A breath of fresh air

When home and office make you suffer …

Building products used indoors in homes and offices can have significant impact on indoor air quality (IAQ) through emission of volatile- or semi-volatile organic compounds (VOCs/SVOCs). In order to protect the health and well-being of occupants in homes and company buildings from potentially toxic emissions, EU and national regulations require that products used indoors be tested following clearly defined methods. In Germany, and increasingly throughout Europe, the AgBB evaluation scheme is used. Material emission testing relies mainly on environmental test chambers combined with sampling of chamber air onto adsorbent tubes and Thermal Desorption GC/MS analysis. Tests generally take 28 days, but thermal extraction offers an easier and less expensive way of getting reliable information about product emissions, for R&D purposes or for quality control of existing approved products.

PVC, linoleum, carpeting, laminate, parquet, and cork – the choice of floor covering for homes and offices seems almost endless - and once you have chosen the type, a similarly endless choice of producers and quality levels can cause headaches even before the flooring has been installed. Unfortunately, a successful installation may not quite signal the end of your headaches. If the carefully chosen flooring – or the glue used to install it - emits VOCs/SVOCs, these could contaminate the indoor air and even cause irritation and negative health effects. And to top it off, reactions to contaminants in air are highly individual, varying significantly from person to person. Hardened breathers of inner city air and perpetually recycled indoor atmospheres in modern energy-efficient buildings may feel nothing. Others may be in for constant suffering while in the building. And the list of real or perceived symptoms is endless. If headaches, mucus membrane irritation, fatigue, allergic reactions, immune system deficiency, frequent infections, deterioration of pre-existing asthmatic conditions, depressions, or simply a sudden general lack of well-being occurs after moving into a new building – or after a building has been renovated or redecorated, the informed physician should not exclude a case of sick building syndrome (SBS).

According to the US EPA, indicators of SBS include: Building occupants complain of symptoms associated with acute discomfort, e.g., headache; eye, nose, or throat irritation; dry cough; dry or itchy skin; dizziness and nausea; difficulty in concentrating; fatigue; and sensitivity to odors.

The cause of the symptoms is not known. Most of the complainants report relief soon after leaving the building.

We humans in modern society spend most of our lives indoors, depending on the season up to 80 – 90 % of every day. This means that IAQ in homes and offices has significant and decisive influence on our health and well-being. Temperature and relative humidity (RH) are also critical factors. In addition, VOC- (C_6-C_{16}) and

Used for the determination of material emissions: The GERSTEL TDS/TDS A2 mounted on a GC/MS System.

Text: Guido Deußing

SVOC (>C_{16}-C_{22}) contamination plays a role that is increasingly in focus of regulating government agencies. Many construction products used in buildings are potential sources of VOC- or SVOC emissions. Apart from the flooring materials and the glues used to install them, some of the culprits may be paints, lacquers, varnishes, coatings, wood preservation products, wall paper, caulks and sealants, cement, prefabricated bricks, and concrete. We are surrounded by a huge range of industrially produced materials that contain a long list of ingredients and additives to make them easy to use, low cost and durable. The European Union is recognizing the importance of this area and is moving towards regulation of emission of chemicals into indoor air.

In the "Proposal for a Regulation of the European Parliament and of the Council laying down harmonized conditions for the marketing of the construction products" the following is stated:

Annex I, Part 3. Hygiene, health and the environment:

"The construction works must be designed and built in such a way that they will not be a threat neither to the hygiene nor health of the occupants and neighbors, nor exert a exceedingly high impact over their entire life cycle to the environmental quality nor to the climate, during their construction, use and demolition, in particular as a result of any of the following:

(a) the giving-off of toxic gas;

(b) the emissions of dangerous substances, volatile organic compounds (VOC), greenhouse gases or dangerous particles into indoor or out door air; Etc…."

The European Union states that it takes into account the extraordinary importance of the European Construction Products Directive for the well-being of building occupants.

The German Federal Environmental Agency (Umweltbundesamt – UBA) states: "… Building products used to construct a building or incorporated into a building must in particular fulfill these requirements that no chemical, physical, or biological influences pose any danger or give rise to inappropriate inconvenience (§16 MBO)."

Uniform assessment protocol

So far, so good. But, to paraphrase a popular saying, good intentions don't always pave the way to paradise. True to the old credo: Trust, but verify. Construction products should be checked in a standardized way in order to even the playing field for producers by applying the same rules to everyone while allowing the consumer to win by being allowed to live, work, and play in a healthy indoor environment. The Committee for Health-related Evaluation of Building Products produced the AgBB evaluation scheme, which is used in Germany and increasingly throughout Europe. The process enables a clear and uniform assessment of emissions of VOCs and SVOCs under standard conditions. "These test conditions for flooring have given us, for the first time, a set of stan-

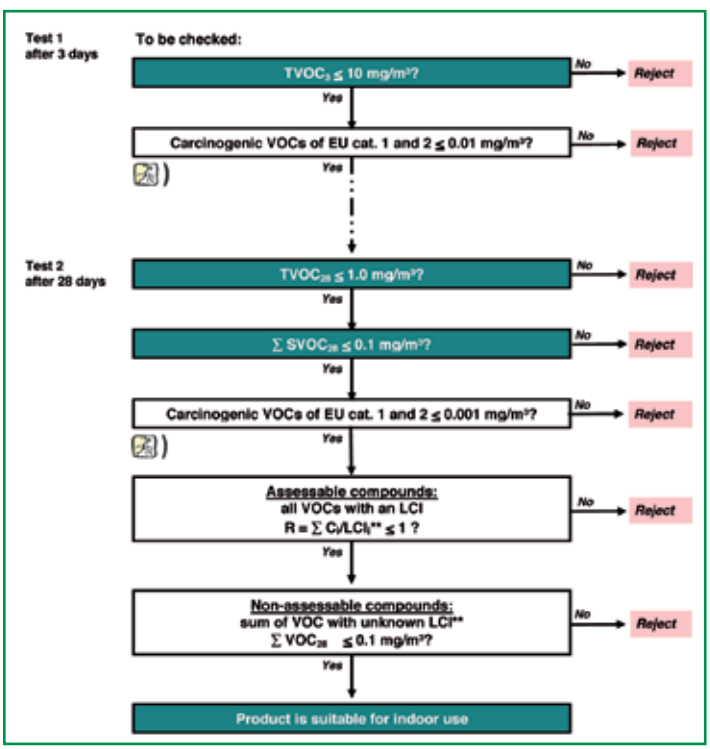

Fig.: AgBB scheme for health-related evaluation of construction products. Gerd Bittner: „A product that meets the AgBB criteria is well suited for use indoors in buildings." * VOC: Retention time range equal to C_6-C_{16}, SVOC: Retention time range equal to > C_{16}-C_{22}, ** LCI: Lowest Concentration of Interest.

Causes of Sick Building Syndrome:

According to the US EPA, the following have been cited as causes of or contributing factors to sick building syndrome:

Inadequate ventilation

Chemical contaminants from indoor sources: For example: adhesives, carpeting, upholstery, manufactured wood products, copy machines, pesticides, and cleaning agents may emit volatile organic compounds (VOCs), including formaldehyde)

Chemical contaminants from outdoor sources:

For example, pollutants from motor vehicle exhausts; plumbing vents, and building exhausts (e.g., bathrooms and kitchens) can enter the building through poorly located air intake vents, windows, and other openings. In addition, combustion products can enter a building from a nearby garage)

Biological contaminants:

Bacteria, molds, pollen, and viruses are types of biological contaminants. These contaminants may breed in stagnant water that has accumulated in ducts, humidifiers and drain pans, or where water has collected on ceiling tiles, carpeting, or insulation.

These elements may act in combination, and may supplement other complaints such as inadequate temperature, humidity, or lighting. Even after a building investigation, however, the specific causes of the complaints may remain unknown.

Source:

USEPA - www.epa.gov/iaq/pubs/sbs.html

LCI values

LCI is an acronym for "Lowest Concentrations of Interest", i.e. the lowest concentration of toxicological relevance for a particular compound in indoor air in residential and office buildings. LCI values are not equivalent to or related to Occupational Exposure Limits (OELs) or Recommended Exposure Levels (RELs) as specified for occupational safety.

OEL values

OEL is an acronym for "Occupational Exposure Limits", By definition, the occupational exposure limit is the contaminant level to which you can be exposed continually, day after day during your whole working life without experiencing any negative health effects as a result.

AgBB

Committee for health related assessment of construction products (German: AgBB) was formed in 1997 by a Working Group for "Environmental Health Protection" brought together under a cooperation between the Health Authorities of the German States. Among the members of the AgBB are State Health Authorities, the German Federal Environmental Protection Agency (UBA), the German Institute for Construction Technology (DIBt), The federal Institute for Material Research (BAM), and various other regional and federal State Agencies.

Some test methods for Emission testing of flooring materials

- **DIN EN ISO 16000-9** Emission chamber test method.
- **DIN EN ISO 16000-11** Sampling, storage, and preparation of samples.
- **DIN ISO 16000-6** Determination of VOCs in indoor air and in Environmental test chambers. Sampling on TenaxTA followed by Thermal Desorption – GC/MS.
- **DIN ISO 16000-3** Determination of formaldehyde and other carbonyl compounds; Sampling
- Evaluation scheme for health related assessment of emissions from construction products (AgBB)
- German Institute for Construction Technology (DIBt) Product Approval details

More Information

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dardized test conditions for approval of flooring materials that are used for an annual verification check of the emission properties of approved products", states Gerd Bittner of the Textiles & Flooring Institute (TFI) in Aachen, Germany. Testing of flooring materials and flooring systems (i.e. including the glue used to install the flooring) is performed at the TFI using environmental test chambers based on the DIN EN ISO 16000-11, DIN EN ISO 16000-9, and DIN ISO 16000-6 standards for indoor air. These standards specify conditions for all aspects of testing various flooring materials in environmental test chambers as well as the analytical determination of identity and concentration of emitted organic compounds (VOCs/SVOCs). Chamber air is collected using active pumped sampling onto a suitable adsorbent tube after three and 28 days. The tubes are typically filled with Tenax TA® and the analysis, as specified in the AgBB scheme is performed by Thermal Desorption - Gas Chromatography combined with Mass Spectrometry Detection (GC/MS) of the analytes. A non-polar separation column is used, which means that individual analytes can be assigned to a boiling point range or retention time range C_6-C_{16} (VOC) or >C_{16}-C_{22} (SVOC) as specified in the AgBB scheme for health-related evaluation of construction products rev. 2010.

The term "individual analytes" refers to both identified and non-identified compounds. The AgBB scheme requires a limit of detection of 1 µg/m³ for each compound in order to comprehensively cover and describe the material emissions. Depending on the specific requirements, quantitative information on individual compounds must be obtained. Whenever individual compound concentrations exceed 5 µg/m³, they must be quantified both individually and in summation as part of the relevant group.

Exceptions are EU category 1 and 2 carcinogens. For identified carcinogens and compounds that have an LCI value, compound specific quantification must be performed. Unidentified compounds as well as compounds to which no LCI value is assigned are quantified as toluene equivalents.

GERSTEL TE: Thanks to the large thermal extraction tube, a range of different sample types and **amounts can be analyzed based on thermal extraction in the TE.**

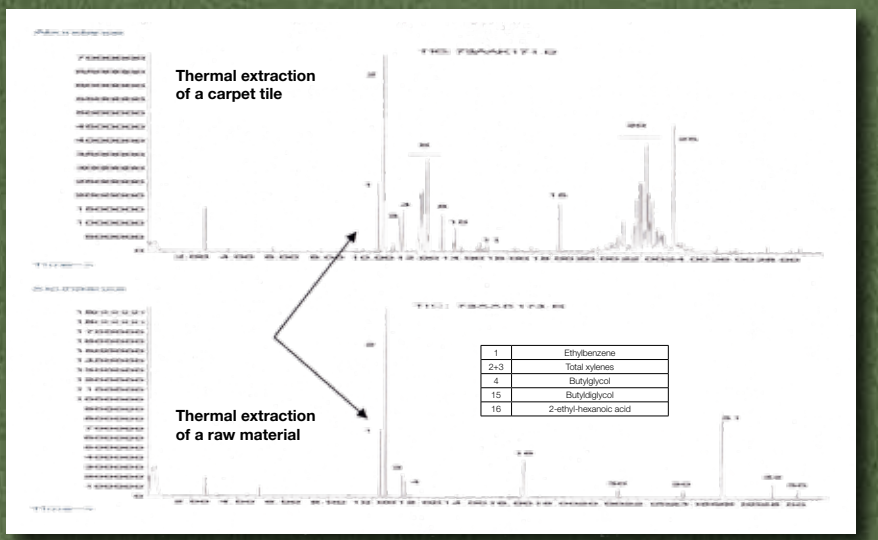
Thermal extraction as a highly suitable rapid test method

The test over 28 days, as required in the AgBB scheme, results in a comprehensive and standardized emission profile, according to Gerd Bittner. Typical peak patterns can be observed and compared during data analysis and key analytes are therefore easily found. Emissions from different materials are easily compared both quantitatively and qualitatively, and quantitation using internal standard, typically expressed as an equivalent toluene concentration, is easily performed as specified for the unknown minor compounds and those without LCI values. However, emission chamber test results take almost a month to produce and they are highly labor- and cost intensive. This poses a serious problem for the industry, especially during product development: Test cycles of a month can cause significant project delays with serious consequences, for example, in terms of development cost and loss of competitiveness. A clear indication of the emission profile of a product in every development stage, or during trouble shooting following customer complaints, can save companies both lots of time and pots of money. For these reasons, the TFI has for many years offered their customers accelerated emission tests based on thermal extraction, a dynamic headspace technique based on trapping on a standard adsorbent tube.

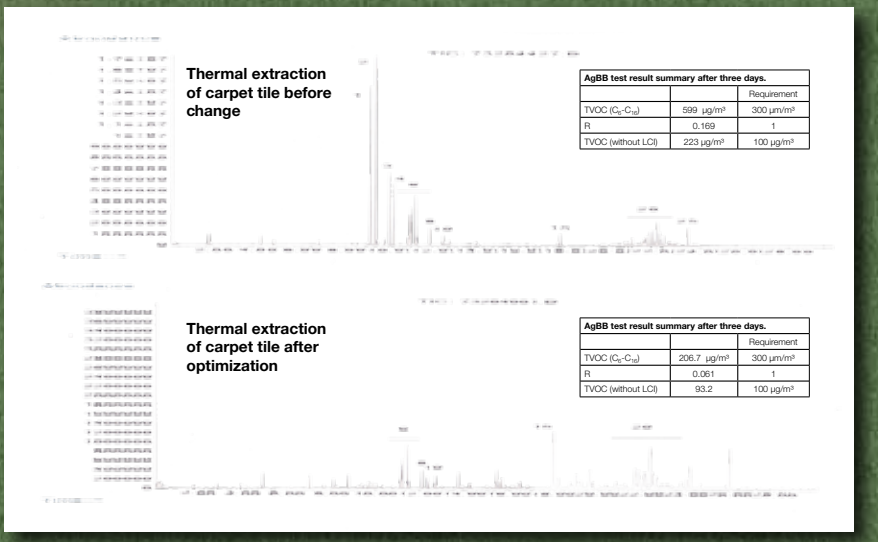
Industry clients come to the TFI for emission tests during product development; for regular Quality Control of product batches; for trouble shooting following customer complaints; as well as for sample identity verification. Testing is often performed using the GERSTEL Thermal Extractor (TE). The large extraction tube of the TE (ID 14 mm, length of heated zone 75 mm) can be loaded with much larger and more representative samples than regular thermal desorption tubes. "We use the Thermal Extractor to test textiles, elastic flooring material, multi-layer systems, as well as glues used to install flooring material", reports Mr. Bittner. The samples are heated in a flow of inert gas and the extracted analytes are purged onto the adsorbent tube and concentrated on TenaxTA. Thermal Desorption (TD)-GC/MS analysis is subsequently performed following the AgBB guidelines.

"By adapting the Thermal Extraction methods used to the corresponding emission chamber methods, we have achieved good qualitative correlation between thermal extraction and emission chamber tests for various materials; in other words, we find the same typical peak patterns, making it easy to compare results", says Gerd Bittner, before concluding: "In our experience, the accelerated thermal extraction tests give us the ability to quickly establish the emission potential of flooring materials and their associated adhesive systems, as well as to compare emissions from different combinations. Thermal extraction is a valuable and efficient complement to standard emission chamber tests."

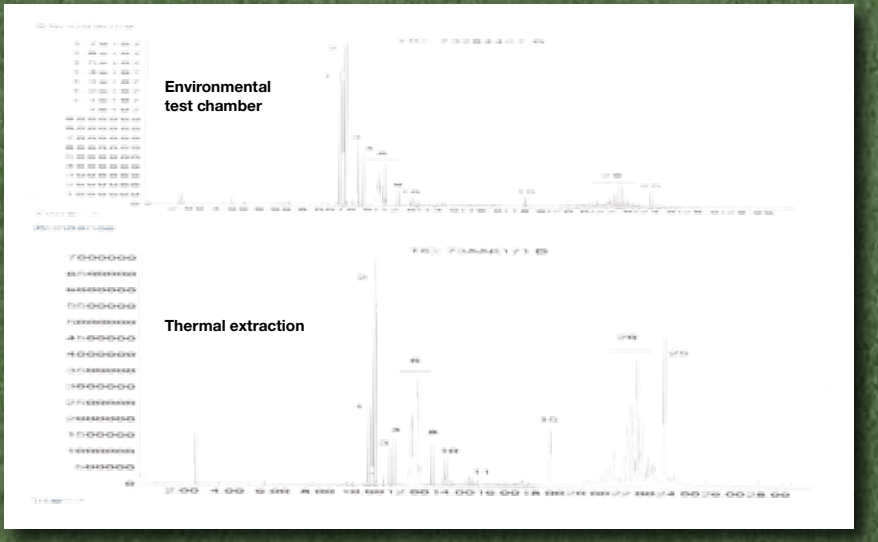
Thermal extraction using the GERSTEL TE: an efficient alternative to environmental chamber testing – practical examples from the TFI



Optimization of carpet tiles I:
A carpet tile was taken from a production facility for accelerated VOC/SVOC emission testing. The result: Large compound peaks were found in the retention time range from 10 – 14 min. To determine the source(s) of the emissions, all raw products used in the production of the carpet tile were individually tested for emissions using thermal extraction. The TFI quickly identified the source and was able to propose a clear strategy for optimizing the carpet tile production to ensure lower material emissions.



Optimization of carpet tiles II:
Thermal Desorption GC/MS chromatogram of analytes extracted from a carpet tile sample using thermal extraction.
Major compound peaks were found in the retention time range from 8 – 14 min (upper chromatogram). The source of the emissions was identified and substituted. The change was successful as can be seen in the lower chromatogram, showing the emission test of the optimized product.



Useful tool and great complement:
Comparison of emission tests performed after three days in an environmental test chamber (above) and accelerated emission testing using thermal extraction (below). Good correlation is seen between the peak patterns in the two chromatograms, both obtained by Thermal Desorption-GC/MS. Thermal extraction results in a more efficient recovery of higher boiling compounds as can be seen. Thermal Extraction is an efficient tool for evaluating intermediate or final products either in the product development stage; for trouble shooting following customer complaints; or for production control.