Application Note 068

The development of construction product regulations relating to chemical emissions and how to comply with them

Summary

This Application Note describes recent regulatory developments controlling the release of volatile and semi-volatile organic chemicals (VOCs and SVOCs) from a wide range of construction products and materials exposed to indoor air. It also discusses the sampling and analytical technology available for measuring chemical emissions and how this equipment can be used to minimise the regulatory test burden and aid development of new, low-emission products.

Regulations relating to chemical emissions

Increased awareness of the potential health risks associated with poor indoor air quality has led to calls for the regulation and labelling of construction materials, decorative products and consumer goods used indoors. As a result, regulatory requirements relating to emissions of potentially harmful chemicals from these products into the indoor environment are currently undergoing major review in many parts of the world.

These regulations impact many manufacturers, with producers of flooring, furniture, wood-based products, insulation materials, spray polyurethane foam, coatings, adhesives, sealants, vehicle trim, domestic goods, cleaning products and even medical devices being affected, together with all their suppliers.

Europe

The European Construction Products Regulation (CPR[1]) has arguably the biggest worldwide impact on construction product manufacturers. The series of events that led to the CPR began in 1989, when its predecessor, the Construction Products Directive (CPD), was introduced with its 'Essential Requirement 3' (ER3) requiring that chemical emissions from products used indoors must not adversely affect the indoor environment or the health and comfort of occupants. A wide range of structural and decorative materials were covered by this legislation; however, ER3 was never properly implemented under the CPD, largely due to the lack of suitable and broadly applicable ('horizontal') test methods.

This has now been rectified under the CPR with the finalisation of EN 16516 as a horizontal method for testing chemical emissions from materials (publication expected September 2017) and the development of a harmonised list of safe levels for over 100 organic compounds (so-called 'lowest concentrations of interest' or LCIs[2]). Use of the new test method and LCI list is being embedded in relevant European product standards and will be implemented as a mandatory part of the CE marking process for any affected construction material made or sold within the European Union. Chemical emission testing is expected to be required both for initial product certification by an accredited third-party laboratory and for in-house 'factory production control' of emissions at specified intervals. The list of harmonised LCIs will also be continually maintained and is expected to be updated annually.

Work on these requirements has also been driven by the promulgation of German,[3,4] French,[5,6] and Belgian[7] national regulations, which require emissions testing of certain construction and decorative products and which establish performance criteria for product approval or classification. European national regulations like these will be superseded by the CPR, as it is rolled out across all relevant trades and European member states.

Over and above the CPR, European legislators have also enacted important legislation on the evaluation and authorisation of chemicals under 'REACH',[8] which came into force in June 2007, and is being phased-in gradually. Under REACH, chemical manufacturers, importers and downstream users need to prepare technical dossiers and/or 'Chemical Safety Reports' depending on tonnages. If a consumer product contains a potentially hazardous chemical at a level above 0.1%, and if it is possible for that chemical to be emitted under normal usage conditions (intentional or unintentional release), this must be assessed. Current guidance on implementation of emissions testing for articles and preparations (general consumer goods) under REACH specifies many of the methods developed for construction products.

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US

Concern relating to product emissions and their potential impact on indoor environments and human health are driving similar regulatory developments in the US. One example is Standard 189.1,[9] developed by a consortium of American agencies including the national standards agency ANSI and the indoor air quality interest group ASHRAE.

In parallel with this, another US agency, the International Code Council, is collaborating with ASTM and the American Institute of Architects to incorporate the International Green Construction Code (IGCC) into a regulatory framework for new and existing buildings, establishing minimum green requirements for buildings and complementing voluntary rating systems. One other relevant regulation is the LEED 'green buildings' program.[10]

China

'Chinese REACH'[11] makes similar requirements to the European equivalent, and was initiated in 2010. As the world's foremost manufacturing centre, Chinese companies are also likely to be impacted by European and US regulations that control chemical emissions from construction materials, decorative products and other consumer goods used indoors.

Procedures and standard methods for assessing chemical emissions

The various standard methods for testing emissions or release of VOCs and SVOCs from products and materials are usually broken down into multiple sections covering sample collection and preparation, emissions testing and vapour analysis. The vast majority of released chemicals are collected on adsorbent-packed tubes ('sorbent tubes') and analysed by thermal desorption (TD) with gas chromatography (GC) and detection by mass spectrometry (MS) and/or flame ionisation detection (FID). Relevant international standard methods include EN 16516,[12] ISO 16000-series standards[13] and a number of ASTM standards such as D5116[14] and D6196.[15] Method selection depends on geography and the regulation being adhered to.

Overall, the test procedure involves placing representative material or product samples into test chambers under prescribed conditions of temperature, humidity and clean air flow rate. Emitted organic vapours are then trapped on sorbent tubes at prescribed times and under specified sampling conditions (Figure 1). Note that alternative samplers and test methods are used for a few compounds such as ammonia and formaldehyde.

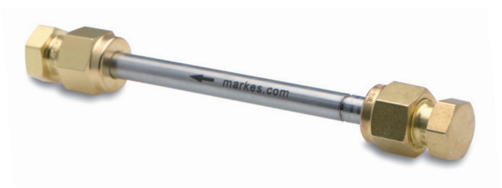

Figure 1: 3½″ × ¼″ adsorbent-packed TD tubes (here shown with brass storage caps) can be used for a wide variety of applications, including the sampling of construction products.

There are a wide range of test chamber options for measuring material emissions. Reference methods for initial product certification carried out by accredited third-party laboratories generally require the use of small environmental chambers (typically stainless steel or glass, 50 to 1000 L volume) with tests that take 3–28 days. Complementary screening methods for routine verification of product performance and factory production control usually use quicker tests with micro-chambers (see ASTM D7706[16] and EN 16516[12]).

Small environmental chambers

Procedures for final product certification typically involve placing a representative sample of the material in a 50–1000 L 'small' chamber (Figure 2) under simulated real-use conditions and with only the relevant surfaces exposed. Samples of chamber air, including any emitted chemical vapours, are collected onto sorbent tubes at specific times (typically 3, 10 or 28 days), and analysis is carried out using TD–GC–MS-based techniques as described above. Before a reference method can be implemented by a laboratory, it must be accredited by the relevant approval process or a 'notified body'.

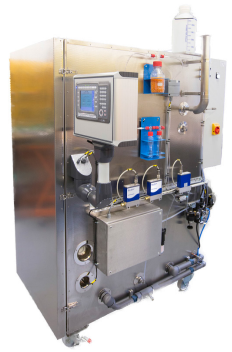

Figure 2: Typical 1 m^3 small chamber used for final product certification. *Image credit: SP Technical Research Institute of Sweden.*

Microchambers

Microchamber devices such as Markes' Micro-Chamber/ Thermal Extractor™ (μ-CTE™, Figure 3) speed up emission testing for routine screening, by using 44 cm^3 or 114 cm^3 micro-scale chambers to sample air or gas from representative samples of materials onto sorbent tubes. Subsequent analysis is by TD–GC–MS in the normal way.

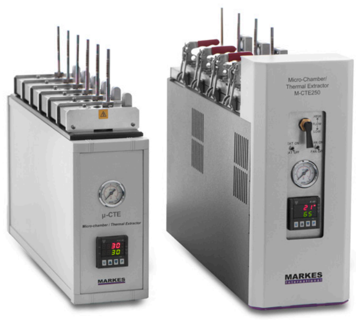

Figure 3: Markes' μ-CTE for rapid sampling of VOC and SVOC emissions onto sorbent tubes. Left: Six-chamber model. Right: Four-chamber model.

Microchambers generate emission screening data (typically within 30–40 minutes of sample preparation) that correlates well with the results of extended small chamber tests (see Application Note 069). This makes them suitable for screening incoming raw materials, routine product quality control and for testing emission levels from products under development. Microchambers can also be used to estimate the results from longer-term certification tests and may be operated at elevated temperatures to speed up equilibration – SVOC emissions are particularly of interest. More information is provided in Application Note 067 (an introduction to the µ-CTE), Application Note 073 (a peer-reviewed study by the Fraunhofer Wilhelm-Klauditz-Institute) and Application Note 103 (using the µ-CTE for routine screening).

TD–GC–MS analysis

Whichever small-chamber or microchamber option is selected for emission testing, most organic vapours are collected in sorbent tubes (Figure 1), typically packed with Tenax TA or a combination of sorbents, prior to TD–GC–MS analysis in accordance with standard methods. The benefits of thermal desorption for assessing chemical emissions are numerous, and are discussed in more detail in Application Note 089.

Before being analysed, the sampled tubes are unsealed, fitted with analytical caps and placed into a thermal desorber such as Markes' TD100-xr™ instrument (Figure 4). They are then integrity-checked before being heated in a flow of pure inert 'carrier' gas to release the retained compounds and transfer them onto a narrow, electrically-cooled internal focusing trap. This is the first of a two-stage thermal desorption process.

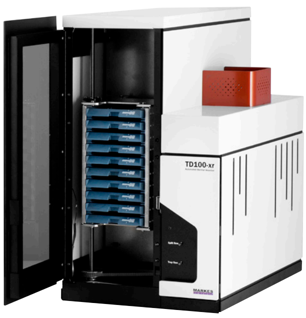

Figure 4: Markes' TD100-xr 100-tube automated thermal desorber.

Subsequent rapid heating of the TD instrument's internal focusing trap, in a reverse flow of carrier gas, transfers (injects) the VOCs and SVOCs to the GC column in a narrow band, which ensures sharp peaks and high levels of sensitivity.

Conclusions

Manufacturers need to be aware of, but not alarmed by, current regulatory developments in the construction products sector and how these changes could impact their business. As well as third-party certification of products, market demand for new low-emission (higher-value) products and the need for raw material checks and factory production control of product emissions means that many companies will benefit from in-house emission-testing capability.

Microchamber technology and robust TD–GC–MS systems all have a key role to play in making chemical emission testing a practical and useful in-house test facility for major construction product manufacturers.

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