THE EFFECTS OF IMPROVED RESIDENTIAL FILTRATION ON PARTICLE EXPOSURE

Introduction

Over 60 per cent of Canadian houses are heated with forced air. Traditionally, filters are placed in the circulating air ductwork to protect the furnace and fans. With the increase awareness of indoor air quality, some filters are now being installed to reduce occupant exposure to respirable particles. There is a broad range of furnace filters to choose from, but no common rating system to help with selection. Thus, it has become difficult for the homeowner to select a suitable filter and to know what effects can be expected. The objective of this research project was to create a consumer document to assist in filter selection.

Research Project

CMHC commissioned a project to investigate furnace filter efficiency so that it could better advise the public on filter selection. To formulate this advice, five different types of filters were tested in six occupied houses with a variety of occupancies, locations and dust sources. The testing took place during the winter and early spring to minimize atmospheric dust entry that occurs with open windows. For each filter, testing was conducted to determine its efficiency, clean air delivery rate (CADR), cumulative indoor particle concentrations and personal particle exposure. Unfortunately, the filters were installed in each house for a matter of days only. Therefore, questions about the effects of filter loading or long-term house particle trends cannot be answered by the data generated by this study.

The five filters, installed sequentially in each house, were:

- a medium-cost, 25-mm pleated filter with factory-applied passive electrostatic charge;
- a DC-current, charged-media type;
- a 100-mm pleated media filter;
- an electrostatic precipitator or “electronic” (plate and wire type) filter (ESP); and
- a by-pass filter, either with a HEPA filter or with an internal filter bank.

For each testing, these filters were compared to results obtained without a filter.

The ESP produces ozone during operation. As these units were presumed to be effective, separate ozone testing was required prior to recommending them to consumers. During this exercise, 15 houses with existing ESPs were tested to determine the ozone generation rates of the units, as found and after cleaning.

Results

Study results showed that the electrostatic precipitator (ESP) was the most efficient of the filters tested. The other filters tested can be classified as having intermediate efficiency, falling between the no-filter/standard filter baseline and the high efficiency of the ESP. However, because their relative efficiencies varied from house to house, it would take a far bigger sample, with longer sampling periods, to differentiate clearly between these “medium-efficiency” filters.

The clean air delivery rate (CADR) is the volume of completely clean air that is required to produce the same particle removal effect as the filter being tested. It was obtained by multiplying the system airflow in L/s by the measured filter efficiency. Again, there was a distinct pattern of near zero for the “no filter,” 200 to 300 L/s for the ESP and a mid-range of CADR flow for the four other filters.

The particle concentrations peaked during activity periods, no matter what filter type was in use and whether determined at the fixed stations or by personal monitoring apparatus. The cumulative results show that the ESP is the best device for reducing indoor particle and the no-filter control was the least successful. Two factors affected the results:

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- testing was conducted over a short period of time, thus limiting the observation of long-term effects of the filters; and
- the dust production or source effects overwhelmed the dust reduction potential of filters.

The ozone levels determined in the separate testing showed that in 14 of the 15 houses, the ESP units produce measurable amounts of additional ozone. The levels were always lower in the house than in the outdoor air. However, measured inside levels of ozone never exceeded 20 ppb, which is less than the Canadian one-hour residential guideline of 120 ppb (Health Canada, 1989).

Conclusion

This research showed that the amount of particle in the duct system can be reduced when an upgraded filter is installed in a forced-air furnace circulation system. The results also showed that, because the particle source tend to overwhelm removal by air filters, this reduction will not necessarily result in a significantly reduced indoor particle exposure.

Household particle can be reduced through standard approaches such as:
- removing footwear upon entry;
- keeping major dust generators (i.e., smoking and pets) out of the house;
- reducing dust collecting surfaces (open shelves, carpets, upholstered furniture, etc.);
- diligent and frequent vacuuming with an efficient vacuum cleaner; and
- reducing the entry of particle-laden outdoor air by closing windows, improving airtightness and installing an intake filter on the air supply.

If these improvements are made, then the installation of an efficient furnace filter, with the furnace fan operating continuously, would probably make a significant reduction on the remaining, minimal particle exposure.

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Research Report: Evaluation of Residential Furnace Filters, 1999

Research Consultant: Bowser Technical Inc.

A full report on this research project is available from the Canadian Housing Information Centre at the address below.

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