Paint Volatile Organic Compound Emissions and Volatile Organic Compound Content Comparison Study

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Introduction

One of the components of many green building regulations (e.g., IgCC PV2 (2010)), standards(e.g., ASHRAE 189.1 (2009)), and certification programs (e.g., USGBC LEED NC (2009)), is good or improved indoor air quality (IAQ). A contributor to poor indoor air quality is the presence of airborne chemicals emitted from interior building products, such as paint. Thus, a means of achieving improved IAQ is source control, i.e. placing limits on the emissions of chemicals, specifically volatile organic compounds (VOCs), from interior building products.

For dry products, such as furniture and flooring,the limits are based on measured VOC emissions as they affect building occupant health and comfort. However, the requirements for paint are often based on VOC content limits designed to reduce emissions of VOCs that contribute to outdoor air pollution, particularly ozone formation. They were not designed to address the impact on the indoor environment and do not address the emissions of specific compounds with known health impacts.

To understand the relationship between VOC content and emissions, 14-day dynamic, environmental chamber emissions tests were conducted on 26 paint products with a range of stated VOC content levels from 0 to 150 g/L. The products were analyzed for emissions of VOCs and low molecular weight aldehydes.

ID	GLOSS LEVEL	VOC CONTENT (g/L)	TVOC EMISSIONS (µg/m³)	MAIN VOCs OBSERVED(µg/m³)	HCHO EMISSIONS (µg/m³)
1	SG	48	680	Texanol	7.4
2	F	47	19	Texanol	22
3	SG	0	< 5	0	BQL
4	F	< 50	11	0	9.4
5	SG	< 50	< 5	0	BQL
6	F	< 50	< 5	0	BQL
7	SG	136	1080	Texanol	10
8	SG	< 50	< 5	EG (16)	BQL
9	F	< 100	170	Texanol	BQL
10	F	< 50	42	Texanol	BQL
11	SG	140	65	EG (210)	BQL
12	F	98	920	EG (200), Texanol	BQL
13	SG	47	23	EG (65)	BQL
14	F	48	310	EG (89), Texanol	BQL
15	F	16	56	EG (14)	16
16	E	45	1390	Texanol	BQL
17	SG	37	1260	2-EHA, HA	0
18	E	95	1610	55956-25-7, 7434-89-1, Texanol	BQL
19	S	36	1160	2-EHA, HA	23
20	G	41	810	2-EHA, HA	16
21	F	16	260	Texanol	BQL
22	SG	9	730	7434-89-1, Texanol	BQL
23	SG	90	2100	Texanol	BQL
24	SG	46	73	Texanol	BQL
25	SG	90	2420	Texanol	BQL
26	SG	29	40	Texanol	BQL

Table 1: Paint sample test summary

HCHO=Formaldehyde, EG=Ethylene Glycol, HA=Hexanoic acid, 2-EHA=2-Ethylhexanoic acid, SG=Semi-gloss, F=Flat, E=Eggshell, S=Satin, G=Gloss, BQL = Below Quantifiable Level (<2µg/m³)

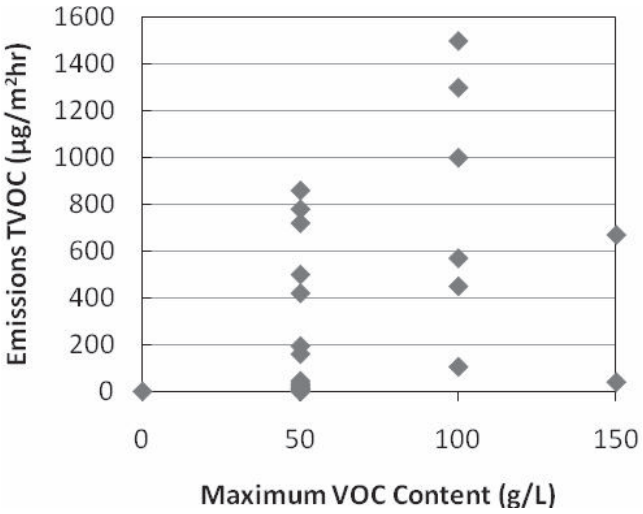

Figure 1: The measured TVOC emission factor(µg/m²hr) versus the stated maximum VOC content level (g/L)

Materials/Methods

Twenty-six un-tinted paint samples were tested following the "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers" (CDPH/EHLB/Standard Method V1.1 (2010)). The paint was applied to conditioned 12" x 12" pieces of 1/2" gypsum drywall via a 3/8" nap roller using a coverage value within the stated coverage range for each tested paint. The paint was applied to the interior surface of the drywall only, with the edges sealed with sodium silicate and low VOC emitting aluminium tape. A sample of the drywall with no paint and the edges sealed with the aluminium tape was simultaneously tested to account for any VOC emission contributions from the drywall and/or tape.

After the paint was applied to the drywall, each sample was immediately loaded into a dynamic,environmental test chamber controlled at 23° ±2°C, 50% ± 5% RH and 1.0 ± 0.05 (air changes per hour (ACH). The chamber air was then sampled for emissions of total volatile organic compounds (TVOC), individual volatile organic compounds (IVOC), formaldehyde and other aldehydes over a fourteen day test period.

Volatile organic compound measurements were made by collecting chamber air onto a Tenax-TA solid sorbent which was thermally desorbed into a gas chromatography/mass spectrometric detection system (GC/MS). The testing follows EPA Method TO-17 (1999). Emissions of target list aldehydes, including formaldehyde, were measured following ASTM D 5197 (2009),using high performance liquid chromatography(HPLC) with UV detection.

Results

A summary of the paint samples tested is presented in Table 1. All of the paints tested were base formulations, with no added tint. The paints tested covered a range of gloss levels,from flat to gloss, as well as a range of stated maximum VOC content levels, from 0 to 150 g/L, with all the paints indicated as conforming to the LEED NC low-emitting credit criteria for paints and coatings. However,samples 2, 4, 7, 15, 17, 19 and 20 have formaldehyde emissions levels above the CACREL (9µg/m³), the limit for dry product emissions. And samples 11 and 12 haveethylene glycol emissions at or above 1/2 the CACREL (200 µg/m³). Additionally, as is demonstrated in Figure 1, there is no observed correlation between the measured TVOC emissions level and the stated maximum VOC content level.

Conclusions

The results demonstrate that paint VOC content should not be used as a proxy for paint VOC emissions into indoor air, as there is no correlation between the two measures. This may result in measured indoor air TVOC levels that do not meet building clearance testing levels for TVOC. Further, measurable levels of formaldehyde and/or ethylene glycol were observed in the emissions from almost half (12)of the paint samples. These results demonstrate that low TVOC content is not necessarily indicative of acceptable VOC emissions for specific compounds with known health impacts. Thus, building designers, owners and operators,or occupants may be provided a false sense of security regarding the quality of the indoor air.

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