Mark LaLiberte

President of LaLiberteOnline Inc. and a principal of Building Knowledge Inc., Mark LaLiberte is a highly regarded green building consultant who helps builders nationwide understand and apply proper building science construction principles to improve their homes. www.buildingknowledge.com; www.laliberteonline.com.

Clearing the Air

The type of air filters you provide in your homes can have a lasting effect on indoor air quality for your customers.

If I asked you to rate the quality of the air in the homes you build, how would it score? Would that rating be based on anything more than a guess?

Very few of us know if our homes are filled with harmful gases or lung-damaging particulates. There are two primary sources of this invisible pollution soup. The first is comprised of gaseous pollutants from complex chemicals that originate in all the stuff we use. Some of these gases are toxic to start with, but most are relatively harmless in small amounts until they mix with each other. Because there is little data on the effects of these chemicals on health, we must assume these compounds should be diluted and ventilated or preferably eliminated before we start. The other key ingredient is particulate matter from plants, animals, shoes, carpet, cooking, and other sources. Many are unaware of these hazards until they cause us to sneeze or there's a detectable odor.

As discussed in previous issues, it is imperative that homes have both controlled and distributed ventilation as well as good filtration. We are covering the particulate side of this equation here.

So, how do we manage the invisible? One tool, in combination with good ventilation, is an active air filtration system, measured by filter performance. Here are five criteria for evaluating and comparing active filtration systems.

PARTICLE REMOVAL

Before considering the merits of different types of filters, it's important to understand the problem: Just how big and how numerous are the particles floating in the air inside most homes?

Dust particle size is typically measured in microns or micrometers, which are 0.0001 of a centimeter. In bright light, a 10-micron particle is just visible to the naked eye. The dust particles dancing in a sunbeam are probably larger than 10 microns in diameter, as are pollen, mold spores, and dust mites. Visible particles account for less than 2% of the particles floating around a typical house; the other 500,000 to 1 million particles per cubic foot are much smaller—usually in the 0.3- to 1-micron size range. These may stay suspended in the air for hours, days, or weeks at a time.

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) has had filtration system standards and testing protocols in place for many years. Unfortunately, reporting values have always been poorly understood and the old standards have become outdated. ASHRAE's primary focus was on protecting HVAC equipment and coils, and for this reason the standards were biased toward large-particle filtration efficiencies.

When the goal is to capture large particles, even standard glass-fiber filters (or as we know them, "see-through furnace filters") have capture values of 75% or better. Filter test reports under the revised ASRHAE 52.2-1999 now show the particle removal efficiency of filters across a range of dust particle sizes. Contractors can use these new reports to help clients compare the difference between furnace filters, which are very efficient at removing relatively large particles, and people filters, which are designed to capture much smaller particle sizes. These revised ASHRAE standards spawned a new term: MERV (Minimum Efficiency Reporting Value). The MERV rating for a filter is based on composite average particle removal efficiencies through a range of particle sizes from 0.3 to 10 microns. The higher the MERV rating, the better the filter is at removing small particles.

It is important to note a comment attached to ASHRAE's 52.2 test standard, which points out that the test protocol it employed may not be appropriate for "electronic air cleaners" and "electrostatic filters." The highly conductive carbon dust used to establish the test standards may interfere with the effectiveness of electrically charged air filters and compromise the accuracy of the MERV ratings. For this reason, some manufacturers of electronic or electrostatic filters choose not to have their products tested.

If your goal is to provide improved air quality, you need to install something more than a standard furnace filter. Selecting a high-efficiency filtration system that will effectively remove most of the "respirable" particles is a good choice. Some systems on the market require their own fan to overcome the inherent resistance of these high-efficiency filter media.

We often see the designation HEPA (High Efficiency Particulate Arresting) on stand-alone units

PHOTO: RAY NG

MERV Ratings & Filter Applications

Std. 52.2 Min. Efficiency Reporting Value (MERV)	ASHRAE Arrestance Std 52.1	Typical Controlled Contaminant	Typical Applications and Limitations
17–20	N/A	• **≤ 0.30 µm Particle Size** Virus (unattached); carbon dust; sea salt; all combustion smoke; radon progeny	• Clean rooms • Radioactive materials • Pharmaceutical manufacturing • Carcinogenic materials • Orthopedic surgery
13–16	> 98–99%	• **0.30–1.0 µm Particle Size** All bacteria; most tobacco smoke; droplet nuclei (sneeze); cooking oil; most smoke; insecticide dust; copier toner; most face powder; most paint pigments	• Hospital inpatient care • General surgery • Smoking lounges • Superior commercial buildings
9–12	> 95–98%	• **1.0–3.0 µm Particle Size** Legionella; humidifier dust; lead dust; milled flour; coal dust; auto emissions; nebulizer drops; welding fumes	• Superior residential • Better commercial buildings • Hospital laboratories
5–8	80–95%	• **3.0–10.0 µm Particle Size** Mold; spores; hair spray; fabric protector; dusting aids; cement dust; pudding mix; snuff; powdered milk	• Commercial buildings • Better residential • Industrial workplaces • Paint booth inlet air
1–4	60–80%	• **> 10.0 µm Particle Size** Pollen; Spanish moss; dust mites; sanding dust; spray-paint dust; textile fibers; carpet fibers	• Minimum filtration • Residential • Window air conditioners

SOURCE: ASHRAE AND NAFA

designed for bedrooms and other living spaces. These portable HEPA filters may be effective in removing some amount of respirable particles, but they will not deliver the benefits of a whole-house filtration system.

Adding a HEPA filter to the furnace return air system, using a bypass configuration, can be an effective way of removing respirable particulates from the air inside the entire house. In this case, the goal is to clean the air in the house over time by sampling a percentage of furnace return air through the high-efficiency filtration system. This may be an effective strategy if efforts have already been taken to reduce dust sources.

AIRFLOW RESISTANCE

It is almost always true that the more effective a filter is at removing smaller particles, the more it restricts airflow. This is one reason why electronic air cleaners are so popular. They create little resistance to airflow, yet also have a relatively high particle removal efficiency.

When installing a filter in furnace ductwork, there are some practical limits as to how much restriction is reasonable. For example, most manufacturers rate the airflow capabilities of their furnaces at 0.5 inch to 0.7 inch external static pressure (ESP)—this typically would include the resistance of the standard filter shipped with the unit.

Considering, however, that reasonable duct design would result in a 0.3-inch pressure drop and the resistance of an air conditioning coil would add another 0.15 inch to 0.25 inch, selection of high-MERV filters will have an immediate impact on airflow performance of the heating and cooling system.

Contractors must become familiar with the resistance values for the various filter types. When this issue is included in the design of the air-handling system, the right size blower can be chosen or, preferably, a furnace with a variable speed. This type of furnace can allow the speed of the blower to be adjusted after the system's airflow is calculated and set.

NOISE, MAINTENANCE, AND COST

Noise is an important consideration when selecting a filtration system, because stand-alone types require a fan and the furnace may require increased flow. High-efficiency systems also must overcome the high static resistance of additional filters. Many of the portable filtration systems are so noisy that occupants will not turn them on. The responsible HVAC contractor should advocate for a separately ducted filtration system and quieter furnace technology, such as two-speed or variable-speed furnace and air conditioning systems when very high efficiency filtration is desired.

Intuitively, the more efficient the filter, the more dust it will capture and the more often it will need to be replaced or cleaned. Filter life may be extended by adding more surface area, such as with a deep pleated filter. Some filtration media also have higher dust-loading characteristics. Simple filters trap particles on the surface of the media (referred to as face loading). Better media designs encourage loading throughout the depth of the media.

Ironically, most media filters get more effective over time, as they begin to plug up with particulates. Others, such as electronic air cleaners, get less efficient as they load up. Contractors need to help their customers understand that a very efficient, high-MERV, 1-inch-thick filter is going to have a very short service life, and will require more frequent replacement based on lifestyle, home location, and flooring type.

It's actually quite easy to enjoy a high level of indoor air quality. Install hard-surface flooring systems; select HVAC equipment that is efficient, sealed, and capable of moving air across a higher quality filter; and help homeowners understand that most particulate matter is a by-product of lifestyle. Houses are more than the sum of their parts; by putting this knowledge to work, we can build the best homes ever constructed.

Gord Cooke, Building Knowledge Inc., contributed to this article.