

# Influence of UV Light on Voc Emissions

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## SUMMARY

Indoor air quality can be strongly influenced by the presence of adhesives, mortars and in general all the building products in our houses, even if they are not in direct contact with indoor air. In this study a paint, after the addition of some VOC as markers, has been applied on a glass plate, and its emission decay has been studied. Markers considered are toluene and xilenes (o,m,p). In the paint formulation propylene glycol, ethylene glycol, diethylene glycol, Butyl Carbitol and Butyl Carbitol acetate are present.

Two specimens have been transferred in two chambers: a traditional one, and another one equipped with a UV light. Emissions of VOC markers have been studied in the first days as function of time, in order to understand if their decay behaviour could be influenced by UV.

Decay results obtained from two experiments have been compared in order to detect some differences.

## KEYWORDS

*VOC; emission chambers; indoor air; paints*

## 1 INTRODUCTION

Indoor air quality can be strongly influenced by the presence of VOC coming from adhesives, paints, furniture, tobacco smoking, and also can be affected by the presence of pollutants coming from the environment. As described by Hoshi in 2008, typical VOC coming from atmospheric environment nowadays are aromatic compounds, above all benzene, toluene and xylene, but also some aliphatic compounds and terpenes have been detected in town air.

Several studies tried to evaluate the effectiveness of some sorptive building materials in decreasing VOC in air (Seo, 2007). In our study we applied our experience in the evaluation of low-VOC building materials, following ISO 16000, considering the UV effect on markers emission rate decreasing.

Some aromatic markers have been added on a paint, and their emission rate detected as function of time during the first 2 days of the application in emission chamber.

## 2 MATERIALS AND METHODS

A modified vinyl resin-based washable paint in water dispersion for decorating internal walls, has been chosen. The paint contains in the formula the vinylic resin, propylene glycol, ethylene glycol, diethylene glycol, Butyl Carbitol and Butyl Carbitol acetate as coalescing agents and fillers, in particular a certain amount of Titanium Oxide.

For this study amounts of 0.5% w/w of toluene, o-xylene, m-xylene and p-xylene have been added.

Emission test chambers have been used for years in our analytical laboratory, in order to evaluate the content of volatile organic compounds emitted by building products. The chambers, made of stainless steel, have a volume of 110 l, controlled relative humidity and temperature ( $T=23 \pm 1^\circ\text{C}$ ;  $\text{RH}= 50 \pm 5\%$ ), and loading factor  $0.45 \text{ m}^2/\text{m}^3$ . The chamber is fluxed by purified air, with a flow rate of  $0.5 \text{ h}^{-1}$ , which allows a complete change of the air in

the chamber every two hours. Usually the sample is mixed uniformly, weighed and applied on a glass non adsorbent surface; the test specimen is transferred into the chamber immediately after preparation.

100 mg of pure reagents toluene and o-m-p xylenes have been added into 200 g of paint formulation . The paint is mixed with a mixer suitable for paints, weighed and 200 g/m<sup>2</sup> are applied each on two glass plates. The specimens are immediately transferred into the emission chambers, a traditional one, and another one equipped with a UV lamp, working in a  $\lambda$  of 300 nm, with a wattage of 6W in order to obtain a very low heating inside the chamber. The UV light has been switched on 4 hours every day. In the first day the sample has been exposed to UV rays after the film forming process. Emission behaviours have been detected and plotted for the first 48 hours of the experiment.

After 24 hours,25h,26h and 48h,49h,50h the application of the specimens in chambers, exhaust air is passed through a sample tube filled with a suitable adsorbent material (Tenax TA®). Tenax tubes are then desorbed by a thermo-desorber; volatile organic compounds are separated by gas-chromatography, identified and quantified by MS detector.

### 3 RESULTS

All results are expressed in percentage, considering as 100% the highest emission detected in the first hours of the application in chambers.

#### Glycols, Butylcarbitol and Butylcarbitol acetate

No differences between the paint with and without the UV lamp have been detected in terms of glycols emissions.

As shown in next tables, concentration of propylene glycol and ethylene glycols are the same for the two experiments, with the exception of propylene glycol which does not decrease after 48 hours the application with UV light.

Table 1. Propylene glycol % emissions

| Time | Traditional chamber | UV chamber |
|------|---------------------|------------|
| 24h  | 88.66%              | 98.45%     |
| 25h  | 100%                | 92.32%     |
| 26h  | 98.22%              | 100%       |
| 48h  | 19.58%              | 52.22%     |
| 52h  | 17.18%              | 50.45 %    |
| 54h  | 14.92%              | 48.21%     |

Table 2. Diethylene glycol % emissions

| Time | Traditional chamber | UV chamber |
|------|---------------------|------------|
| 24h  | 63.24%              | 72.29%     |
| 25h  | 72.80%              | 68.96%     |
| 26h  | 73.99%              | 77.00%     |
| 48h  | 100%                | 100%       |
| 52h  | 96.82%              | 94.51%     |
| 54h  | 96.44%              | 95.45%     |

Table 3. BCA % emissions

| Time | Traditional chamber | UV chamber |
|------|---------------------|------------|
| 24h  | 89.12%              | 89.08%     |

|     |        |        |
|-----|--------|--------|
| 25h | 100%   | 89.70% |
| 26h | 95.04% | 100%   |
| 48h | 82.97% | 84.97% |
| 52h | 87.42% | 84.87% |
| 54h | 86.14% | 84.02% |

Table 4. BC % emissions

| Time | Traditional chamber | UV chamber |
|------|---------------------|------------|
| 24h  | 90.06%              | 92.71%     |
| 25h  | 100%                | 93.55%     |
| 26h  | 91.93%              | 100%       |
| 48h  | 70.61%              | 77.96%     |
| 52h  | 72.71%              | 77.07%     |
| 54h  | 71.95%              | 76.45%     |

Next figures show the emission rate decay of the compounds contained in paint as function of time: the dashed curve are correlated with UV lighth chamber.

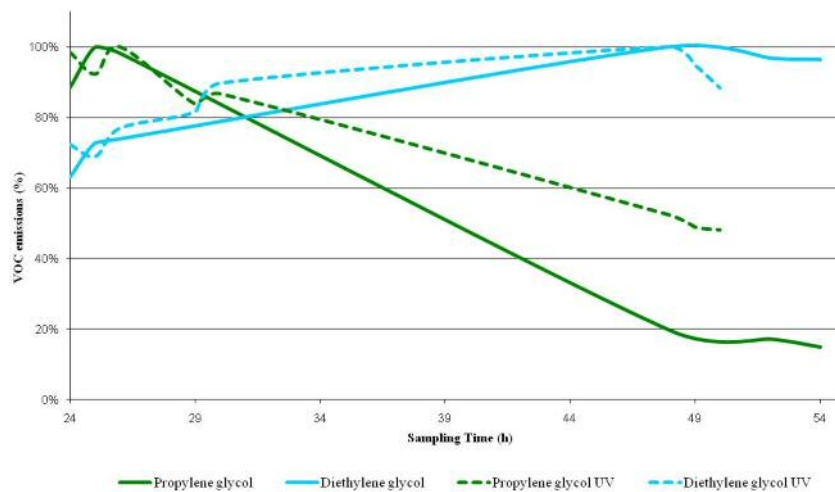


Figure 1. Glycols decay (propylene glycol green profile; diethylene glycol blue profile)

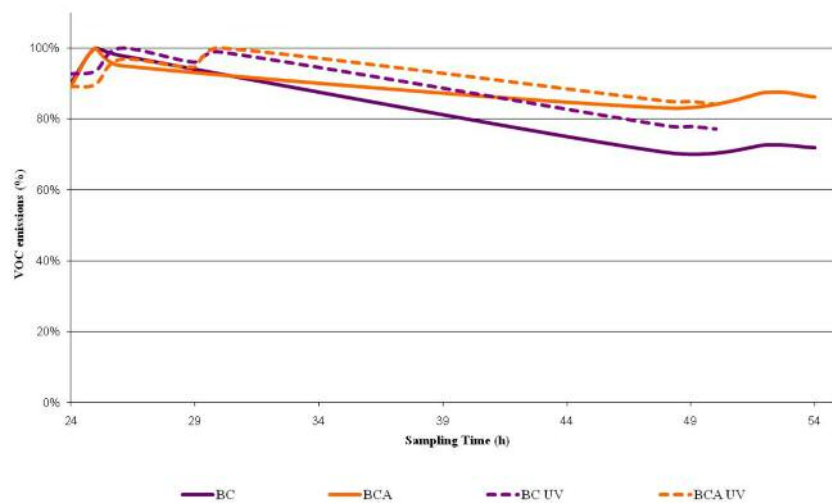


Figure 2. BC (violet profile) and BCA (red profile) decay

## Aromatic hydrocarbons

Considered aromatic hydrocarbons, which have been added in the formulation, show a different behaviour: the application of UV light strongly enhance the emission rate decay as function of time for both the species.

Table 5. Toluene % emissions

| Time | Traditional chamber | UV chamber |
|------|---------------------|------------|
| 24h  | 95.05%              | 100%       |
| 25h  | 100%                | 78.91%     |
| 26h  | 91.73%              | 70.64%     |
| 48h  | 33.31%              | 13.16%     |
| 52h  | 21.82%              | 8.57%      |
| 54h  | 18.06%              | 8.89%      |

Table 6. Xylene % emissions

| Time | Traditional chamber | UV chamber |
|------|---------------------|------------|
| 24h  | 94.58%              | 100%       |
| 25h  | 100%                | 81.11%     |
| 26h  | 98.33%              | 75.03%     |
| 48h  | 30.15%              | 19.52%     |
| 52h  | 26.12%              | 14.31%     |
| 54h  | 22.63%              | 12.54%     |

Next figures show the emission rate decay of the considered markers: the dashed curve are correlated with UV light chamber.

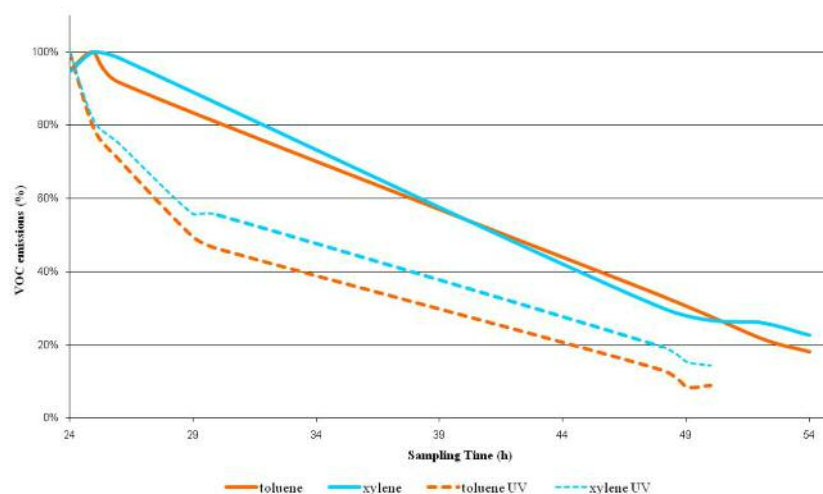


Figure 2. toluene (red profile) and xylenes (blue profile) decay

## 4 DISCUSSION

One water-based paint with  $\text{TiO}_2$  as one of the fillers present in the formulation have been study in terms of emission after the addition of aromatic markers.

Toluene and o,m,p-xylenes have been added in order to detect their decay in the indoor air with and without the presence of UV light.

The first two days after the application of the paints in emission chambers have been observed, sampling the air on Tenax tubes and analysing VOC compounds by GC/MS technique.

All glycols still present in the formulation have the same emission rate if UV is applied or not: they have high emissions in the first hours of the experiment, decreasing as function of time during the filmation of the paint.

Aromatic compounds added in the formulation have a different behaviour. In the traditional emission chamber, in fact, toluene and xylenes have high emissions which decrease as function of time.

When the UV light is applied on the second specimen, all aromatic hydrocarbons emissions have been detected, finding different results in terms both of concentration expressed as  $\mu\text{g}/\text{m}^3$  and of emission rate. In particular, emission rate is strongly affected by the UV light. Aromatic in fact faster decrease in presence of UV then in the traditional chamber.

Relative humidity is quite high during the first day of both the experiments (an average of  $\sim 80\%$  RH) and this parameter could have been enhanced the UV light effect on emission rate decrease on aromatic compounds. Titanium oxide in paint formulation have the catalytic rule, essential to give the phenomenon observed.

It is well know that UV light can interact with  $\pi$  bonds in aromatic compounds, probably giving the observed effect of fast decreasing of their emissions in indoor

## 5 CONCLUSIONS

We use to think about VOC as emissions, we all try to find new materials which can guarantee a good quality of indoor air, materials which have low VOC emissions. This preliminary work tries to find a method to speed up a kind of VOC emissions cleaning when the indoor air is strongly affected by them.

We demonstrated that UV light in presence of high relative humidity can accelerate the emission rate of some volatile compounds, in particular the organic compounds with  $\pi$  bonds such as aromatics. This kind of treatment could be very useful in case of emissions due to aromatic compounds in job-sites, where VOC can be due to materials applied, or furniture for example.

Next step of this work will be the comparison of the same UV light effect on different paints, with other catalytic raw materials which can enhance the decreasing of VOC emissions. Other volatile compounds as markers will be taken into consideration for a wider study of UV effect.

## ACKNOWLEDGEMENT

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## 6 REFERENCES

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