Formaldehyde Emissions from Man-Made Mineral Fibre Products

R. Oppl, T. Neuhaus and I. Bondgaard

Eurofins Environment A/S, Smedeskovvej 38, 8464 Galten, Denmark
email: ReinhardOppl@Eurofins.com www.eurofins.com

Summary: *Four mineral fibre insulation products containing phenol-urea-formaldehyde binder were tested for their emissions of formaldehyde in several assemblies for simulation of real usage in a building. The results were compared to requirements in several emission classification systems. Contribution of man-made mineral fibre products to indoor air contamination by formaldehyde was estimated.*

Keywords: *formaldehyde, emissions, indoor air, mineral fibres, insulation products, stone wool, glass wool*

1 Introduction

Man-made mineral fibre insulation products containing phenol-urea-formaldehyde binder could emit formaldehyde and could therefore influence the indoor air quality.

As insulation products are normally not directly exposed to indoor air, Eurofins Environment A/S performed emission tests simulating real usage in buildings and compared these results with other building materials and ambient outdoor and indoor air concentrations found in literature.

2 Methods

Four man-made mineral fibre insulation products containing phenol-urea-formaldehyde binder from different producers were tested for their emissions of formaldehyde. The samples had been selected by EURIMA (European Insulation Manufacturers Association) as samples representative for a large portion of the material in use in Europe.

Fig. 1. Insulation material in full construction in test chamber.

The emission tests were performed for the non-covered material and for the material in two lightweight wall constructions that mimicked a typical actual use in a building.

One construction was realised by covering the insulation material with a gypsum board, and the other construction with an additional PE foil (with overlap not fixed by tape) between material and gypsum board.

In all cases one edge of the material or the construction was covered by aluminium foil and the other edges as well as the back of the construction or the material were covered by the walls of the test chamber.

The tests were performed with stainless steel test chambers that were flushed with clean air of 50 % RH at a temperature of 23 °C. EN 13419 and ISO 16000 standards were applied [1], [2], [3]. Loading was 1.41 m^2/m^3, ventilation was 0.5 per hour, area specific ventilation was 0.35 m/h.

Air samples were drawn through DNPH tubes that then were analysed by HPLC as described in ISO 16000-3. Test duration was 28 days with 4 testing times: 1, 3, 7 and 28 days after loading the test chambers. For two materials, additional testing was performed after 42 and after 77 days.

The emission rates after 3 days and after 28 days were then calculated into air concentration in a model room as described in ISO 16000-9 [2], with 7 m^2 floor area, 2.5 m height and 24 m^2 wall area.

The results are given in table 1. The uncertainty was ± 20 % (relative standard deviation).

3 Results

Table 1. Formaldehyde air concentration, mg/m³.

	3 days	28 days	77 days
Stone wool 1,			
non-covered material	0.067	0.052	
covered, gypsum board	0.035	0.041	
covered, gypsum board + PE foil	0.007	0.011	
Stone wool 2,			
non-covered material	0.160	0.090	0.052
covered, gypsum board	0.059	0.079	0.043
covered, gypsum board + PE foil	0.010	0.027	0.023
Glass wool 1,			
non-covered material	0.090	0.057	
covered, gypsum board	0.046	0.045	
covered, gypsum board + PE foil	0.009	0.013	
Glass wool 2,			
non-covered material	0.086	0.070	0.038
covered, gypsum board	0.038	0.060	0.042
covered, gypsum board + PE foil	0.007	0.013	0.013

The results of each material were plotted against time for the non-covered material with one surface showing to the test chamber, then with this surface covered with gypsum board, then with an additional PE foil between material and gypsum board. The results are given in figures 2 - 7, expressed as emission rates per surface area and hour. The error bars represent the ± 20% within-laboratory uncertainty (expressed as relative standard deviation).

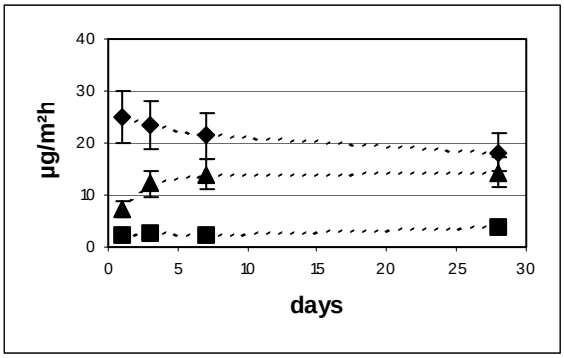

Fig. 2. Emission rates, stone wool 1 (28 days test)

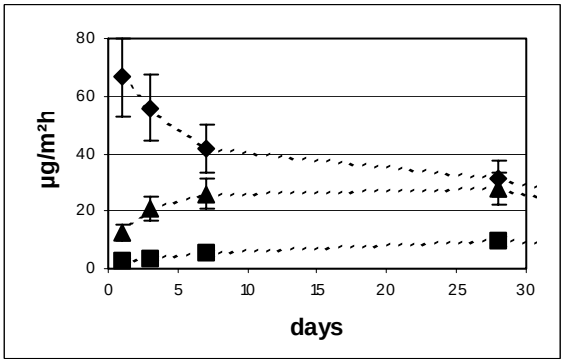

Fig. 3. Emission rates, stone wool 2 (28 days test)

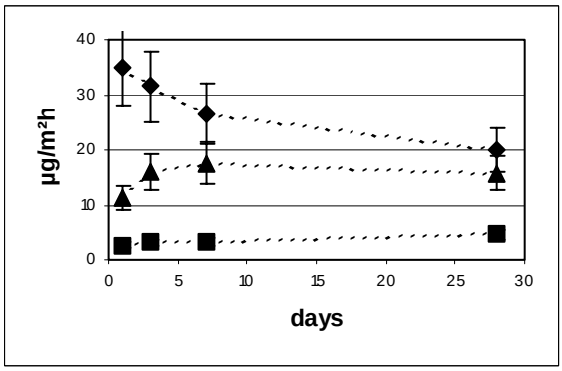

Fig. 4. Emission rates, glass wool 1 (28 days test)

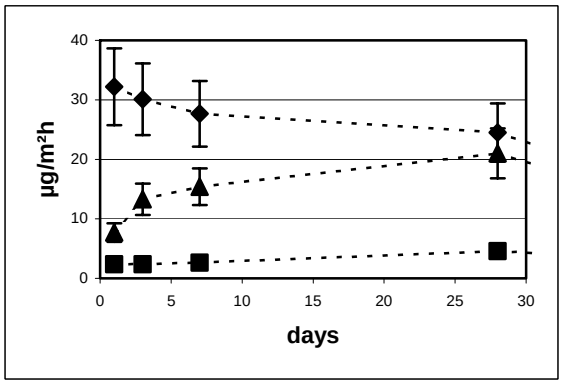

Fig. 5. Emission rates, glass wool 2 (28 days test)

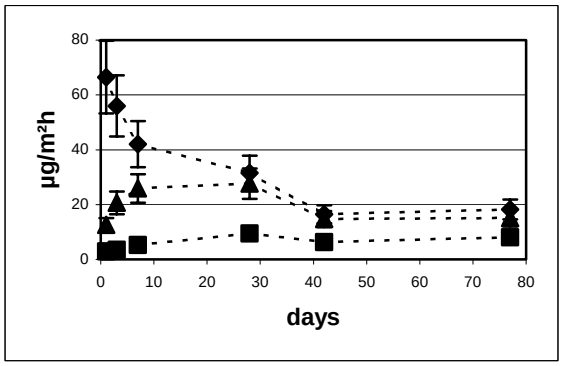

Fig. 6. As fig. 3 (stone wool 2), but 77 days test

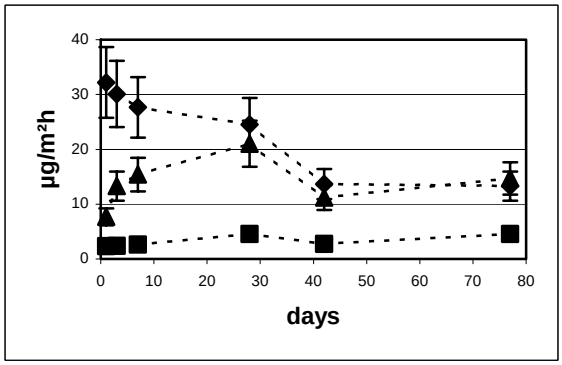

Fig. 7. As fig. 5 (glass wool 2), but 77 days test

4 Discussion

Insulation material in simulated real use showed significantly lower emissions than non-covered material. With gypsum board and insulation alone, the formaldehyde level nearly reached that of the non-covered material after 28 days. Further decrease of emission after 28 days was seen with both materials that were tested a longer time than 28 days. The Formaldehyde emissions in the full construction with gypsum and PE foil were stable at a low level from 42-77 days

The results were compared with current assessment criteria in use in Europe, see table 2.

Table 2. Formaldehyde criteria, mg/m³.

	28 days
E1 for wooden products [4]	0.120
M1, Finland [5]	0.140*
CHPS, California [6], after 14 days	0.033

* Re-calculated for an air exchange of 0.5 h^{-1} and a loading of 1.41 m²/m³ as applied in this study.

The non-covered insulation material and the material in construction complied with the European E1and the Finnish M1 criteria for formaldehyde. All tested products complied with the Californian CHPS criterion for formaldehyde emissions when in complete construction (including PE foil).

Several published and unpublished studies showed typical formaldehyde concentration in outdoor air in the range between 0,0001 and 0,005 mg/m³ and typical ubiquitous formaldehyde concentration in indoor air always was at least 0,01 mg/m³ [7]. Thus the formaldehyde emission from completely covered insulation material was in the same order of magnitude as ubiquitous formaldehyde concentration in indoor air and only slightly higher than typical formaldehyde concentration in outdoor air.

5 Summary

It could be shown that formaldehyde emissions from stone wool and glass wool insulation material were well below the "E1" and the Finnish "M1" formaldehyde emissions criteria. When covered with PE foil and gypsum board, the contribution to indoor air concentration was below 0.01 mg/m³ in most cases, which is in the same order of magnitude as ubiquitous indoor formaldehyde concentration.

Acknowledgement

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References

[1] ISO 16000-3, Determination of formaldehyde and other carbonyl compounds - Active sampling method, 2001

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[5] The Building Information Foundation RTS: Emission classification of building materials, available in the Internet at www.rts.fi/emission_classification_of_building_materials.htm

[6] California Department of Health Services, Indoor Air Quality Division: Standard practice for the testing of volatile organic emissions from various sources using small-scale environmental chambers, CA/DHS/EHLB/R-174, available in the Internet at www.dhs.ca.gov/ps/deodc/ehlb/iaq/VOCS/Practice.htm

[7] see for example: Office of Environmental Health Hazard Assessment: Prioritization of Toxic Air Contaminants - Children's Environmental Health Protection Act: Formaldehyde, October 2001, available in the Internet at www.oehha.ca.gov/air/toxic_contaminants/pdf_zip/formaldehyde_final.pdf