

Occurrence of odorous compounds in the emission of building materials measured by GC-olfactometry

O. Ramalho¹, S. Moularat¹, W. Horn², H. Knudsen³, P. Wargocki⁴, B. Müller⁵

¹University of Paris-Est, Scientific and Technical Center for Building (CSTB), Marne-La-Vallée, France

²Federal Institute for Materials Research and Testing (BAM), Berlin, Germany

³Danish Building Research Institute (SBI), Aalborg University, Hørsholm, Denmark

⁴ICIEE, Technical University of Denmark, Lyngby, Denmark

⁵Technical University of Berlin, Hermann-Rietschel-Institute, Berlin, Germany

INTRODUCTION

The background odour of indoor environments plays a large part in the well-being and comfort of people and most notably in the perception of air quality. However, odours from indoor materials are not much documented as they tend to be replaced by fragrances and household products in order to create a personalized space. The purpose of this work is to identify the most frequent odorous compounds from building materials both from a literature review and experiments on a set of 16 materials from Denmark.

Literature review

- Selection of studies based on the use of coupled gas chromatography and mass spectrometry to on-line olfactometry by a human subject (GC/MS-O).
- 15 studies covering around 50 different building materials and close to 70 real environments (homes and offices).
- 156 different odorous compounds were identified.
- Most cited per study : **aldehydes** (hexanal 13 times and nonanal 11 times), **carboxylic acids** (propanoic and hexanoic acids 8 and 7 times respectively), **phenol** (7 times), **unsaturated ketones** and **aldehydes** (1-octen-3-one and trans-2-nonenal, 4 times each). Some **glycol ethers** also appear as potential odorous compounds, in particular 2-(2-Butoxyethoxy)-ethanol cited 4 times.

GC/MS-O EXPERIMENT

- 16 building material samples (painted and unpainted gypsum board, wood boards, linoleum and vinyl floorings, carpets and sealants).
- 2 male subjects performed the experiment. Good agreement when odour intensity > 5 on the 0 - 10 scale of potentiometer.
- Odorous events detected by one or both were counted.
- Identification using Nist'05 library, retention indexes, direct injection.
- Recorded odour intensity was superposed to the chromatogram to achieve identification of odorous compounds.
- Qualitative data analysis at the moment.

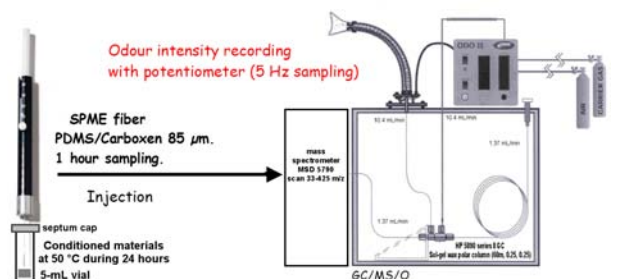


Fig. 1 : Static headspace SPME sampling and GC/MS-O configuration

RESULTS

- The number of identified odorous compounds vary between 0 (gypsum board) and 60 (linoleum).
- Unidentified odorous events may reach **89%** (alkoxysilicone sealant)
- **118 different odorous compounds** were identified (242 combined with literature review).
- Specific compounds like **4-phenylcyclohexene** or **4-cyanocyclohexene** are exclusively associated with carpet samples (from reactions of styrene with *cis*-butadiene or acrylonitrile with *cis*-butadiene in the latex adhesive).
- Unsaturated carbonyl compounds were mostly associated with linoleum samples formed by oxydation of unsaturated fatty acids.
- **Alkyl lactones** (γ -hexalactone to γ -nonalactone), first time reported in building materials (linoleum), from cellulose degradation.

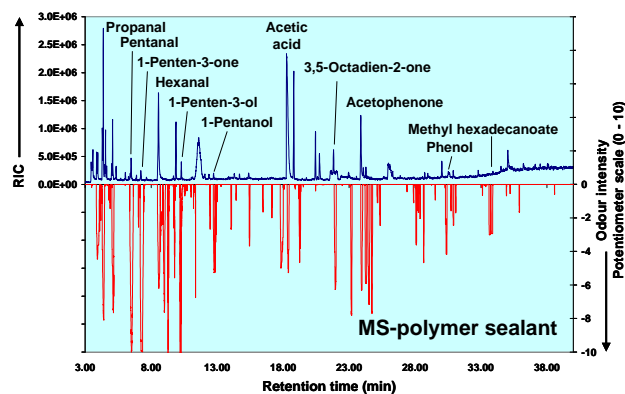


Fig. 2 : Superposed chromatogram and odour intensity monitoring

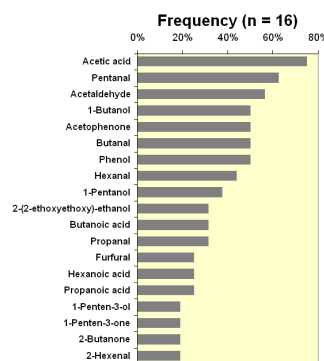


Fig. 3 : the 20 most frequent odorous compounds found

The identified odorous compounds are mostly oxygenated compounds related to oxidative ageing of materials whether based on natural products or man-made.

Correspondence analysis was performed on the qualitative data to find a trend in the occurrence of odorous compounds.

Natural-based materials are clearly separated from man-made or modified materials (varnished wood).

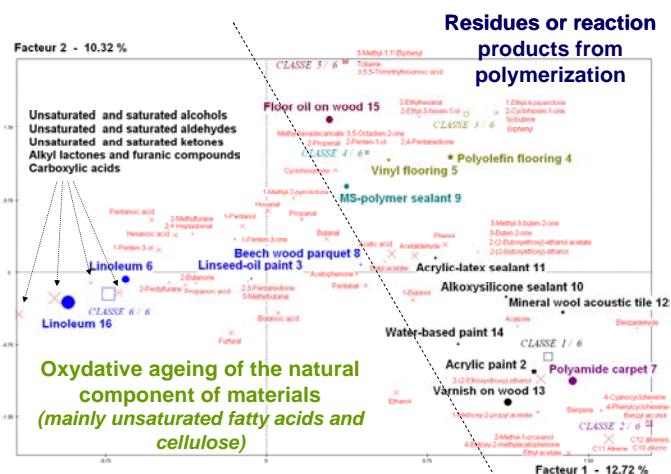


Fig. 4 : Correspondence analysis (15 x 118) – 10 dimensions (89% variance). Hierarchical classification results in 6 classes.

CONCLUSION

- This study confirms and implements past studies.
- Most of the odorous compounds are caused by oxidative ageing and thus related to some aroma compounds from the food industry (γ -alkyl lactones).
- The reason why these compounds smell may be related to their association with degradation processes and our perception of variations in the environment.