemical reactions during curing were reported.

This project will develop a material with retarded compound release leading to a temporarily constant emission profile or at least a significantly decelerated one. It will contain at least 4 VOCs, that are typically emitted from building materials and relevant for the health-related evaluation, e.g., furfural, 2-ethyl-1-hexanol, D5 siloxane or methyl isothiazolinone. Based on data obtained by material characterisation regarding all parameters that have an impact on the compound release, a numerical model will be developed enabling the calculation of the emission profile for any VOC introduced.

The availability of Primary Reference Materials in gaseous form (gPRM) and gCRM will be improved. Test gases provided by manufacturers today that contain compounds as stated in the EU-LCI list are mostly not certified and traceability to SI units is rarely demonstrated. The gPRMs and gCRMs developed in this project will establish the traceability chain for the measurement data of emissions of dangerous substances from building materials into indoor air.

By validation of relevant metrological parameters of the ERM, gPRM and gCRM and their use as reference materials for the verification of the performance of the test method EN 16516 in an inter-laboratory comparison, detailed data on the total measurement uncertainty involving all parts of the method will be provided for the first time.

Results

Development of an ERM with consistent emissions for QA/QC of the EN 16516 emission test chamber method (Objective 1)

A list of relevant compounds for the ERM, gPRM and gCRM was drawn up under consultation with the EU-LCI working group and the project's chief stakeholder. This list involves relevant compounds of the chemical groups of alkanes, glycols, aldehydes, terpenes, alcohols, aromatic hydrocarbons, isothiazolinones, and cyclic dimethylsiloxanes. These are representing typical emissions of building materials and are partly relevant to consumer's health.

First batches of reservoir materials serving as temporally constant emission source were produced and thoroughly investigated. Polymeric microcapsules loaded with single VOCs – currently n-heptane, toluene, limonene) – as well as zeolites impregnated with the target compounds under high pressure were used. Measurements of both types indicate eligibility for stabilisation of the emission profile. The project consortium is continuing to work on the optimisation of the process parameters. Once the target stability has been demonstrated, ways are sought to combine the reservoir materials into a multi-component material that can be safely delivered to the end user.

Development of gaseous certified reference materials of indoor air pollutants relevant for the health-related evaluation of building materials as stated in the EU-LCI list (Objective 2)

The compounds that have been selected for gPRM and gCRM are those demanded by EN 16516 in the so-called check standard, with the exception of hexadecane that cannot be used in gas cylinders due to its low volatility. Instead of 1,2,3-trimethylbenzene as prescribed by the test standard, the consortium in consultation with the stakeholder advisory board has selected 1,3,5-trimethylbenzene. The former is only available in poor purity, which cannot be used in a reference material. In addition to that, a gPRM for formaldehyde will be developed.

Two types of cylinders with inert inner surfaces for the preparation of the gPRM and two types of adsorbents for the gCRM (Tenax TA and multi-bed) have been selected. Dynamic methods have been set up to generate a gas mixture of the selected components in air according to ISO 6145-4. The dynamic gas mixture has already been used to sample sorbent tubes to obtain the first gCRMs, which have initially been used to set up a high-accuracy analytical method.

In the next phase of the project, the gPRM end mixture in the low ppm level will be prepared from mother mixtures with single components according to ISO 6442-1 and undergoes short- and long-term stability tests. An uncertainty of 5% is targeted at a shelf life of 1 year. The gPRM will finally be used for the validation of the gCRMs.

Validation of the newly developed ERM, gPRM and gCRM (Objective 3)

In this objective the reference products undergo internal and external validation involving an inter-laboratory comparison with the stakeholder community. The work on this objective has not started yet.

Development of a suitable numerical model to predict the compound release out of the ERM (Objective 4)

Experiments have been started to identify the transport controlling steps in the ERM. At first, work has been performed in an empty emission chamber to investigate the reproducibility and spatial distribution of the main parameters which are expected to impact the emission rate of the ERM, such as temperature, pressure, and fan velocity. This is a step towards determining the contribution of the test chamber to the overall measurement uncertainty.

For the next step, measurements with interim versions of the ERM will be carried out under varying chamber parameters.

Impact

During the first nine months of the project, to maximise the impact of the project and ensure a wide dissemination of the knowledge generated, a website was created (<https://www.bam.de/metriaq>) and a stakeholder advisory board with 19 members was set up containing representatives from the EU-LCI working group, indoor emission testing laboratories, labelling schemes, manufacturers of construction products, regulators, and standardisation bodies. News is furthermore posted in the LinkedIn group “VOC measurements”. Any activities undertaken so far are summarised below.

Impact on industrial and other user communities

The relevant industrial user communities will already be involved in the validation of the ERMs and gCRMs developed in this project. After validation, these communities will be able to uptake the project outputs for: (i) providing reliable emission testing data with a properly estimated uncertainty; (ii) complying to the QA/QC measures required by the relevant testing standards (EN 16402, EN 16516, EN 16738, ISO 12219 series, ISO 16000 series); (iii) organising RRT to monitor the proficiency of test laboratories; and (iv) calibration of analytical instruments. Moreover, emissions from building materials and wooden showcases in museums or galleries or from cultural heritage artwork itself can affect indoor air quality. The comparable and accurate measurement of VOCs released from artworks is a critical point for conservation and monitoring of artwork state.

The project will engage with industrial and end user communities through the set-up of its Stakeholder Advisory Board (SAB).

- Introduction of project and discussion of first results on the occasion of the “1st Meeting of the MetrIAQ Stakeholder Advisory Board” on 16 February 2022, online.

Impact on the metrology and scientific communities

NMIs/DIs will be able to produce the ERMs developed and validated during the project and have access to ERMs that emit a larger number of substances thereby extending their portfolio of reference materials. This in turn will provide the stakeholders from testing institutes, labelling schemes, and industry with guidelines for using the ERMs to ensure uniform use and the best possible performance. Specifically, BAM and FhG intend to commercialise the ERM and make it available to stakeholders. In addition, BAM will use the ERMs to organise an internationally recognised RRT for the emission test chamber method according to EN 16516 and ISO 16000-9. Further to this, VSL intends to develop new calibration services on the project’s development of dynamic and static reference materials.

The partners in this consortium are actively involved in the CCQM Gas Analysis Working Group (GAWG) and in EURAMET Metrology in Chemistry Technical Committee (TC-MC) and the outputs from this project will be presented to them. The successful development of gPRMs and gCRMs will support the organisation of future Key Comparisons organised by the CCQM GAWG and EURAMET TC-MC and will allow new calibration and measurement capability claims in the field of indoor air and VOC analysis. The gained know-how can be used by the scientific community and by other reference material providers for the preparation of similar calibration standards.

Research results achieved during the project will be submitted for publication in high impact peer-reviewed scientific journals. A workshop and online webinars on the preparation of traceable and accurate gCRMs and ERMs will be held, to which representatives of industry (both manufacturers and users), academic, standardisation and users will be invited. Young academics will be promoted by integrating the project’s approaches in designing functional materials in the master course “Architecture” held at POLITO.

Impact on relevant standards

The project will provide impact for all standards describing procedures for the determination of chemical emissions from materials for interior use and requiring the use of emission test chambers, such as EN 16516, EN 16402, EN 16738, ISO 16000 series, ISO 12219 series. They all have similar QA/QC requirements in common and recommend the use of external references. With the validation data acquired in this project the total uncertainty of measurement results obtained with the test chamber method will be determined and delivered in form of reporting documents to the respective standardisation committees for use in upcoming revision work.

- Formal information of CEN/TC 351/WG 2 on start of the project, June 2021

Through interaction with ISO/TC158 “Gas Analysis” data on the performance characteristic of gas generators can be used to improve documentary standards such as those on dynamic methods for preparation of

calibration gas mixtures (e.g., ISO 6142-1, ISO 6145-4 and ISO 6145-8). Further to this the project intends to provide input to the standardisation committees ISO/TC61 SC11 Products, ISO/TC146 SC6 Indoor air and CEN/TC421 Emission safety of combustible air fresheners.

Longer-term economic, social and environmental impacts

The project hopes to support the longer-term market position of European manufacturers of low-emitting products through the availability of better reference materials and hence increased reliability of testing. Once, the declaration of emission data for CE marking is mandatory, more reliable testing will also increase consumer confidence in the product and the manufacturer, and thus increase sales. A similar effect on voluntary evaluation schemes that help consumers make decisions when choosing low-emitting products is also expected. Moreover, an improved comparability in emissions tests strengthens customers' trust in these labels, promotes fair competition between manufacturers, and safeguards the European common market in building future products.

The improvement of the metrological infrastructure in the field of materials emissions testing supports the long-term European harmonisation of the health-based evaluation of indoor emissions from construction products regulated by the CPR. This will support a higher level of consumer protection and should improve the health and well-being of the citizens. Furthermore, the results of this project might give additional impetus to those European member states that still are in the early stages of implementing an infrastructure for emissions testing, such as Slovenia.

- Press release “BAM develops reference material for better indoor air”, published on 4 November 2021

List of publications

No publications yet.

Project start date and duration:		01 June 2021, 36 months
Coordinator: Dr Matthias Richter, BAM		Tel: +49 30 8104 4132
Project website address: https://www.bam.de/metriaq		E-mail: matthias.richter@bam.de
Chief Stakeholder Organisation: GEV – Association for the Control of Emissions in Products for Flooring Installation, Adhesives and Building Materials		Chief Stakeholder Contact: Klaus Winkels klaus.winkels@emicode.com
Internal Funded Partners:	External Funded Partners:	Unfunded Partners:
1. BAM, Germany	4. Eurofins, Denmark	-
2. TUBITAK, Turkey	5. FhG, Germany	
3. VSL, Netherlands	6. POLITO, Italy	
	7. VITO, Belgium	
	8. ZAG, Slovenia	