Test of indoor air cleaners

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Clean indoor air is important for human health and well-being. Clean air is usually be obtained by reduction of indoor air pollutant sources and by ensuring sufficient ventilation. However, the outdoor air is not always clean, so often the incoming air is cleaned by filtration. Air cleaning devices may also be placed in the indoor environment.

We have tested five commercially available air cleaning devices which are all designed to remove aerosol particles from the indoor air. Cleaning of coarse particles is good for removing pollen, mould, and dust particles, cleaning of fine particles for removing long-range transported particles, and cleaning of ultra-fine particles for removing particles from local combustion and many indoor sources.

We tested air cleaners from five producers: Electrolux, IQAir, Elixair, Plymovent, and LightAir. The device from LightAir was an electrostatic precipitator with the ion flow on the outside of the device. All the others used fans to suck the air through some filters, and in one case also through an electrostatic precipitator. These were tested, one by one, in a room with a ventilation rate of 0.6 air changes/hour. The incoming air was first filtered and then an aerosol generator injected particles into it. The incoming aerosol and the aerosol in the room were monitored with a Scanning Mobility Particle Sizer (SMPS) and an Optical Particle sizer (OPS). Two fans in the room ensured that the air was well mixed. Each experiment lasted about 24 h. In the beginning the aerosol generator was on while the air cleaner was off. Then after 160 min the air cleaner was turned on and the particle concentration decreased until it reached a steady-state. A few hours before the end of the experiment the aerosol generator was turned off. Then the particle concentration decreased rapidly. Similar studies have considered this fast decay only (Zuraimi *et al* 2011; Kim *et al* 2013), but by utilising a longer data time series we reduced the uncertainties of our results.

The number size distribution in the chamber is described by the balance equation (assuming no indoor sources)

$$\frac{dN_i}{dt} = N_{vent,i}\lambda - N_i(\lambda + \beta_i + \gamma_i) + J_{coag,i}$$

where N_i is the number concentration of particles in size class i in the chamber, $N_{vent,i}$ is the corresponding concentration for the incoming aerosol, λ is the ventilation rate, β_i and γ_i are respectively the deposition and cleaning rates for particles of size class i, and $J_{coag,i}$ is the change rate due to coagulation.

We used the measured number size distribution data to estimate λ, β_i, and γ_i. This is possible because we measured periods with and without the air cleaners, and with and without incoming particles. By multiplying the cleaning rate with the room volume we obtained the Clean Air Delivery Rate (CADR) which is a standard measure of air cleaner performance.

For most of the air cleaners the CADR size dependence is small for particles smaller than 600 nm, and for supermicron particles the CADR was somewhat higher. The LightAir device was an exception. This was expected because of a different method for cleaning the air. The obtained CADR fit well with the information from the producers.

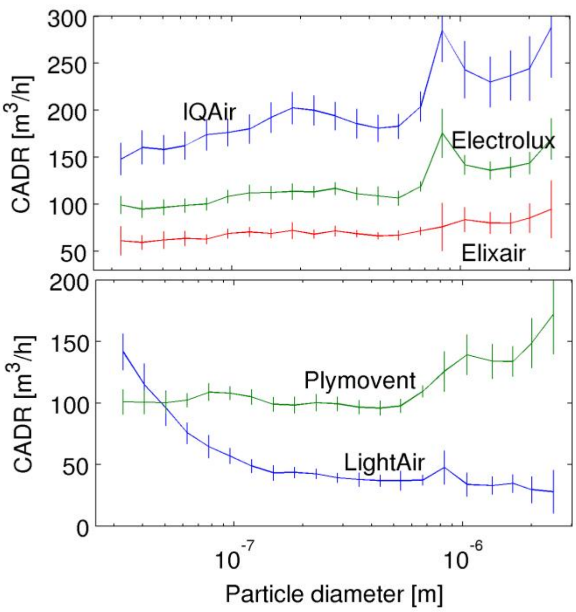

Figure 1. Size-resolved Clean Air Delivery Rates.

Zuraimi, M.S., Nilsson, G.J., Magee, R.J. (2011) *Build. Environ.* **46**, 2512-2519.
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