



PROPAINT – Evaluation of the Protective effects of Microclimate Frames for Paintings against Air Pollution

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Introduction

One of the main objectives of the EU PROPAINT project was to evaluate the protective effect of microclimate frames (mc-frames) for paintings by the use of three complementary dosimeters; EWO, PQC and Glass Slide Dosimeters. In addition the concentration of pollutants was measured by the use of passive gas samplers in order to correlate single pollutant concentrations with dosimeters responses. Measurements of organic (acetic acid, formic acid, formaldehyde and VOCs) and inorganic (NO_2 , O_3 , SO_2) pollutants were performed both inside and outside different types of mc-frames for paintings (Figure 1). The results will allow us to better understand the protective effects of mc-frames.



Figure 1: Types of frames used in PROPAINT project.

Methodology – Sampling locations

The measurements were carried out inside and outside mc-frames for paintings with and without paintings installed (Figure 2). The selected field sites were the international transporting and frame design company SIT-Artyd laboratories (Madrid, Spain), 12 locations in 11 end-user museums and one mc-frame in transit.

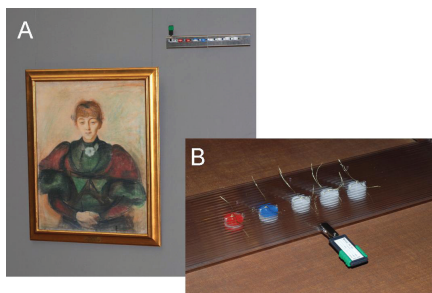


Figure 2: Passive gas samplers exposed outside (A) and inside (B) the mc-frame at the National Museum of Art, Architecture and Design, The National Gallery in Oslo, Norway (Photo courtesy of Trond Aslaksby).

Results from Passive Gas Samplers

Inorganic pollutants

Inorganic gases, such as NO_2 , SO_2 and O_3 , are formed mainly outdoors and infiltrate to the indoor environment, and into mc-frames. NO_2 and O_3 were measured inside nearly all the mc-frames, varying between 1 and $5 \mu\text{g m}^{-3}$, and 1 and $7 \mu\text{g m}^{-3}$, respectively (Figure 3). SO_2 concentrations inside mc-frames were generally very low ($< 0.5 \mu\text{g m}^{-3}$). In contrast, high concentrations of inorganic gases were detected in the room locations (Figure 3).

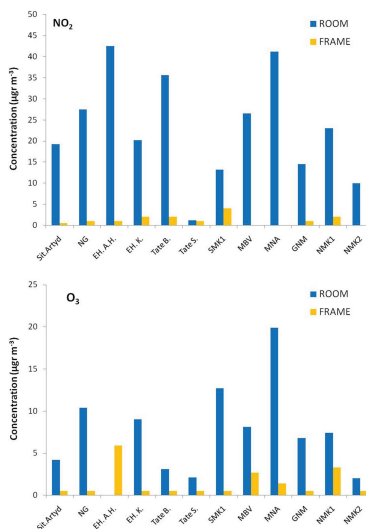


Figure 3: Concentration of NO_2 and O_3 inside and outside mc-frames.

Organic pollutants

The concentrations of organic compounds (acetic and formic acid, formaldehyde, TVOC) measured inside mc-frames (Figure 4) were generally much higher than those for the inorganic compounds (NO_2 , SO_2 , O_3). Organic compounds are emitted by materials commonly used in the construction of mc-frames and from the objects inside the frames.

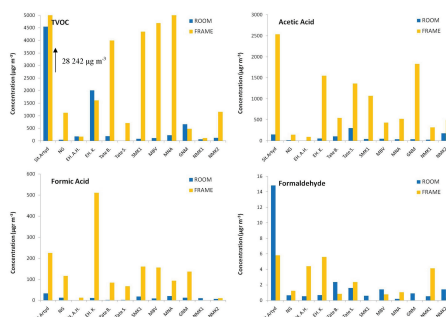


Figure 4: Total concentration of volatile organic compounds (TVOC), acetic acid, formic acid and formaldehyde measured inside and outside mc-frames.

A wide variety of organic compounds was measured inside the mc-frames. The most frequently measured compounds were α -pinene and limonene which were observed in 13 out of 14 mc-frames (Figure 5). Toluene was also widely measured in nearly all mc-frames (12 out of 14 mc-frames). Chloroform, 2-methyl-2-propenoic acid methyl ester, 2-ethyl-1-hexanol and 3-carene were measured at high concentrations ($> 500 \mu\text{g m}^{-3}$) in some of the mc-frames (Figure 5).

Concluding Remarks

The results obtained by passive gas samplers inside and outside mc-frames for paintings allow us to conclude that:

- The main problem in the room locations is the oxidising species infiltrating from outdoors. Whereas the main problem inside mc-frames is the organic,

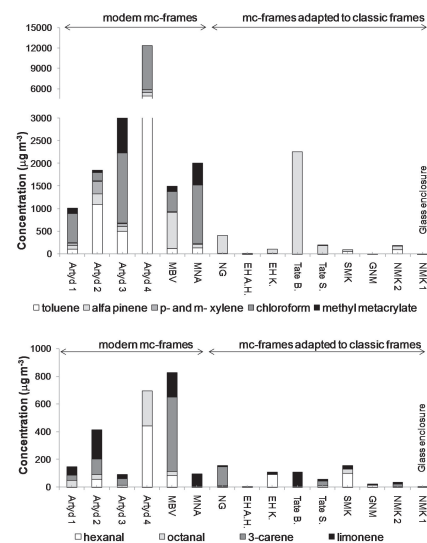


Figure 5: Concentration of specific VOC inside "modern" mc-frames and mc-frames adapted to "historic" frames including the glass enclosure.

gases emitted from materials (e.g. frame and / or paintings).

- Oxidizing compounds were detected in low concentrations inside the mc-frames whereas high concentrations were measured in the rooms. The study has demonstrated the protective effects of mc-frames for paintings against externally generated pollutants.
- In contrast, high levels of VOCs such as acetic and formic acid, toluene, p- and m-xylenes, α -pinene, limonene and 3-carene were detected inside the mc-frames. The high concentration of some of these VOCs inside mc-frames may be harmful for enclosed paintings.
- More research on the impact of organic compounds, and particularly of organic acids, on paintings needs to be performed.
- The recommendation is to make mc-frames as air tight as possible for the optimum protection of the paintings. However, this may lead to the accumulation of a variety of internally generated organic compounds. Due to the lack of information about degradation effects on paintings of exposure to organic compounds, the present best recommendation is: a) to avoid the use of construction materials with high emission of organic compounds; and b) to observe a longer period of time between construction of the mc-frame and installation of the painting.

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