

Title: Metrology for the determination of emissions of dangerous substances from building materials into indoor air

Abstract

Products such as building materials and furniture, emit VOCs (volatile organic compounds) that are ubiquitous in indoor air which can cause sensory irritation and health complaints. Given that European citizens spend more than 80 % of their time indoors, it is vital to have a healthy indoor environment. This can be achieved by controlling the emission sources and by eliminating or limiting the release of harmful substances into the air. Based on EU regulation No 305/2011/EU, the EN 16516 standard establishes a mandatory test procedure for the determination of emissions of dangerous substances from building materials into indoor air by use of emission test chambers. However, reliability and comparability of measurement results is currently compromised due to the lack of well-defined emission reference materials (ERM) and traceable gaseous certified reference materials (gCRM). Both are required to ensure reliable comparability of indoor air emission measurement. Proposals addressing this SRT will focus on the development of well-defined emission reference materials (ERM) and gaseous certified reference materials (gCRM) for indoor air pollutants, as demanded by EN 16516.

Keywords

EN 16516, indoor air, emission reference materials, reference gas standards, material emissions, emission test chamber, volatile organic compounds

Background to the Metrological Challenges

VOC emissions can cause health issues often referred to as the “Sick Building Syndrome” (SBS). A healthy indoor environment can be achieved by controlling the sources and by eliminating or limiting the release of harmful substances into the air. One way to mitigate this issue is to use building materials that are proven to be low VOC emitting. EU regulation No 305/2011/EU lays down basic requirements for construction works, saying that they should “not be a threat to the hygiene or health and safety of workers, occupants or neighbours [...] as a result of [...] the emissions of dangerous substances, volatile organic compounds, greenhouse gases or dangerous particles into indoor or outdoor air [...]”. In order to comply with requirements of EN 16516, laboratories accredited under ISO/IEC 17025 must ensure their measurement results are traceable to SI-units and explain the associated uncertainty to show their conformity assessment. To enable these verifications, stable ERMs are urgently needed. Since such suitable ERMs are currently not available on the market, commercial products are being used for this purpose (e.g. flooring, paints, etc.) but show a lack of reproducibility.

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 (toluene and formaldehyde). 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 round robin tests (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 the decreasing emission profile, thus making it difficult to predict the emission rate, which is essential for an external reference. This further underpins the need for ERMs with reproducible and homogenous emission properties, 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.

At present, gas sampling is normally carried out on adsorbent tubes, and the analysis by thermal desorption gas chromatographic techniques. Since relevant target compounds on the EU-LCI list are limited, and due to the lack of suitable reference gas standards, calibration and quality control (QC) measures are normally carried

out by use of liquid VOC standard solutions. In most cases, these test solutions are homemade, bringing about an additional source of measurement uncertainty. Important approaches towards the availability of primary gas standards of indoor related components have also been made in the EMRP projects ENV01 MACPoll and ENV56 KEY-VOC. Due to the different physical-chemical properties of the compounds the availability of both gas standards in gas cylinders and in the form of transfer standards, e.g. well-defined sampled adsorbent tubes, particularly for higher boiling VOCs should be advanced. The sink-effect in exposure chambers have been investigated and recovery tests are described in EN ISO 16000-9. However, the validation of the chamber and the total measurement uncertainty of the measurement results have not been yet addressed. As such, there is a particular need for reference materials for aldehydes (e.g. furfural), unsaturated aldehydes, (e.g. butenal), cyclic dimethylsiloxanes (e.g. decamethylcyclopentasiloxane (D5)) and glycol compounds (e.g. diglyme).

For the improvement of the internal and external quality assurance infrastructure of independent testing laboratories and a better comparability of test results, which are the basis for the health-related evaluation of building materials used indoors, the availability of both validated ERM and traceable indoor-related gas standards in the form of gCRM must be ensured. Overall, novel ERMs and gCRMs need to be developed and validated to enable chamber operators to implement the QA/QC requirements claimed by EN 16516 and enable testing institutes to reliably measure VOC emissions of materials into indoor air. Such efforts would ensure improved comparability of measurement results which would be indispensable for a health-related evaluation of building products.

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 traceable measurement and characterisation of emissions from volatile organic compounds (VOC) found in materials for interior use, as well as, the comparability of measurement results and mitigation of the measurement uncertainty. This shall be achieved by the development of well-defined emission reference materials (ERM) and gaseous certified reference materials (gCRM) for indoor air pollutants, as demanded by EN 16516

The specific objectives are:

1. To develop an emission reference material (ERM) to ensure the quality assurance and quality control (QA/QC) of the emission chamber test method, as described in EN 16516, based on materials with temporarily constant emission profiles, or at least a significantly decelerated decline of the emission profile over time as compared to the state of the art. A period of at least 14 days should be the target for this consistent emission. The ERM should contain and release relevant compounds typically emitted by construction products within the range of the EU-LCI-list [1] (e.g. aromatic hydrocarbons, aliphatic hydrocarbons, aldehydes, ketones, aromatic alcohols, glycols, isothiazolinones or siloxanes).
2. To develop gaseous certified reference materials (gCRM) of indoor air pollutants, for compounds selected from key groups such as aldehydes, unsaturated aldehydes, cyclic dimethylsiloxanes and glycol compounds, that are relevant for the health-related evaluation of building products (such as furfural, butenal, decamethylcyclopentasiloxane (D5) and diglyme) as stated in the EU-LCI-list.
3. To validate the newly developed ERM and gCRM by investigating the short- and long-term stability, reproducibility and uncertainty in an inter-laboratory performance comparison, thereby demonstrating the benefits of the reference materials for the test procedure demanded by 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 aim to support the customised generation of the product developed in Objective 1.
5. To contribute to the standards development work of the technical committees CEN/TC 351/WG 2 and ISO/TC 146/SC 6 to ensure that the outputs of the project are aligned with their needs, communicated quickly 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.

The proposed research shall be justified by clear reference to the measurement needs within strategic documents published by the relevant Regulatory body or Standards Developing Organisation or by a letter signed by the convener of the respective TC/WG. EURAMET encourages proposals that include representatives from industry, regulators and standardisation bodies actively participating in the projects. The proposal must name a “Chief Stakeholder”, not a member of the consortium, but a representative of the user community that will benefit from the proposed work. The “Chief Stakeholder” should write a letter of support explaining how their organisation will make use of the outcomes from the research, be consulted regularly by the consortium during the project to ensure that the planned outcomes are still relevant, and be prepared to report to EURAMET on the benefits they have gained from the project.

Proposers should establish the current state of the art, and explain how their proposed research goes beyond this. In particular, proposers should outline the achievements of the EMRP ENV01 MACPoll and ENV56 KEY - VOC and how their proposal will build on those.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 0.8 M€, and has defined an upper limit of 1.0 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 30 % of the total EU Contribution across all selected projects in this TP.

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 materials and building products sector.

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

CEN identified this topic as one of their priorities. Details are available at:

https://msu.euramet.org/current_calls/pre_norm_2020/documents/cen_priority_001.pdf

The references were provided by PRT submitters; proposers should therefore establish the relevance of any references.

[1] https://ec.europa.eu/growth/sectors/construction/eu-lci/values_en