

Li T, Siegel JA. 2021. The impact of control strategies on filtration performance. *Energy & Buildings*, **251**, 111378. DOI: [10.1016/j.enbuild.2021.111378](https://doi.org/10.1016/j.enbuild.2021.111378)

Abstract

Particle filtration systems are widely used indoors to reduce particle concentration. Increasing the runtime, the fraction of time a system operates, can improve the removal performance but also comes at a greater energy cost. Thus, operation strategies are needed to improve performance while conserving energy. In this work, we used exposure reduction, a metric for filtration effectiveness, and removal efficacy, the ratio of exposure reduction to runtime to provide a quantitative assessment on four operation strategies including strategies sensitive to concentration and/or presence of emission events, pulsing the system regardless of concentration, and pulsing during elevated concentration periods. A time-varying mass balance model is used to estimate indoor concentration with stochastic emission events. The results show that the concentration strategy, which synchronizes the system operation with high indoor concentrations has the highest removal efficacy. It could achieve a comparable level of concentration reduction as continuous operation at runtimes as low as 80%. The runtime of this strategy can be further reduced by increasing its concentration threshold. This strategy provides opportunities to regulate indoor concentration while conserving fan energy use, especially in regions with relatively low ambient concentrations and strong episodic sources.

Main findings

- **Continuous** filtration systems operation *maximizes* exposure reduction and energy use
- Operation strategies based on monitoring and cycling can **optimize filtration**
- **Concentration threshold** can reduce runtime while causing little increase in exposure
- The benefits come from *synchronizing operation with high concentration periods*
- Benefits depends on outdoor concentration, infiltration, HVAC sizing, and emissions

Support provided by:

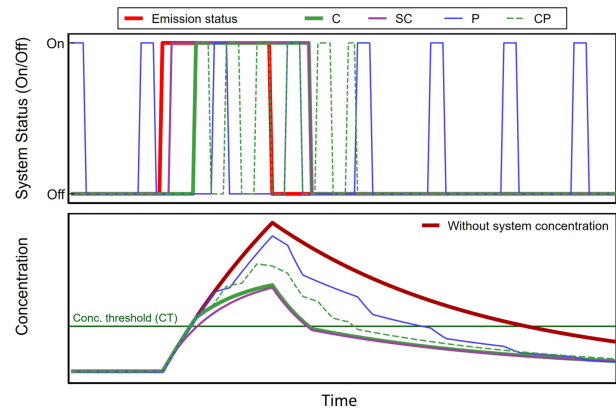


Figure 1. System and emission status (top) and the concentration profile without and with the four operation strategies (bottom): concentration (C), source and concentration (SC), pulsed (P), and concentration pulsed (CP).

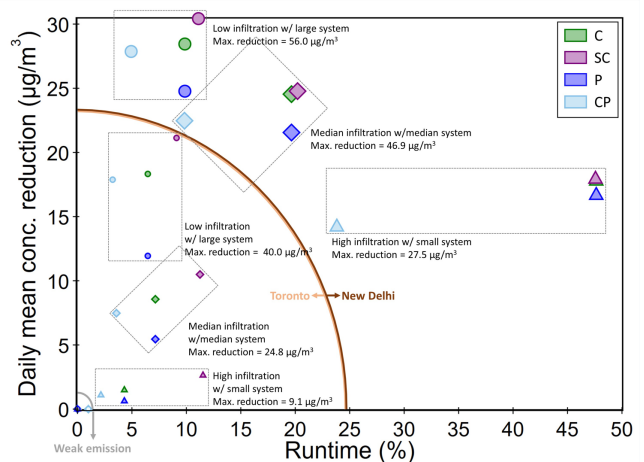


Figure 6. Daily mean concentration reduction of the four strategies: concentration (C), source and concentration (SC), pulsed (P), and concentration pulsed (CP) as a function of runtime. In the figure, the marker size indicates outdoor concentration, the shape indicates scenario, and the color indicates strategies. The strategies in the same scenario are grouped by the grey dashed box with labels on the side.

