Mendell A, Olson A, Siegel JA. 2022. Evaluation of fixed and adaptive concentration thresholds for particle filter systems. *Indoor Air*, **32(10)**, e13134. DOI: 10.1111/ina.13134

**Abstract**

Particle filtration can effectively reduce indoor concentrations of particulate matter (PM) but may incur high energy use. This study evaluates fixed and adaptive concentration thresholds to automate the operation of filtration systems. Simulated environments were derived from week-long continuous PM measurements from Dylos DC1700 ($N$ = 104) and Alphasense OPC-N2 ($N$ = 100) particle counters deployed in apartments in Toronto. A fixed threshold of 4.0 μg·m$^{-3}$ resulted in a mean air cleaner runtime of 6.9% to 21.0% depending on clean air delivery rate (CADR) and particle sensor, while providing mean concentration reductions of 67% to 71% compared to operating the air cleaner constantly (runtime = 100%). In most environments, runtime could be further reduced by raising the fixed threshold while resulting in only a modest decrease in absolute and normalized mean exposure reduction. Using an adaptive threshold derived from a k-means clustering approach generally provided substantial exposure reduction while preventing high runtimes. These results were generally insensitive to cleaning power and the monitor used to measure particle concentrations. Reducing the energy usage of particle filter systems will make them a more viable and sustainable means of improving occupant health.

**Main findings**

1. Operating an air cleaner only when a threshold particle concentration is exceeded is more energy efficient than continuous operation.
2. A threshold of 4 μg·m$^{-3}$ reduces runtimes substantially and provides most of the benefit of continuous operation.
3. Using a clustering algorithm creates an environment-specific adaptive threshold.
4. The use of this adaptive threshold allows even more energy-efficient operation.

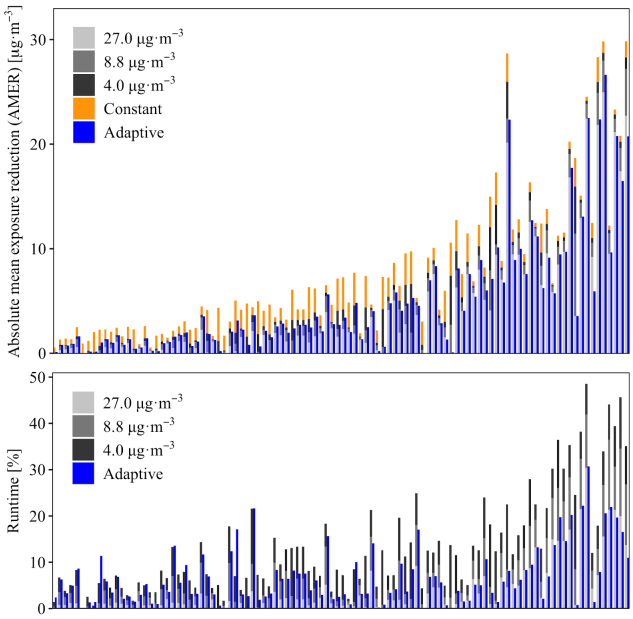


**Fig. 1.** Absolute mean exposure reduction (upper plot) and runtime (lower plot) of the selected thresholds using a CADR/V ratio of 2.5 h$^{-1}$ for the simulated environments derived from Dylos DC1700 measurements. ($N$ = 104). Each pair of bars represents one apartment. Results are arranged by the simulated mean concentration in each environment without air cleaning. The runtime fraction for constant air cleaning is not shown as this will always extend to 100%. The two environments with the highest simulated mean concentration are not included to improve visual clarity.

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