SUPPORTING INFORMATION

Kinetic analysis of competition between aerosol particle removal and generation by ionization air purifiers

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Characterization of the air-purifiers used in the experiments

A common residential ionization air purifier (IAP) was used in experiments. A commercial ozone generator (OG) marketed as an "air cleaner" despite its lack of any particle filtration capabilities, was used for comparison. Rates of ozone emission and particle removal were measured by operating these devices in a 600L Teflon chamber filled with ambient air (Figure 1) at room temperature and 40±4% relative humidity. Ozone concentrations were measured with a calibrated photometric ozone monitor, which withdrew and returned air through Teflon lines at 1.5 SLM. Particles were counted in seven size channels between 0.15 – 5 μm with a laser particle counter. The time resolution was 27 seconds per size distribution. To avoid saturation effects in counting, the air withdrawn from the chamber (0.3-0.5 SLM) was mixed with a much larger flow of particle-free air (30 SML) before entering the particle counter. It was explicitly verified that the sampling instruments themselves had negligible effects on the measured concentrations of ozone and particles in the chamber.

Figure 2a shows that ozone concentration in the chamber increases linearly with time once the air purifier is turned on. This is expected for a zero-order emission process for $t << t_{loss}$, where t_{loss} is the lifetime of ozone in the chamber (several hours for such a Teflon chamber). The ozone emission rate can be calculated from the initial slope as follows:*

$$Rate\ (\text{mg hr}^{-1}) = 1.18\times10^{-4}\times V_{chamber}\,(\text{L})\times\frac{d[\text{O}_3]}{dt}\,(\text{ppb min}^{-1})$$

The particle concentration in the chamber decreases exponentially with time after turning IAP on (Figure 2b). Within experimental uncertainties, the same removal rates were observed for

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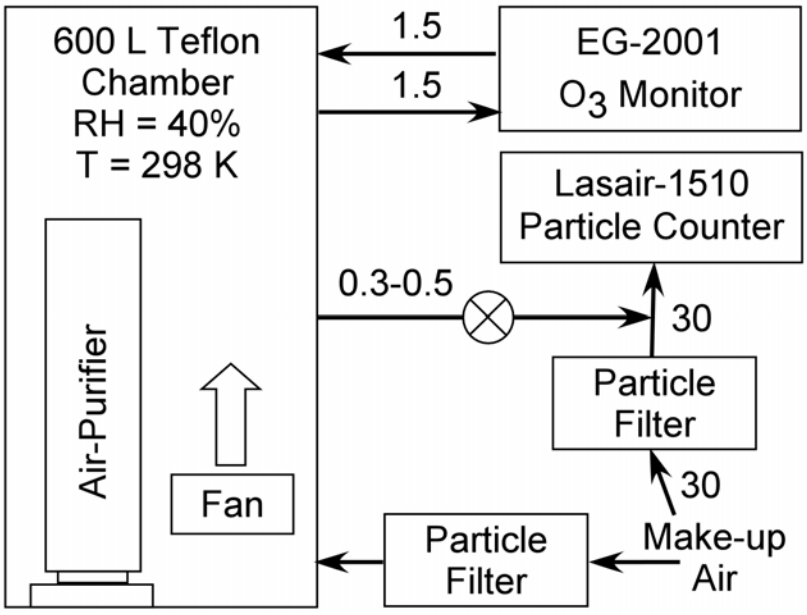
particles in the 0.15 μm, 0.20 μm, and 0.30 μm size channels. The counting rates for particles larger than 0.3 μm were quite low, and could not be measured reliably. The total number concentration of particles decayed with approximately the same rate constant as for the 0.15-0.30 μm range. The observed rate constant for the total particle count in this 600L chamber is k_{ap} = 0.0095(5) s^{-1}. This corresponds to the γF value[†] of 342(20) SLM = 20(1) m^3 hr^{-1}.

Supporting Figure 1: Experimental setup for quantification of ozone-emission and particle removal rates by air purifiers. The numbers by the arrows are air flows in SLM.



[†] See equation (1) in the main text for the definition of γF.

Supporting Figure 2: Sample measurements of the ozone emission rate (a) and particle removal rate (b) by the IAP. Panel (b) displays base-10 logarithm of the measured particle counts; filled circles correspond to 0.15 μm size channel, open circles to 0.20 μm, filled triangles to 0.30 μm, and open triangles to the total particle count, 0.15-5 μm. The lines are the least-square fits to the respective data sets.