Dust & Furnace Filters

Thanks to David Hill, HVCI was very pleased to have Don Fugler from the Research Division of CMHC address the members at our November dinner meeting. You may be surprised by the results of this research and the conclusions to be drawn. Thanks to CMHC for Tables 2 & 3 in this article.

The problem . . .

The sun shines brightly through a window in your customer's home and lights up thousands of swirling motes of "dust". Many folks want to get rid of this dust. They may have health concerns, especially with the spiralling incidence of allergic reactions in the general population, or they may want a cleaner home with less housework. Often they turn to their heating contractor for a solution. So what do you tell them? Get a better filter? Let's look at the research.

Furnace filters were originally designed to protect the furnace and its blower. They were relatively porous—designed to catch the big stuff but not stress the blower motor or significantly effect the system static pressure.

Now, with the increased awareness of indoor air quality there are a wide variety of filters available for filtering indoor air. Unfortunately there is no common rating system on these filters, so the homeowner and contractor alike may find it difficult to compare products and to know what to expect. Tables 1A & 1B describe and compare the various filter rating systems.

Table 1A

Filter Rating	What it measures	Health considerations
Arrestance ASHRAE 52.1	**weight** of particles only particles >10 microns in size weigh enough to be measured	protects furnace fan does not measure respirable particles
Dust Spot ASHRAE 52.1	**size** of particles 2 to 10 microns	filtering of only the largest of respirable particles measured
DOP Rating (HEPA filters)	**size** of particles > 0.3 microns	filtering of 99% of paticles larger than 0.3 microns measured
New ASHRAE 52.2	**size** of particles 1 to 16 microns	filtering of only larger respirable particles measured

Particles in the air . .

Some dust comes into our homes with infiltrating air. However, much of the dust in our homes comes from ourselves and our lifestyles. Consider the following most common sources of "dust"—or particles in the air— in our homes:

- Tracked in dust
- Dust on floors and other surfaces disturbed by activity.
- Smoke from tobacco, candles and cooking
- Human and pet shedding —skin flakes (dander) and hair/fur
- Material bits—carpets, clothes, linen, drapes
- Biological sources—moulds & bacteria

Size Matters

Most of the particles we see swirling in the sunlight are too large to inhale. Some of them—the 10 to 15 micron sized particles—are inhaled but filtered in the upper respiratory tract. They never reach our lungs. The smallest particles in the air we breath—those under .01 micron in size—are inhaled, but then exhaled. Particles that are less than 2.5 microns but larger than .01 micron are the ones that stay in our lungs and affect our health. These ***respirable particles*** are the dangerous ones. They include smoke, mould and mite spores, bacteria and viruses.

Of particular importance in this connection are damp areas of the home since both moulds and mites require moisture to survive. Don

Table 1B

Comparing Filter Rating Efficiencies
75% Arrestance = 10% Dust Spot
90% Arrestance = 20% Dust Spot
98% Arrestance = 50% Dust Spot
50% Dust Spot = 15% DOP

pointed out that a damp basement is as damaging to health as having a smoker in the home!

Size also relates to air particles in another way. This is the length of time particles are suspended in the air. The smaller and generally more dangerous the particle, the longer it remains suspended in the air. Viruses can remain suspended for up to 10 days. Cat dander and tobacco smoke (major human allergens) can remain suspended in the air for up to 10 hours. Mites and bacteria remain suspended for up to 5 minutes.

Larger particles like human hair, skin flakes and observable dust fall to the floor in 5 seconds. This why we will always have "dust balls" regardless of filtering. This material falls out of the airstream too quickly to be filtered. Though it may collect in ducts by falling through return air grills.

Activity stirs up dust

Our activities also effect the air quality in our homes. In the middle of the night or when no one is in the home—that is, when activity is minimal—indoor air has its lowest particle concentrations. Conversely, vacuuming and walking across floors, especially carpeted floors, stirs up particles. The research included extensive vacuuming and activity tests. When dust was dumped on a carpet and vacuumed, only 60% of the dust was removed with the first vacuuming. Only 90% was removed by vacuuming 19 times! Whereas, 95% of dust dumped on hard flooring was recovered with one quick vacuuming.

You'll see how all these facts come into play in the filter evaluations discussed below.

Research

The first portion of the study involved testing 10 different filters in one home. Then the following 5 types of higher efficient filters were each tested in five additional homes:

1) 1" premium media filter
2) Charged media type electronic
3) 4" pleated media filter
4) HEPA* bypass filter
5) ESP — Electronic plate and wire

Table 2

Filter	% improvement during periods of occupant activity	% improvement during periods of occupant inactivity
1" premium	21	57
Charged media	9	29
4" pleated	9	13
HEPA bypass	23	38
ESP	31	71

House air was tested with these filters in use and particle count compared to unfiltered house air. Each filter was used only one or two days; so dust accumulation on filters could not be evaluated.

ESP filters, the most effective in the testing above, produce some ozone during use. However measured ozone levels in outside air were always greater than in house air. Also, though ozone levels were measurable in ducts when the ESP filter was in use, these levels never exceeded health guidelines.

As for HEPA filters which test at 99% efficient, since they are installed as bypass filters only a portion of the air in the house will be drawn through them. They are the most efficient filter, but only 25–50% of total HVAC cfm is being filtered in a bypass installation. This why they rated lower than expected—only about 50% efficient—in actual testing.

The "Pig Pen" Picture . . .

Picture occupants moving around their homes stirring up dust particles into the air around themselves, like "Pig Pen" in a *Peanuts* comic strip. Dust in this cloud is relatively unaffected by the efficiency of the furnace filter since the filter is far away—down a duct somewhere.

So exposure to airborne dust is directly linked to occupant activity. Filters have only a moderate effect. During periods of inactivity, filters were more effective. Remember however, particle counts were also much lower during these periods.

*HEPA—high efficiency particle arrestor

Cost of Clean Air . . .

A comparison of cost was also contained in the study. For a furnace fan filter to be effective, a furnace must run continuously. Normal furnace run time during winter is only 10–20% of the time. Don suggested the very first question you ask your customer was whether they were willing to run the furnace fan continuously at a cost of up to $200 per year for electricity. If not, then adding a more efficient filter will have little or no effect on the quality of air in their home.

2) Reduce dust collecting surfaces—carpets, open shelves, upholstered furniture. Use area rugs and wash them or beat them regularly.
3) Vacuum diligently and frequently with an efficient vacuum cleaner.
4) Keep major dust generators outside—smoking and pets especially.
5) Use an efficient furnace filter. This will cause lower particulate levels than if no air handling system is used.

Table 3

Filter	Cost per year maintenance & capital cost over 15 years	Amount of Clean Air produced (litres/sec)	Cost of Clean Air per year($/litres/sec)
1" pleated	$48	17	$3.36
1" premium	$100	97	$1.13
charged media	$43	44	$1.25
4" pleated	$93	60	$1.71
HEPA bypass	$240	175	$2.03
ESP	$67	298	**$0.26**

Table 3 shows the cost for each type of filter compared to cost per unit of clean air provided to the home. Note that the cost of the filter was in no way related to the cost of clean air. The ESP filter was by far the most cost effective filter—greatest amount of clean air at the least cost. Whereas the cheapest filter (1" pleated) was the most expensive in terms of clean air provided.

Conclusions

Yes, an upgraded filter will reduce the particles in the duct air. However, this reduction is only moderate. The following list provides the "best current guess" of how to remove respirable particles in indoor air. Or as Don said, "Do what your mother told you!"

1) Remove footwear on entry. The research found an 80% reduction in leaded dust when footwear was removed. Furthermore, only 40% of leaded dust was removed from carpet by vacuuming. 100% was removed vacuuming hard surface floors.

Duct Cleaning

Customers often ask about duct cleaning, especially in relation to dust in their homes. The CMHC research done on this topic led to the following conclusions:

1) Duct cleaning will not usually change the quality of air you breathe, nor significantly affect airflow or heating costs.
2) Duct cleaning may be beneficial in the following circumstances:
   - construction debris is left in ducts
   - duct system is damp (mould growth)
   - there is actual blockage to furnace air flow.

Pet hair and debris in a return air system can usually be cleaned with a household vacuum. Use of biocides in ducts is not recomended.

This article was written from a synopsis of CMHC About Your House *fact sheets and from David Hill's & Nelle Maxey's notes on Don Fugler's presentation.*

Copies of the original CMHC study, Evaluation of Residential Furnace Filters (1999), *may be obtained at no charge by calling 1 800 668-2642.*