4B4) The Formation of Secondary Products During the Indoor Reaction of Ozone with Terpenes Emitted from Natural Paint

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1. Introduction

Natural paint is a potential source of volatile biogenic hydrocarbons in indoor environments. The raw ingredients of this paint are essential oils, resins, and plant pigments. The volatile biogenic hydrocarbons such as limonene, alpha-pinene and beta-pinene are usually classified as monoterpenes and known to be extracted from essential oils. These monoterpenes have been extensively studied due to their high reactivity with atmospheric oxidants such as ozone.

The formation of secondary organic compounds (chemicals and particulate matters) is a major concern because of their impact on indoor air quality (IAQ). The presence of these secondary organic compounds has been reported as an important source of various health problems. One significant example is "sick building syndrome (SBS)" in confined working environments.

The study has been conducted to identify and quantify the volatile biogenic hydrocarbons emitted from natural paint. The ozone-initiated oxidation of volatile biogenic hydrocarbons emitted from natural paint has been also monitored in this study. The formations of secondary organic compounds and submicron particle has been observed during the ozone-initiated oxidation with the biogenic hydrocarbons emitted from the natural paint. We have demonstrated that indoor air quality could be significantly affected by the emitted biogenic hydrocarbons and their reactions with ozone.

2. Experimental Methods

Preliminary experiments have been conducted in a 5 L Teflon bag. The major chemical components emitted from natural paint have been identified and quantified using FT/IR (Midac I Series).

Ozone-initiated oxidations with emitted volatile biogenic hydrocarbons have been carried out in a Teflon chamber (volume = 1 m^3). Particle number concentrations were measured using Condensation Particle Counter (CPC, TSI 3025). Secondary organic compounds were measured by HPLC using 1,4-DNPH sampling cartridges.

3. Results and Conclusion

FTIR analysis showed that the identified reactive monoterpenes were limonene, beta-pinene, and camphene. The degradation of the monoterpenes by ozone were monitored using FTIR, which is shown at Fig. 1. Limonene exhibited a most significant decrease in the presence of ozone among the monoterpenes. Fig. 2 shows the observed formation of submicron particles under different experimental conditions including five levels of ozone (50, 100, 200, 500, 1000 ppm) and two different volume of paint (10 and 30 ml, respectively). We can observe the increase of particle numbers at 2000 minutes again (secondary reaction) when the higher volume of paint has been used. Secondary organic compounds such as aldehydes and ketones were also formed during an ozonolysis.

The research demonstrated that the volatile biogenic hydrocarbons emitted from natural paint on indoor surfaces can be degraded by ozone and transformed to more toxic secondary organic products. The research has also shown that secondary increase of particle number concentration can be caused by the formation of secondary organic products (aldehyde, etc.). They could be a potential source making an adverse impact on indoor air quality and as well as on human health.

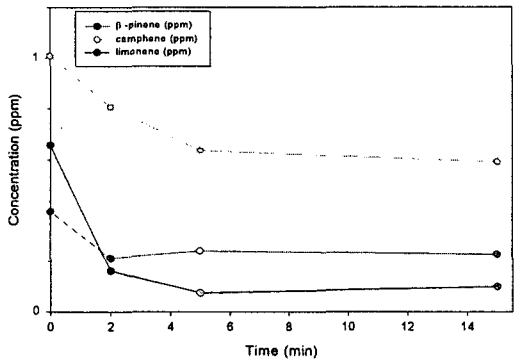

Fig. 1. Degradation of monoterpenes emitted from natural paint during ozonolysis.

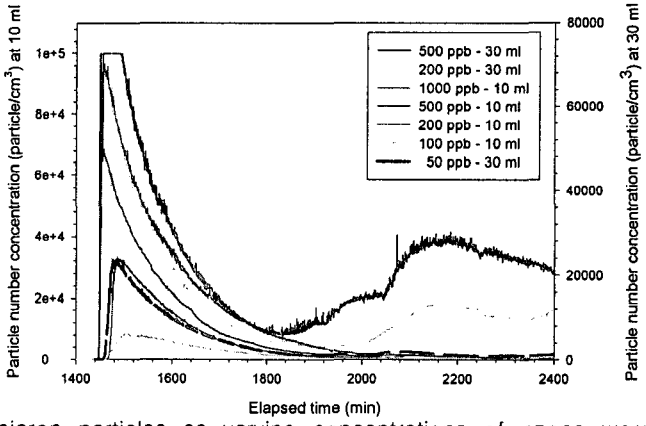

Fig. 2. Formation of submicron particles as varying concentrations of ozone were introduced inside chamber.

References

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