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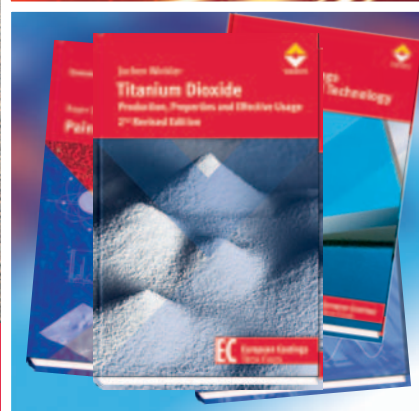
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Clearing the air indoors

New developments and harmonisation in VOC emissions standards

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Many VOC emissions and VOC content specifications now exist, all with different limit values and test procedures. Some degree of harmonisation across Europe is now underway. Harmonised standards will allow low VOC requirements to be incorporated into regulations, CE marking and eco labels. The programme for sustainable buildings, LEED, will significantly modify its testing procedures.

Products with low emissions of volatile organic chemicals (VOCs) into indoor air can promote public health. Regulations for reducing emissions from products into indoor air are, however, established only in two countries, Germany and France, even though some other European countries are expected to establish similar compulsory requirements soon – for example, Belgium in 2014.

Programmes for sustainable buildings (such as LEED, BREEAM) and eco labels (e.g. EMICODE, GUT, Blue Angel, Indoor Air Comfort, Indoor Advantage) are attracting more and more users. All these promote the use of low emission products.

Similarities and differences in test procedures

Historically, Europe and the USA have followed different approaches to characterising low VOC emitting products, even though there are some common aspects. The main similarities are:

- » VOC emissions are characterised by simulating actual use in ventilated test chambers.
- » The test climate is set to 23 °C and 50 % relative humidity air supply.
- » The parameters studied are volatile organic chemicals (VOC) and volatile aldehydes; mostly tested by sampling and analysing test chamber air by adsorption of VOCs on the porous polymer "Tenax TA", thermal desorption, GC/MS; absorption of volatile aldehydes with DNPH, solvent desorption and HPLC.

The main differences between the test procedures are as follows. In the USA and for LEED, many paints or coatings are applied on gypsum or other porous substrates. As that substrate may show emissions of its own, expensive double testing is necessary (substrate before and after application of the coating). Test reproducibility also suffers due to the variable properties of the substrate.

In Europe, this is regarded as unreliable and too expensive. All coatings are applied on inert surfaces such as glass or metal sheets (as in *Figure 1*). This differs from most use patterns, but is much more reproducible. Only Germany evades harmonisation and requires testing of parquet varnishes on a specific type of wood.

In the USA and for LEED, emissions are evaluated after 14 days storage in a ventilated test chamber (or earlier for furniture). In Europe, emissions are evaluated after 28 days storage in a ventilated test chamber (often after 3 days as well, to cover the case of renovation and early re-occupancy). See *Figures 2 and 3*.

In the USA and for LEED, the ventilation rate during testing is one air change per hour. In Europe, the ventilation rate is only 1/2 air change per hour, meaning less dilution of emitted compounds.

Differences in calculation procedures and VOC range

Any test results need to be calculated to air concentrations in a reference room or emissions scenario, for comparison with the limit values.

In the USA and for LEED, several different emissions scenarios are used for private offices, open-plan offices and classrooms. California is preparing a residential emissions scenario.

This means that one and the same product can comply with the specified limit values either for one, or several, or all of the emissions scenarios.

In Europe this is regarded too complicated, and only one single European Reference Room is defined as the worst-case emissions scenario for all uses. This is a room of 12 m² surface and 2.5 m height with one window and one door used to rate compliance for all products.

In the USA, most VOC rating schemes limit only 35 individual VOCs taken from California's list of CRELs (chronic respiratory exposure limit values). All other VOCs remain



Figure 1: Application of an adhesive onto glass for emissions testing

unregulated. In Europe, some specifications regulate almost 200 VOCs; others limit this to only a short list. But all set limits for emissions of total VOCs (TVOC) to include the VOCs without individual limit values.

Today each country in Europe may set its own limit values for VOC emissions. But there is an initiative in progress that intends to propose Europe-wide harmonised VOC limit values in the near future.

Current and future developments in Europe

Europe has seen a considerable harmonisation of VOC emissions testing and limit values. The German AgBB approach (AgBB 2012) [1] not only served as the basis for German regulations on limitation of VOC emissions from certain construction products into indoor air, but this approach is also taken as starting point by more and more voluntary eco labels.

Typically, AgBB is understood as basic level of requirements, while the voluntary labels set a more stringent benchmark for the products on the market with lowest emissions.

The AgBB approach consists of a limitation of total emissions of VOCs, of SVOCs (semi-volatile organic compounds), and of limit values for almost 200 individual VOCs. These limit values are called LCI (Lowest Concentration of Interest) and are derived by a group of scientists by dividing an occupational exposure limit for the workplace by safety factors, also taking into account additional toxicological information.



Figure 2: Ventilated emissions test chambers are made of stainless steel

A different list of such limit values was published in France (AFSSET 2009) [2] but never reached regulatory status. There are some attempts to harmonise these lists of LCI values across Europe. As regards coatings, German regulations apply to floor coatings and parquet varnishes. French regulations on VOC emissions do not exclude high emission products from the French market. A label is required, indicating the VOC emissions class of that product, based on specifications for TVOC and for ten individual VOCs including formaldehyde [3].

A new draft for a Belgian regulation will require in 2014 that VOC emission limits are not exceeded. The limits are similar to the German LCI limit values, with some minor differences. Belgium intends to refer to harmonised European LCI limits as soon as these are available.

Some CE marks will include VOC emission limits

The CE mark is required for a number of construction products as a prerequisite for being sold in any Member State of the European Union. A CE mark can be attached to a product if it follows a declaration of performance with results of tests performed in line with product-specific European standards, traditionally covering aspects such as mechanical stability and burning behaviour. Soon this will also include VOC emissions for several product groups. Then no construction product without a CE mark – and thus without a statement on VOC emissions level – can be distributed within the European Union, if VOC criteria for CE marking are available for that type of product.

Results at a glance

» There is currently a wide range of VOC emissions and VOC content specifications, all with different limit values and testing methodology. Some degree of harmonisation across Europe is now underway.

» CEN TC 351 will introduce a harmonised European VOC emissions testing standard in 2013, allowing low VOC requirements to be incorporated into regulations, CE marking and eco labels.

» France requires compulsory labelling of VOC emissions class for all products applied indoors. Belgium will require VOC emission limit compliance in 2014.

» VOC limits and testing requirements for paints and coatings are established today in French regulation, and in the voluntary labels Indoor Air Comfort, M1 (Finland), and EMICODE (parquet coatings). Belgian and German regulations apply to floor coatings.

» The programme for sustainable buildings, LEED, will upgrade its requirements for low-emitting interiors and complement the present product-by-product approach with an evaluation per complete system.

Table 1: Parameters specified for testing under different regimes*

Parameter during testing	Draft EN standard	EN 717-1	Most US standards* (ANSI, ASTM, CDPH)
Temperature, °C	23 ± 1	23 ± 0.5	23 ± 1
Relative humidity, %	50 ± 5	45 ± 3	50 ± 5
Loading factor, m ² /m ³	< 50 % - 200 % of ref. room - max. 2.0	1	0.3 - 1.0
Ventilation rate, ach	0.25 - 1.5	1	1

* Notes: (a) These parameters are different from loading and ventilation in emissions scenarios and reference rooms. The parameters here are specified just and only for actual testing; (b) ach = air changes per hour

At present, a horizontal standard for testing VOC emissions is almost finished (CEN 2012a) [4]. It had gone through robustness validation (CEN 2012b) [5] and will be published mid-2013; then it will go through a number of round-robin tests before publication in its final version.

An important finding of the robustness validation regarding paints and coating was that products applied wet on-site can give a falsified high emissions level because some portion of high initial emissions may be adsorbed and remain on the test chamber walls. These will be re-desorbed from the test chamber walls later in the test and increase the test result. This is different from reality where typical indoor walls will not show that strong re-desorption rate. This can be solved by pre-conditioning the fresh test specimen in separate chambers for some days, before the actual start of test. For similar reasons the test specimen shall remain in the test chamber all the time during testing.

Scope of the new CE marking arrangements

The first version of that horizontal standard is expected to be published in mid-2013 as CEN Technical Specification (CEN/TS 16516) [4]. Then a number of product standards will be revised to include VOC emissions. These standards will not re-define the testing method but refer to

that forthcoming horizontal VOC emissions standard CEN/TS 16516 – this is why that standard is called horizontal, meaning that it will be used by a variety of product-specific standards. This process will start in 2013.

The testing standard will follow the principles outlined above. As regards testing, it will specify certain ranges for ventilation and loading factors that will allow running one test only, for reporting in line with several testing protocols: the CEN/TS 16516 standard, the European formaldehyde testing norm EN 717-1, and US American ANSI and ASTM standards and CDPH Section 1350 – see Table 1. The robustness validation study confirmed that keeping testing parameters within these ranges will not impair the quality of the test result (CEN 2012b) [5].

CE marking will not set limit values for VOC emissions into indoor air. Limit values can be defined differently by each Member State of the European Union. The CE marking approach will assign technical classes representing all of the existing national regulatory limit values. As CE marking relies on regulations that specify the required minimum performance in terms of low VOC emissions, voluntary labels will continue to set lower limits for their respective programmes.

CE marking and expected additional national legal requirements will rapidly increase the number of products with low VOC emissions available on the European market.

A testing standard for paints and coatings was drafted as prEN 16402 and publication is expected in mid-2013. A CE mark for paints and coatings is not in planning at present. A CE mark for flooring adhesives is under discussion, but a mandate from the European Commission for amendment of the existing product standard has not yet been released. Even though CE marking will not apply to most coatings, at least not in near future, it can be expected that the new VOC emissions testing standards will be the benchmark for all low VOC programmes, not only for regulations and CE marking. This will promote harmonisation of VOC emissions testing and reduce the overall testing costs for industry.

LEED: the sustainable buildings programme

The programme for sustainable buildings, LEED, more or less adapted the US specifications for specifying low VOC emitting products. In recent versions, LEED has required product certification by private programmes such as CRI Green Label Plus, FloorScore, ANSI/BIFMA X7.1 and Greenguard.

Recently, this has changed and certification by a specific programme is no longer required. Compliance can now be shown just by following the testing plan and respecting the limit values of any programme referenced.

For paints, coatings, adhesives and sealants, VOC content limits were required instead of VOC emissions limits. VOC content limits were developed to protect urban outdoor air against smog formation. They correlate with initial emissions during application, but not at all with emissions into indoor air at a specific point of time during occupancy.

Nevertheless, when LEED requirements for low emission interiors were being developed, these were incorporated as they were the only low VOC guidelines then available in the USA. The US Green Building Council plans to fundamentally change its requirements for Low-Emitting

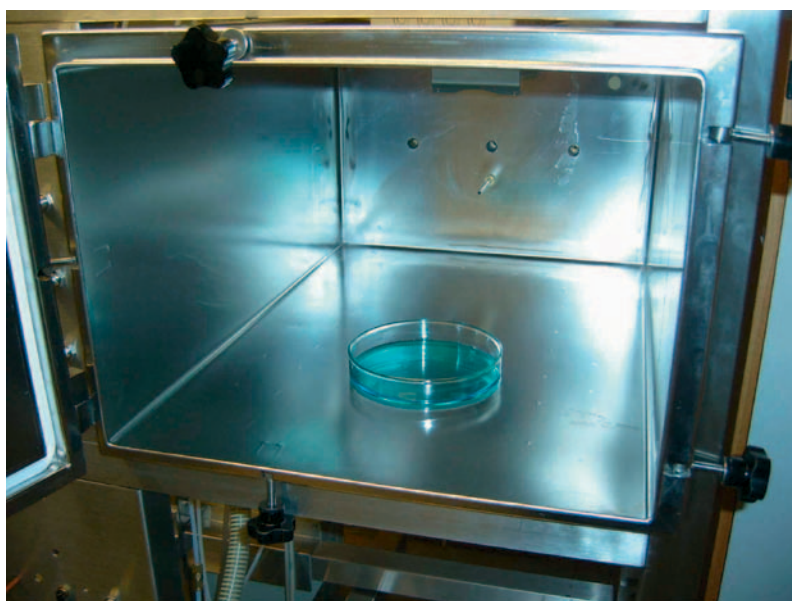


Figure 3: A coating applied on glass is inserted into a test chamber

Interiors in LEED Version 4, expected in late 2013. Based on most recent drafts, the proposed changes can be predicted to be as described below.

New version of LEED will incorporate major changes

LEEDv4 will no longer feature specific labels. Instead it will require compliance with California CDPH Section 01350 (CDPH 2010) [6] which is not a private label but a governmental evaluation scheme. In addition to that, a TVOC limit value will not be set, but the TVOC emissions level has to be disclosed to the user.

LEEDv4 will open up an alternative pathway of compliance for LEED projects outside North America. This will be the German AgBB (AgBB 2012) [1] evaluation scheme, but supplemented with a low limit value for formaldehyde, as for the French A+ class ($10 \mu\text{g}/\text{m}^3$ after 28 days). Paints, coatings, adhesives and sealants will have to meet not only VOC content limits (as before) but also VOC emissions limits (which is new). For the VOC content limits, compliance with local law (such as the Decopaint Directive (2004/42/EC) in Europe) will be accepted as alternative pathway of compliance.

While the present product-by-product approach will still be accepted, LEEDv4 will supplement this with an alternative evaluation per system (floor, ceiling, walls, insulation, and furniture). A system will be considered compliant if all products in that system comply – e.g. screed, primer, adhesive and carpet in a flooring system.

These changes will allow many more products to be included in evaluation for the Low-Emitting Interiors credit of LEEDv4. This will give a strong impulse for more products to show low VOC emissions into indoor air.

Benefits of integrating specifications and testing

Upper limits for VOC emissions from interior products into indoor air are established in several regions inside and outside Europe and the USA. The number of low VOC emissions specifications in regulations, in voluntary labels and in regional LEED specifications will increase.

Showing compliance with these specifications could be done in an economic manner if instead of each country re-inventing the wheel, new specifications used the same testing requirements – if not the same limit values – as used elsewhere in the world.

This would reduce the burden of testing costs for manufacturers. Then locally tested products would have a better starting position on the market if exported to the USA and to Europe, while products from the US and Europe would be available more easily in other regions if low VOC emissions are required there.

Low VOC emissions will gain importance in difficult markets. Two main approaches are available for rating VOC emissions into indoor air. While the US approaches target a small number of individual VOCs, European approaches try to cover all volatile organic emissions. Differences between test methods are to be reduced with a forthcoming European horizontal testing standard for low VOC emissions that will be used in future for CE marking for all products to which CE marking applies. ◀

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