Peroxide Content of Secondary Organic Aerosol

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Abstract

Secondary organic aerosol (SOA) formed from the oxidation of monoterpenes can impact the Earth’s radiation balance, act as cloud condensation nuclei and negatively affect human health. In the summer of 2015, the Secondary Organic Aerosol From Forest Emission Experiment (SOAFFEE) laboratory campaign was launched in order to study the physical properties of SOA generated from the oxidation of α-pinene and Δ-carene. Both compounds are gas-phase monoterpenes emitted into the atmosphere via biogenic sources. In this study, the peroxide content of SOA was determined using an iodometric-spectrophotometric (IS) technique. It was found that the peroxide content of SOA generated during the SOAFFEE campaign was similar to that found in previous studies.

Environmental Chamber

Figure 2. Schematic of the environmental chamber

Materials and Methods

2KI (aq) + 2HCl (aq) + H₂O₂ (aq) → I₂ (s) + 2H₂O (l) + 2KCl (aq)

I₂ (s) + KI (aq) → KI₃ (aq)

Figure 3. Reactions used in the IS technique. Colorless H₂O₂ is converted into yellow colored I₂ ions. The absorbance of the I₂ ions is measured using a high resolution UV/Vis spectrometer.

Results

Figure 4. Experimental set-up used for the IS reactions.

2KI (aq) + 2HCl (aq) + H₂O₂ (aq) → I₂ (s) + 2H₂O (l) + 2KCl (aq)

I₂ (s) + KI (aq) → KI₃ (aq)

Figure 5. UV-Vis absorption spectrum of 15.62 µM H₂O₂ and SOA.

Table 1. Estimated peroxide content in SOA generated during the SOAFFEE campaign.

Table 2. Measured SOA and organic peroxide yields from reactions of monoterpenes with O₃ (Docherty et al., 2005).

Conclusions

The IS technique, used to measure the total peroxide content of SOA, was optimized. The hydrogen peroxide calibration curve constructed during the optimization process agreed well with the literature. SOA created during the SOAFFEE study were analyzed to determine their peroxide content. It was found that the SOA particles had similar amounts of peroxide as those created in previous experimental studies. The results presented here will aid in the determination of SOA composition and formation pathways. However, it is not sufficient to fully quantify the peroxide content of SOA. More UV/Vis absorbance measurements must be collected using SOA generated under different conditions. Furthermore, it is not clear if a hydrogen peroxide calibration curve is sufficient to predict total peroxide content in all types of SOA. Additional experimental methods can be used to validate the IS procedure.

Comparison With Literature