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## **Evaluation of volatile organic compounds and particulate emissions of incense and candle in emission test chamber: impact of test parameters**

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### **SUMMARY**

Burning incenses and candles have been identified as source of Volatile and Semi Volatile Organic Compounds (VOC/SVOC) and particles in indoor environments. In this study, the repeatability and reproducibility of test methods using emission chambers to investigate emissions of volatile and particulate compounds from scented candles and incense products as well as the impact of experimental volume of the emission test chamber has been studied. Finally, the best-adapted emission test chamber and test protocol for the evaluation of incense and candles emissions will be proposed.

### **PRACTICAL IMPLICATIONS**

The comparison of several emission test chambers will choose the most suitable experimental volume for a future regulation.

### **KEYWORDS**

Incense/candle burning, volatile organic compounds, aerosols, indoor air quality.

### **1 INTRODUCTION**

Indoor air quality is influenced by many combustion sources such as candle/incense burning. This source, though being small, emits well-known compounds such as VOC/SVOC and particles that cause adverse health effects. The main objective of this study is to provide a simple and reproducible methodology for the characterization of volatile and particulates emissions by incense and candles used indoors. This methodology will specify particular test conditions (type of test chamber, environmental parameters), types of pollutants studied (gaseous and particulate) and conditions associated samples. It should be representative of the use of incenses and candles in real environments and potential health risks for users of these products.

### **2 MATERIALS/METHODS**

Emissions of 2 candles and 3 incense products selected from a panel of 20 products tested during an intensive field campaign have been characterized using two 1 m<sup>3</sup> emission test chambers (VCE1000 chamber, Vötsch Industrietechnik) and one specific test chamber dedicated to combustion phenomena (0.18 m<sup>3</sup>), built from previous work of Derudi's research group (2012). ISO 16000-3 and ISO 16000-6 standard test methods are used to sample and analyse carbonyl compounds and VOC emitted by air freshener, except for one 1 m<sup>3</sup> emission test chamber where a High Sensitivity – Proton Transfer Reaction – Mass Spectrometer (HS-PTR-MS) has been

installed at the outlet. Finally a Scanning Mobility Particle Sizer spectrometer (SMPS) has been used for particles measurement.

Measurements have been carried out before and during the combustion of the air freshener, and at least 3 hours after the end of combustion. For candles, combustion time has been fixed at 1 hour and candles have been extinguished by mechanical specific apparatus without opening the test chamber. For incenses, combustion time has been adjusted to real time of combustion of the product. Each product has been test at least two times in each emission test chamber.

In all experiments, the indoor climatic conditions were measured as follows: air exchange rate (AER)=0.66(±0.02) h<sup>-1</sup>, chamber temperature (T)=23.0(±0.1)°C and relative humidity (RH)=50(±1)%.

### 3 RESULTS

Although candles were found to be poorly sources of VOC, lots of compounds were observed during the air freshener combustion experiments such as benzene, toluene, xylenes, styrene, naphthalene, monoterpenes, isoprene, formaldehyde, acetaldehyde, benzaldehyde and acetone. All results are normalized on combustion mass average of 1 g for incense and candle. The relative standard deviation may fluctuate up to 15 % according to the studied compound, the emission test chamber and the sampling and analysis method.

### 4 DISCUSSION

Formaldehyde is the most abundant emitted compound, which is up to 10 time more concentrated than benzene, for example. From the measured concentrations in the emission test chambers, mass emission factors will be determined and they will be used to select the most appropriate test chamber and the associated test protocol.

### 5 CONCLUSIONS

Five air fresheners (2 scented candles and 3 incenses) were tested in three emission test chambers (two 1 m<sup>3</sup> and one specific test chamber dedicated to combustion phenomena (0.18 m<sup>3</sup>)). Off-line and on-line sampling and analysis were deployed to monitor VOC and particles emitted during combustion. The resulting mass emission factors could be integrated into existing databases on emission sources of pollutants in indoor environments, especially that related to European collaborative action EPHECT.

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