

Li T, Siegel JA. 2020. In-situ efficiency of filters in residential central HVAC systems. *Indoor Air*, 30(2), 315-325. DOI: [10.1111/ina.12633](https://doi.org/10.1111/ina.12633)

Abstract

High efficiency filtration in residential forced-air heating, ventilation, and air conditioning (HVAC) systems protects equipment and can reduce exposure to particulate matter. Laboratory tests provide a measure of the nominal efficiency, but they may not accurately reflect the in-situ efficiency of the filters because of variations in system conditions and changes in filter performance over time. The primary focus of this paper is to evaluate the effective filtration efficiency, which is inclusive of any loading and system impacts, in 21 occupied residential homes through in-duct concentration measurements. We considered the role of filter media by testing both electret and non-electret media, as well as the role of loading by considering new and used filters. The results show that filters with higher nominal efficiency generally had higher effective filtration efficiency in the same home. In terms of performance change, there is no significant difference in efficiency between initial and 3-month non-electret filters, but the efficiency of electret filters generally decreased over time. However, both nominal efficiency and performance change were vastly overshadowed by the wide variety in loading and system conditions across homes, making it hard to predict filter efficiency in a given home without in-situ measurements.

Main findings

1. In-situ filtration efficiency measurements in 21 homes suggest shortcomings of laboratory filtration tests.
2. There was a wide range of in-situ efficiency for a given filter at different homes.
3. Efficiency differences arise from differences in face velocity, bypass, and dust loading amount and composition.
4. Used electret filters have diminished efficiency when compared to new filters, but non-electret filters have similar performance over their lifetimes.

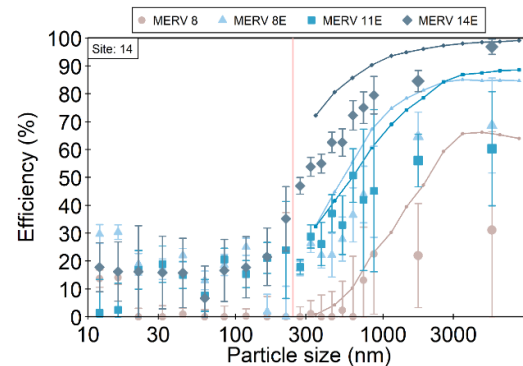


Figure 1 Size-resolved initial effective filtration efficiency with uncertainties plotted versus the geometric mean diameter for each particle size bin (18 individual bins and 2 grouped bins) for the four types of filter (MERV 8, MERV 8E, MERV 11E, and MERV 14E) at (a) Site 14. The solid lines represent the lab-tested initial efficiency from ANSI/ASHRAE Standard 52.2 testing. The red line in the background of the figures defines the particle size ranges measured by the electrical sensor (left) and optical spectrometer (right). MERV = minimum efficiency reporting value.

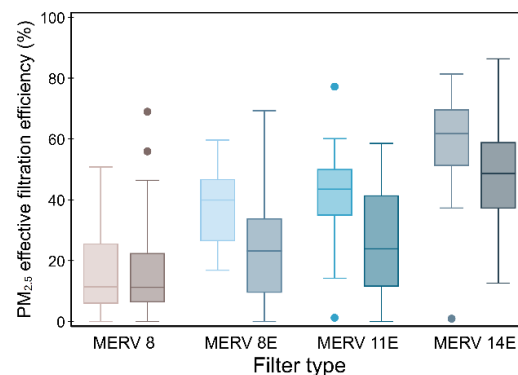


Figure 5 The range of effective filtration efficiencies for PM_{2.5} for each type of filter at the beginning (lighter color) and the end of its service life (darker color) at all sites.

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