Characterization of mid- and long term emissions from building materials : impact of use and wear conditions

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SUMMARY
Indoor emissions from building products are conventionally characterized on new products. But ageing of building products in use in real buildings can change their surface properties and their emissions into indoor air. The aim of this research project was to characterize the impact of wear conditions and use of building products on their middle and long-term indoor emissions. For specific scenarios, in particular those involving oxidation and high relative humidity exposure, significant modifications of VOCs emissions were observed compared to new products.

KEYWORDS
Building products, emission, VOCs, formaldehyde, use, ageing

1 INTRODUCTION
Indoor emissions from building products are conventionally characterized on new products. But ageing of building products in use in real buildings can change their surface properties and their emissions into indoor air. Although ozone induced surface reactivity on building materials has been identified and studied since the 90s (Weschler et al. 1992; Reiss et al. 1995; Lee et al. 1996), studies on the influence of surface reactivity on emissions of pollutants in indoor air remain scarce.

The aim of this research project was to characterize the impact of wear conditions and use of building products on their middle and long-term emissions indoors. Therefore, short-term emissions of new building products will be compared to their mid- and long-term emissions characterized through various scenarios of ageing.

2 MATERIALS/METHODS
One of the key points of this work was the definition of relevant ageing scenarios representative of realistic indoor conditions. Relevant parameters selected and test conditions applied were: temperature (23°C and 35°C), relative humidity (50% and 70%), lightning (dark or light), oxidant exposure (with and without ozone), mechanical wearing (according to ISO/FDIS 4918), using process (household products or sealant application), real ageing (indoor air office exposition).

These scenarios were applied to 5 selected floor coverings: resilient PVC floor covering, linoleum, wood laminate, raw exotic and pinewood parquets.

The testing protocol included two 28 days periods: from 0 to 28 days, emissions from the new materials were measured and from 29 to 56 days, the ageing process was simulated and emissions from the aged material were characterized.

Experiments were performed on new and aged building products using emission test chamber according to EN ISO 16000-9. Samples were collected 3 days after introduction of the building product in the chamber and all 7 days period between 7 to 56 days.

VOCs were sampled and analyzed according to ISO 16000-6 (2011). Samples were collected on Tenax TA sorbent tubes (Perkin Elmer) at 80 mL/min air flow rate and analyzed by thermal desorption (ATD Turbomatrix 350, Perkin Elmer) and gas chromatography (CG) with a flame ionization detector (FID) (Perkin Elmer Autosysteme XL) for quantification and a mass spectrometer (MS) (Perkin Elmer Turbomass) for identification and quantification. All VOCs emitted by the building products and detected at concentration above 1 $\mu g/m^3$ were identified. Carbonyl compounds (including formaldehyde, acetaldehyde) were sampled and analyzed according to ISO 16000-3 (2011). Samples were collected on DNPH coated cartridges (Waters) at 600 mL/min air flow rate and analyzed using HPLC-UV (Alliance, Waters) after liquid extraction with 5 mL of acetonitrile.

3 RESULTS

Influence of ageing on VOCs and carbonyls compounds emissions

VOCs and carbonyls compounds emissions identified during experiments conducted on new and aged floor covering materials were compared in order to analyse the influence of ageing process on emissions into indoor air. Modifications of emissions were observed during most experiments. For the wood laminate concentration of TVOC (total volatile organic compounds according to NF EN ISO 16000-9) was higher with relative humidity, using process, temperature and mechanical wearing scenarios. For the raw exotic parquet, an increase of formaldehyde concentrations was observed too, for temperature and oxidative exposition.

French mandatory labeling and AFSEET protocol compliance

Evaluation of emissions from the five tested floor coverings was realized according to the French mandatory labeling procedure (decree n° 2011-321) and to the AFSSET protocol (AFSSET, 2009) on new (i.e., after 28 days) and aged (i.e., after 56 days) test specimen. For the resilient PVC floor covering, the label was not modified with the different ageing scenario, while the other tested products showed different label for some specific ageing scenario. Table 1 presents results of experiments conducted on the wood laminate.

Table 1. Evaluation of the wood laminate

Parameters	new	Ageing scenario						
		relative humidity	lightening	using process	oxidation exposition	real ageing	temperature	mechanical wearing
French mandatory labeling	A+	A+	A+	A+	A+	A+	A	A
AFSSET compliance	Yes	Yes	Yes	Yes	Yes	Yes	No	No

4 DISCUSSION

For specific scenarios, in particular those involving oxidation and high relative humidity exposure of linoleum and raw pine wood parquet, significant modifications of VOCs emissions were observed compared to new products. Consequently, these experiments will be repeated and additional metrology will be implemented to study the potential formation of volatile gaseous and particulate by-products. A specific methodology to characterize oxygenated organic compounds in both gaseous and particulate phases (Rossignol et al., 2012) and c-TOF AMS (Compact Time-of-Flight Aerosol Mass Spectrometer) to evaluate the potential formation of secondary organic aerosol (SOA) will be used. These experiments are in progress.

5 CONCLUSIONS

The impact of wear conditions and use of building products on their middle and long-term indoor emissions was studied for 5 floor covering: resilient PVC floor covering, linoleum, wood laminate, raw exotic and pinewood parquets. Different scenarios were tested: high temperature, high relative humidity, lightning, oxidant exposure, mechanical wearing, using, and real ageing (indoor air office exposition). For specific scenarios, in particular those involving oxidation and high relative humidity exposure, significant modifications of VOCs emissions were observed compared to new products.

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