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. 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 of building products must be controlled in order to meet the formulated basic requirements (BR) for construction works. This takes place either on manufacturer side or in test laboratories accredited under ISO/IEC 17025. Reliable, accurate, traceable measurements of the emissions are paramount to reach high level consumer protection.

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, they 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. 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. Moreover, 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 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 can be identified that 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.

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.

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 and results

No ERMs with known emission properties exist for the verification of test results of VOC emissions from building materials and other products used indoors. Currently, in comparison exercises, mostly commercial products are used (e. g. flooring, paints, etc.), which often show a lack of reproducibility and consequently lead to unacceptable relative standard deviations (RSD). An important approach was made in the preceding EMRP project ENV01 MACPoll with a lacquer material that was added with a selection of VOCs. The lacquer material was homogeneous and stable, 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 go beyond this by developing a material with retarded release of the selected VOCs leading to a temporarily constant emission profile or at least a significantly decelerated one. It will contain at least 4 VOCs 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 thorough 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 Finite Element Model (FEM) developed in the preceding EMRP project ENV56 KEY-VOCs will be taken as basis and optimised.

Primary Reference Materials in gaseous form (gPRM), which are internationally recognised gas standards of the highest quality produced by NMIs, and gCRM are available for numerous compounds in the outdoor atmosphere, which are only partially relevant for the metrology of indoor air quality. Most building materials emit VOC with lower volatility or even semi-volatile organic compounds (SVOC). Although manufacturers provide test gases for some of these components (e.g. propenal, butenal, decamethylcyclopentasiloxane) they are mostly not certified and traceability to SI units is rarely demonstrated particularly for compounds with low LCI values as stated in the EU-LCI list. 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.

Moreover, this project will ensure both the validation of the relevant metrological parameters of the ERM, gPRM and gCRM, i.e. short- and long-term stability, reproducibility of preparation and estimation of the relative material uncertainty. The suitability of their use as reference materials for the verification of the performance

of the test method EN 16516 will be furthermore assessed in an inter-laboratory comparison. This will be the first detailed investigation on the total measurement uncertainty involving all parts of the method, such as sampling, chamber performance (recovery) and analysis. CEN/TC 351 WG 2 (Emissions form construction products into indoor air), responsible for the development of the standard, but also other related standardisation committees, inter alia ISO/TC 61 SC 11 (Products), ISO/TC 146 SC 6 (Indoor air) or CEN/TC 421 (Combustible air fresheners), will be able to use this validation data for precision and accuracy specifications in future revision work.

Impact

Impact on industrial and other user communities

The relevant industrial user communities, such as testing laboratories, labelling schemes, industrial companies operating own test laboratories or test chamber manufacturers 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 16516, ISO 16000 series); (iii) organising RRT to monitor the proficiency of test laboratories; and (iv) calibration of analytical instruments. The use of the project's developed ERM is not intended to be limited to the test procedure for emission tests of construction materials but universally applicable for procedures that require the use of emission test chambers, such as ISO 16000 parts -24, -28, EN 16738, EN 16402, parts -1, -4, -5, -6, -7 of the ISO 12219 series.

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) which will include representatives from the EU-LCI working group, indoor emission testing laboratories, labelling schemes, manufacturers of construction products, regulators, and standardisation bodies.

Impact on the metrology and scientific communities

The project intends that NMIs/DIs will be able to produce the ERMs developed and validated in this project. This means that NMIs/DIs will have access to ERMs that emit a larger number of substances and to be able to extend their portfolio of reference materials. This in turn will provide the stakeholders from testing institutes, labelling schemes, and industry with guidelines for their use 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. In general, this project will gain knowledge and experience on the preparation of gaseous reference materials, using both static and dynamic methodologies and sorption materials as transfer standards. The gained know-how can be used by the scientific community and by other reference material providers for the preparation of similar calibration standards. The use of these new developed materials (gPRM and gCRM) will also significantly improve confidence in the measurement of dangerous substances from building materials into indoor air.

Research results achieved during the project will be submitted for publication in high impact peer-reviewed scientific journals. Furthermore, good practices guides will be drafted and published, which outline reference material production, the handling of the ERMs and gCRMs, the sampling and the analysis. A workshop and online webinars on the preparation of traceable and accurate gCRMs and ERMs will be held as part of the knowledge transfer, 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

CEN/TC 351/WG 2, which has developed EN 16516 has expressed the need for accurate and traceable references in the CEN/CENELEC priority research Topic No. 1 to this EMPIR Call. 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.

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

This 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. Further to this, 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, e.g. Slovenia.

<table>
<tr><td colspan="2">Project start date and duration:</td><td>01 June 2021 (duration 36 months)</td></tr>
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<tr><td colspan="2">Chief Stakeholder Organisation: GEV – Association for the Control of Emissions in Products for Flooring Installation, Adhesives and Building Materials</td><td>Chief Stakeholder Contact: Klaus Winkels</td></tr>
<tr><td>Internal Funded Partners:
1. BAM, Germany
2. TUBITAK, Turkey
3. VSL, Netherlands</td><td>External Funded Partners:
4. FhG, Germany
5. Eurofins, Denmark
6. POLITO, Italy
7. VITO, Belgium
8. ZAG, Slovenia</td><td>Unfunded Partners:</td></tr>
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