BY JIM ROSENTHAL, CAFS

Images courtesy of Tex-Air Filters.

The greater media surface area of thicker pleated filters provides lower resistance, better efficiency and longer life. This filter design enables the user to install a 4-in. filter in a conventional drop-down filter grille.

Many HVAC technicians falsely believe that the only type of filter to use in a system is a fiberglass one-month “throwaway.” They are convinced that the only purpose of a filter is to protect the equipment from dust and debris and that the need for the better air flow provided by the fiberglass filter overrides any benefit to indoor air quality from a higher-efficiency filter. The purpose of this article is to dispel this myth and to provide information that will help in making filter recommendations that ensure the smooth operation of HVAC systems and better indoor air quality. The result should be more satisfied customers.

Here is a common scenario. A well-meaning homeowner decides that the allergy sufferers in his or her home need better indoor air quality. So they buy an “allergy” filter from their local home-improvement store. In many cases, this filter is too restrictive for their system. After they blow out their compressor or determine that their air-conditioner or heater is not cooling or heating enough, they call their HVAC company for a service call. The technician removes the allergy filter and magically there is enough air flow for the system to run properly. The inevitable conclusion from this type of experience is that all allergy filters are bad and should not be used. The real conclusion should be that the filter chosen was not correct for that system and other options should have been considered.

As a general rule, a properly designed HVAC system should be able to run an allergy filter without a problem. Unfortunately, many systems have been installed and are being installed that have inadequate return air. In a recent study of residential and small-commercial HVAC systems in Austin, TX (conducted by researchers from the University of Texas) it was found that more than two-thirds of the systems did not have sufficient return air. Central Texas is probably not the exception, but is pretty typical of the country as a whole. Consequently, these units are not able to overcome the increased resistance of the more efficient filters. The first step to increased efficiency filtration is to make sure that HVAC systems are properly designed and installed.

But what about all of the systems out there that are not able to handle the increased resistance of a more efficient filter? What can be done with these? The answer is simple: recommend filters that are more efficient but still have low resistance and provide good air flow. In order to understand how to do this, some basic physics should be reviewed.

Basic physics and air flow

The air flow in an HVAC system creates what is known as velocity pressure. The higher the velocity pressure on a surface, the higher the resistance or pressure drop. If the surface area is increased, the velocity pressure is distributed over a wider area, decreasing the resistance. This is why filters are pleated, to give them more surface area.

For example, a typical 20 x 20-in. pleated filter will have the following surface areas of media:

- 1-in. depth = 4.7 sq ft;
- 2-in. depth = 8.1 sq ft; and
- 4-in. depth = 15.4 sq ft.
The same 20 x 20-in. filter in a fiberglass or polyester throwaway would have 2.78 sq ft of media. Using the information in Figure 1, look at what more media surface area does to the resistance of a filter. This table gives the resistance of various types and depths of filters at different air velocities.

### Interpreting the physics

The most interesting numbers in Figure 1 are for the fiberglass filter and the MERV 7 4-in. filter. Although the MERV 7 filter is many times more efficient on all particle sizes than the fiberglass filter, the resistance is essentially the same. This shows that indoor air quality can be improved without an impact on the air flow of an HVAC system. Another interesting thing to note is that the resistance on a 1-in. MERV 7 filter and a 4-in. MERV 11 filter is approximately the same. A MERV 11 filter would be considered an allergy filter that does a good job of removing particles in all size ranges.

The data in Figure 1 also shows that as the efficiency of the media increases, the resistance also increases. Given the restricted air flow of some installed systems, even a 4-in. or 5-in. deep, high-efficiency filter cannot be used. This might explain why some technicians have seen airflow problems with HVAC systems using thicker filters. But it is not the filter that is the problem, it is the system design. The answer is not to go back to a fiberglass filter but rather to decrease the efficiency of the thicker filter. Most of the thicker filters are sold as a MERV 11 or higher but they are also available in a MERV 7 or MERV 8.

In recent years, a number of manufacturers have incorporated this extended media surface concept in their filter-box offerings. Many contractors are installing these deeper filter boxes on both retrofit and new applications. Not only does this give the homeowner the ability to increase filtration efficiency without hampering air flow, since there is much more media surface area, it also means that the filter will last longer. In many cases, a 4-in.-deep or deeper filter

<table>
<thead>
<tr>
<th>Media Type</th>
<th>Air Velocities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>300 fpm</td>
</tr>
<tr>
<td>Fiberglass Filter</td>
<td>0.10 in. wg</td>
</tr>
<tr>
<td>MERV 7 Filter – 1 in.</td>
<td>0.17 in. wg</td>
</tr>
<tr>
<td>MERV 7 Filter – 2 in.</td>
<td>0.14 in. wg</td>
</tr>
<tr>
<td>MERV 7 Filter – 4 in.</td>
<td>0.10 in. wg</td>
</tr>
<tr>
<td>MERV 11 Filter – 1 in.</td>
<td>0.26 in. wg</td>
</tr>
<tr>
<td>MERV 11 Filter – 2 in.</td>
<td>0.20 in. wg</td>
</tr>
<tr>
<td>MERV 11 Filter – 4 in.</td>
<td>0.16 in. wg</td>
</tr>
</tbody>
</table>
By installing a filter box that accommodates a filter of this depth, one is able to take advantage of the deeper pleated filter’s low pressure drop, high efficiency and longer life at a much lower cost per filter.

can last six months without needing to be changed. This fits in nicely with a twice-a-year preventive-maintenance program.

Another option is to install a 4-in. filter box that will fit a standard 4-in. commercial filter. Standard filter sizes are nominal and are made “undersized.” In other words, a 20 x 20 x 1-in. filter is actually 19 1/2 x 19 1/2 x 3/4 in. A 4-in. commercial filter is actually 3 5/8 in. deep. By installing a filter box that accommodates a filter of this depth, one is able to take advantage of the deeper pleated filter’s low pressure drop, high efficiency and longer life at a much lower cost per filter. Commercial 4-in. filters are often one-half the price of one of the proprietary-size filters.

There are also deeper filters designed to be installed in a drop-down return-air grille. These 4- or 5-in.-deep filters have a “header” that fits the size of the filter opening. The deeper part of the filter fits into the recessed part of the filter grille. This design enables the user to have better air flow and a higher-efficiency air filter without retrofitting their filter grille.

Many HVAC units have also been installed using a “filter base.” These filter bases are designed to fit either a 1-in.-thick or a 2-in.-thick filter. Some of the newer bases accommodate a 4-in. filter. It is always a good idea to recommend using the thickest pleated filter option available.

Efficiency and beyond

Filter efficiencies are determined by a test method called ANSI/ASHRAE Standard 52.2-2012. This test method uses the fractional particle size efficiencies of a filter to derive a Minimum Efficiency Reporting Value (MERV). The MERV system is a useful tool in selecting filters to improve indoor air quality. Keep in mind, it is not a rating system and it is not precise.

It is better to look at MERV comparisons between filters as the MERV number plus or minus one. The prime example is a comparison between a MERV 7 and a MERV 8 pleated filter. The difference between these two filters is often less than 5% on particles 3–10 microns in size. The net result is that it would be very difficult, if not impossible, to determine the difference in indoor particle counts when using one filter or the other. However, there is a substantial difference between a MERV 4 polyester filter and a MERV 7 pleated filter.
Improving indoor air quality through filtration is not as simple as a purchase of a high-efficiency allergen filter at the home-improvement store.

Likewise, there is a big difference between a MERV 8 filter and a MERV 11 filter. Going from a MERV 4 polyester filter to a MERV 7 pleated filter or from a MERV 8 pleated filter to MERV 11 pleated filter can have a positive effect on indoor air quality.

Improving indoor air quality through filtration is not as simple as a purchase of a high-efficiency allergen filter at the home-improvement store. It takes some analysis to select the right filter for each application. Hopefully, this article provides some of the tools needed to make that analysis and provide an added service for your customers.

Jim Rosenthal is the Chief Executive Officer of Tex-Air Filters in Fort Worth, Texas. He is a past president of the National Air Filtration Association and a frequent contributor of articles on air filtration and indoor air quality to trade journals and publications. In addition, he has presented training sessions for RSES local, regional and national meetings.

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