



Mahdavi A, Siegel JA. 2020. Extraction of Dust Collected in HVAC Filters for Quantitative Filter Forensics. *Aerosol Science and Technology*, **54**(11): 1282-1292.

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Abstract

The analysis of dust collected on the heating, ventilation, and air-conditioning (HVAC) filters, filter forensics, is a useful approach to explore concentration, size distribution, and composition of indoor particles. The extraction of dust from filters represents one of the biggest challenges for obtaining accurate filter forensics results. Although vacuuming is one of the most common dust extraction techniques, it is unclear how efficient it is and whether it provides a representative sample in terms of particle size. We used a high-capacity vacuum sampler to extract dust from 20 filters artificially loaded with well-characterized test dust as well as from 41 filters naturally loaded in residential HVAC systems. After all extractions, we recovered 0.1–5.5 g and 0.02–11.4 g of dust from the artificially and naturally loaded filters, respectively corresponding to 11.3–52.2% and 1.8–72.9% recovery efficiencies, the ratio of dust recovered to the dust loaded in the filters. Multiple extractions were effective to add to the recovery to enable filter forensics for the detection of multiple analytes. The recovered dust was slightly over-representative of particles > 10 µm. Therefore, caution should be taken when applying filter forensics for studying contaminants associated with smaller particles.

- 4. Vacuuming is promising to provide a representative recovery in terms of particle size for large particles. So, it is an asset if the contaminants of study are more prevalent on larger particles (e.g., > 10 µm).
- 5. Vacuuming provides less representative recovery for smaller size particles (e.g., < 10 µm). Future efforts on the separation of these particles will extend vacuum capacity for obtaining more accurate results for contaminants more concentrated on these particles.

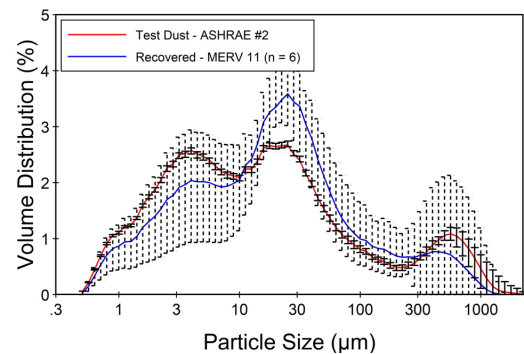


Figure 2b Size distribution of the ASHRAE test dust (loaded on the filter) (red) and the recovered dust (blue) (n represents the number of filters).

Main findings

1. Vacuuming often provides sufficient dust recovery for filter forensics for a wide range of contaminants such as trace metals, semi-volatile organic compounds (SVOCs), and biological contaminants if HVAC filter dust load is sufficient.
2. Multiple vacuum extractions help the recovery sufficiency if the HVAC filter dust load is low, or the filter forensics method detection limit (MDL) is high requiring more dust mass spike.
3. The HVAC filter type selection can help increase the vacuumed dust recovery. Tightly pleated filters with protective metallic or paper screens (e.g., MERV 14) often experience lower dust recovery unless the

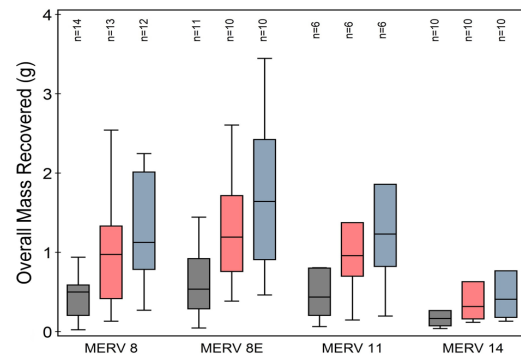


Figure 3a Cumulative mass recovery from the naturally loaded filters. Colors denote cycle number (black: cycle 1, red: cycle 2, and blue: cycle 3). n represents the number of filters that are included in each box.

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