Evaluation of the Ionic Purification Efficiency by the Electrical Low Pressure Impactor (ELPI)

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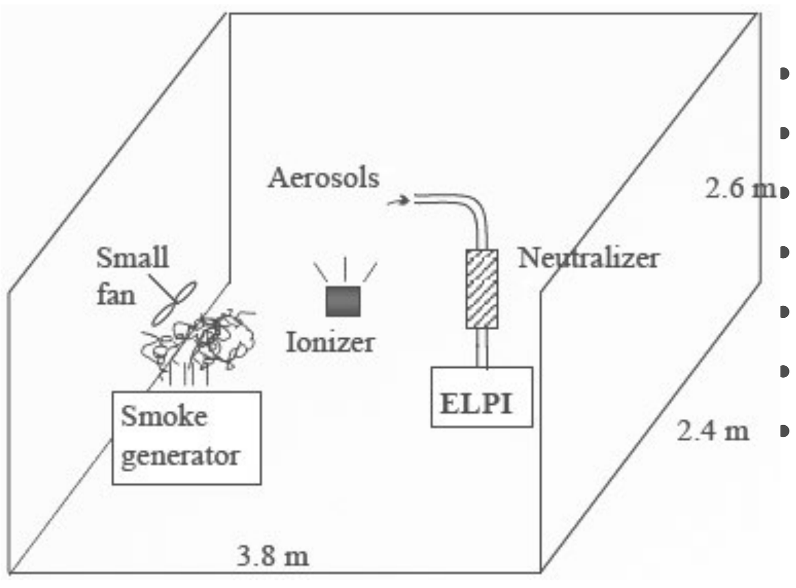
Introduction and Objective

- The ion emission has been shown to reduce the concentration of airborne dust particles and microorganisms in indoor environments. The aerosol particles, charged unipolarly by the emitted ions, repel and migrate toward the surfaces, which results in their rapid deposition. Those ion emitters, which meet health standards (e.g., do not generate ozone above the established thresholds) have been incorporated in commercial air purification devices. The ionic air purifiers are being increasingly used in indoor environments.
- In this study, three ionic air purifiers, VI-3500*, Air Supply/Minimate* (+) positive and Air Supply/Minimate* (-) negative (Wein Products Inc., Los Angeles, CA), were evaluated with respect to their indoor air cleaning efficiency.
- Since some airborne biological agents are primarily represented by submicrometer and micrometer particles (e.g., isolated airborne viruses range from 0.04 to about 0.2-0.3 µm and bacterial spores are about 1 µm in their equivalent optical/aerodynamic diameter), the targeted particle size range was 0.04 to 2 µm.

Methods

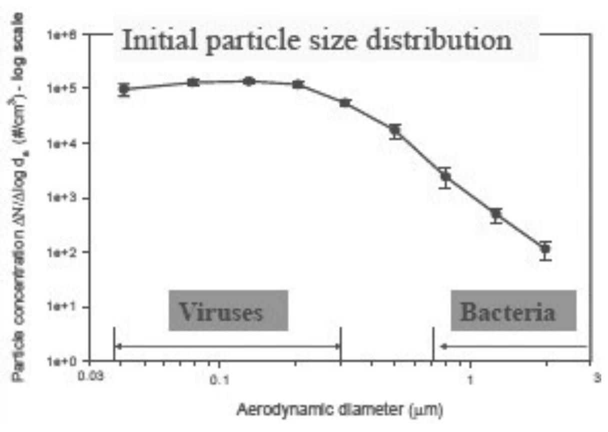


Testing setup

- Indoor test chamber of ~ 25 m^3
- Smoke particle generator
- Electrical low pressure impactor (ELPI, TSI Inc./Dekati Ltd, St. Paul, MN)
- The particle-size-specific concentrations recorded in 12 channels of the ELPI, d_a = 0.04 to 10 µm
- The particle charge distribution measurement
- The ELPI sampling inlet is ~ 0.2 m from the purifier
- Air temperature = 23±10°C
- Relative humidity = 42±9%

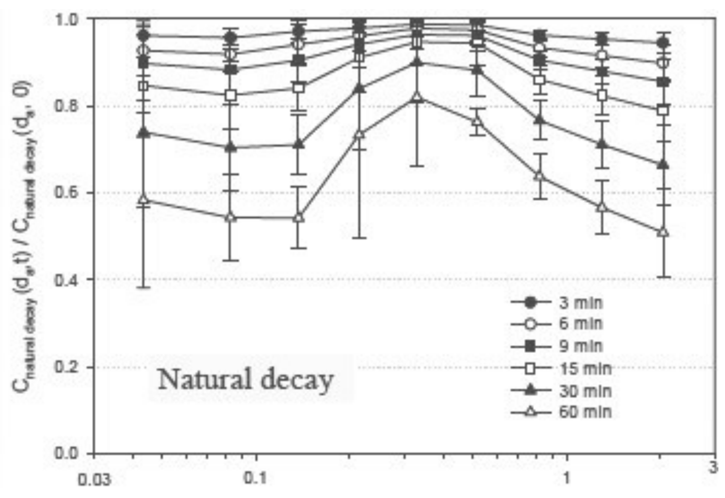
Wein ionic air purifiers	VI-2500	AS150MM (+) positive	AS150MM (-) negative
Ion density	2 million (-) ions / cm³	1.5 million (+) ions / cm³	1.5 million (-) ions / cm³
Measurement distance from the device	4 ft (1.22 m)	2 ft (0.61 m)	2 ft (0.61 m)

Comparison Chart

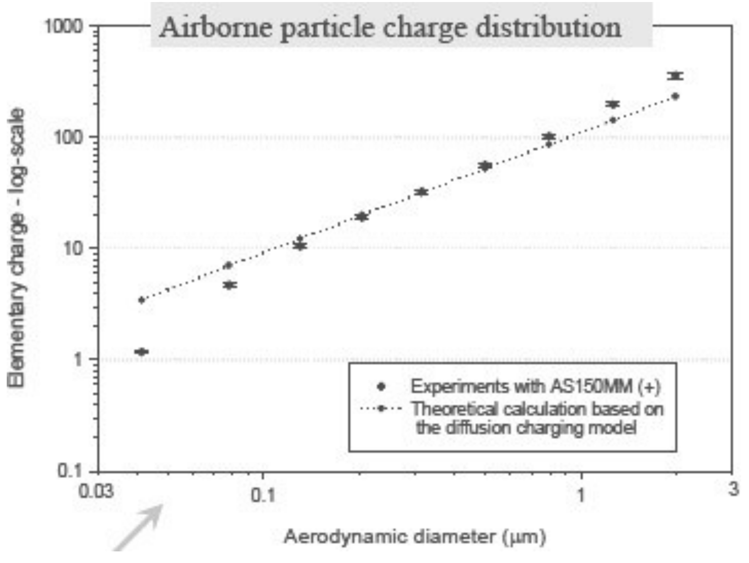


Particle charge distribution measurement

Results

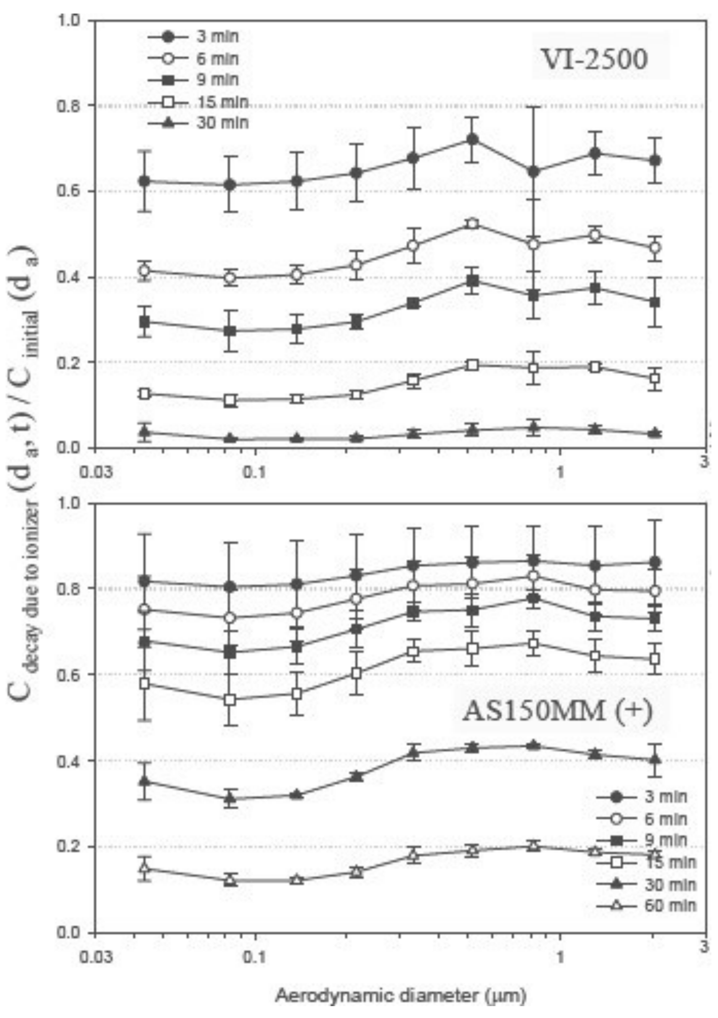


Graph of natural decay results



Distribution of airborne particle charge

Original charges of particles generated in our experiments were very low (less than 1 elementary charge per particle, on average). When an ionic air purifier operated, the airborne particles exhibited considerable positive or negative electric charges, depending on the polarity of the purifier (e.g. the average charge of 1 µm particles reached ~10^{2}e + in 3 minutes when the Air Supply/Minimate (+) operated). The experimental results are in good agreement with the theoretical data obtained using the diffusion charging model.



Results of VI-3500* and AS150MM (+) ionic air purifiers demonstrating significant air purifying efficiency

Ionic air purifiers demonstrate significant air purifying efficiency. A 30-minute operation of the VI-3500* in a room-size chamber removed about 97 % of 0.1 µm particles and about 95% of 1 µm particles from the air, in addition to the natural decay effect. A 60-minute operation of the Air Supply/Minimate (+) and Air Supply/Minimate (-) moved about 83% and 84% of 0.1 µm particles and about 79% and 83% of 1 µm particles from the air, respectively.

*This document originally pertained to VI-2500, AS180i and AS150MM