Zhang Y, Li T, Siegel JA. 2020. Investigating the impact of filters on long-term particle concentration measurements in residences (RP-1649). *Science and Technology for the Built Environment*, **26(8)**, 1037-1047. DOI: 10.1080/23744731.2020.1778402

Abstract

Filters in heating, ventilation, and air-conditioning (HVAC) systems are the most prevalent air cleaning method in residential environments in North America. This study evaluated the long-term impact of residential filtration systems on indoor particle concentrations by examining concentration measurements from low-cost monitors over one year in twenty homes in Toronto, Ontario, Canada. These concentration results suggested that in general, indoor concentration had a similar seasonal trend as the ambient concentration, and indoor activities (e.g., cooking) elevated indoor particle levels for 40-50% of the time. Further, the impacts of electret filters were examined using a non-electret filter with a minimum efficiency reporting value (MERV) of 8 as the reference point at each home. The mean effectiveness of the filters (MERV 8E = −4.19%, MERV 11E = −0.51%, and MERV 14E = 14.5%) were lower than values found in the literature, most likely due to lower HVAC system runtime in our sample of homes (median = 9.6%). Overall, this filter effectiveness analysis reveals that the real-life filter performance was strongly influenced by system and house characteristics (e.g., system runtime, in-situ efficiency, air change rate, and particle source strength), and thus can be different from modeling and laboratory test results.

Main findings

1. Indoor particle concentrations have a similar seasonal pattern as outdoor concentrations where they perk in August and September and decreases in October and November.
2. Both indoor (e.g. cooking and cleaning) and outdoor (e.g. roadside construction) can heavily impact indoor concentrations.
3. Long-term filter effectiveness relative to MERV 8 filters was highly variable and smaller than other effectiveness studies have reported, most likely due to low HVAC runtime, low in-situ filter efficiency, and high air change rate.
4. High-efficiency filters need to be used accordingly for anticipated results, which includes, making sure sufficient runtime, change filter even more frequent than suggested, and having a tighter enclosure.

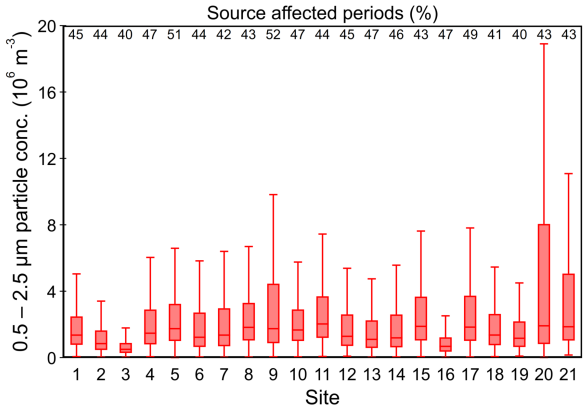

Figure 1. The indoor concentration of 0.5 – 2.5 µm (small) particles for each site. The numbers displayed on the top indicate the fraction of time that sources were detected.

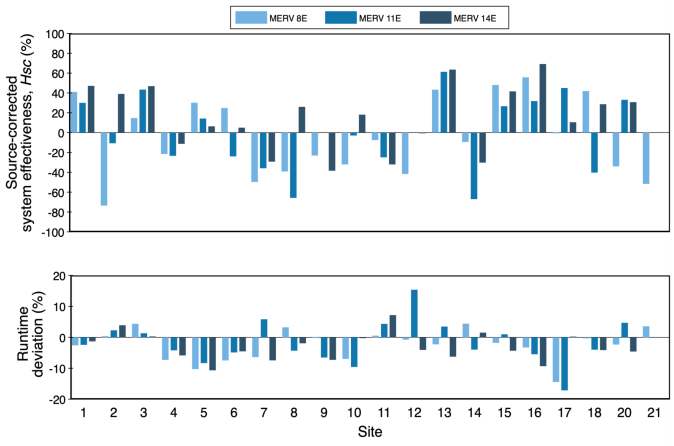

Figure 4. Source-corrected filtration system effectiveness (H_{SC}) of MERV 8E, MERV 11E, and MERV 14E filters relative to MERV 8 filters in each sampled home. The lower part of the figure is the absolute deviation in the system runtime from these three filters from the MERV 8 filter runtime at each home.

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