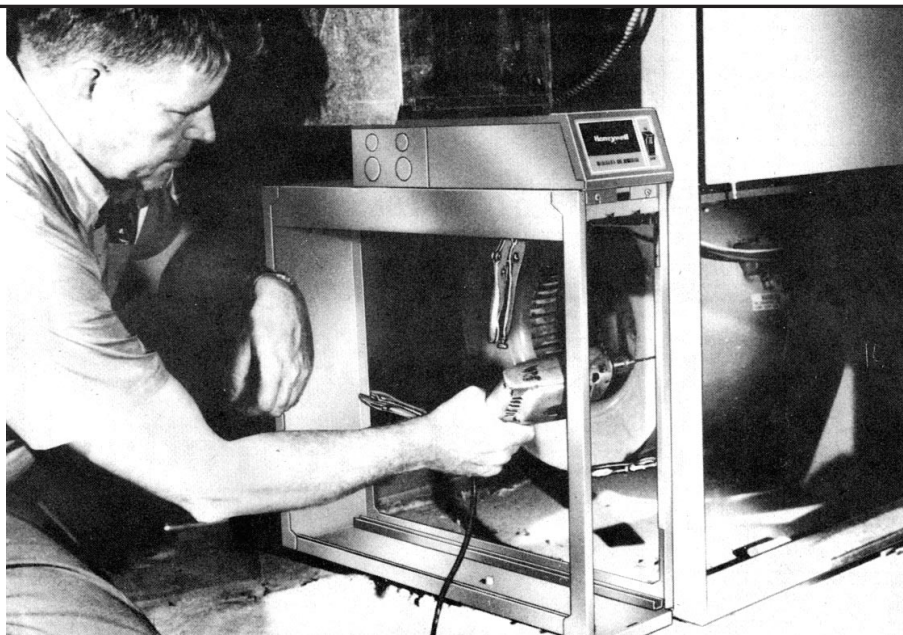


by Gary Mayk

Furnace Add-Ons That Clean the Air

Electrostatic, electronic, and other improved air cleaners boost performance, but add cost and owner maintenance



A technician mounts an electronic air cleaner to the return-air plenum of a typical highboy furnace. The filter should be readily accessible for regular inspection and cleaning.

Although most consumers would rather spend their last housing dollars on a Jacuzzi than on an air cleaner, the benefits of clean indoor air are fast becoming a sales plus. Indoor air quality has become a frequent topic on the evening news and in glossy home magazines. It's a safe assumption that air-cleaning systems will take a bigger percent of the hvac market as manufacturers increasingly promote them, particularly in move-up and luxury homes.

Anne Drake, a spokeswoman for Honeywell, which manufactures a variety of air-cleaning and climate systems, says the company's goal is to have "total climate control" systems, including air cleaners, in 25% of all new construction in the next decade. Right now, only about 5% of new construction has air-cleaning systems, she says.

Just what are we talking about when we discuss "air cleaning systems"? Don't all forced-air hvac systems have air filters? Yes, to varying degrees. But standard furnace filters, usually made of fiberglass, trap only the biggest particles, like the dust and dirt that accumulate behind refrigerators in a home, for instance. Such filters "are designed to protect the equipment, not people," says Jim Wohlford, a Honeywell engineer. In fact, if allowed to accumulate on air conditioner or heat-pump coils, or on blower fan blades, dust reduces the efficiency of the unit and forces the fan to work harder. That can lead to shorter equipment life, even burnouts. To protect people from air pollutants,

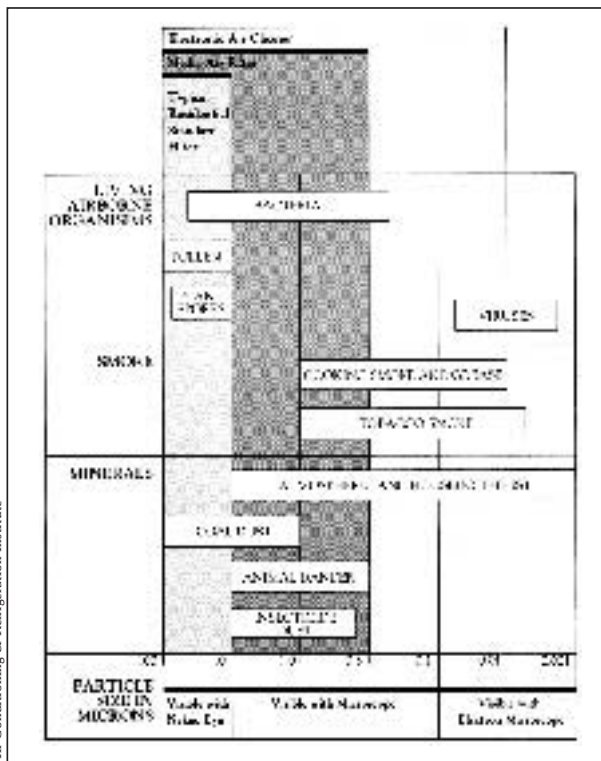


Figure 1. Different filters are capable of trapping different-sized particles.

more efficient filters are needed. The efficiency of these devices varies widely, and as their efficiency rises, so do their prices. None removes 100% of all irritants and pollutants, and none of the practical alternatives removes chemical compounds. But there are practical ways to dramatically cut the level of airborne particles or "particulates."

Types of Air Cleaners

Air cleaners come in three basic types for home use: the standard filter, the media filter, and the electrostatic precipitator, commonly called the "electronic air cleaner." A fourth variation is a self-charging, or electrostatic, filter, which is an upgraded version of the standard type but should not be confused with the more efficient electronic air cleaner.

The denser the filter, the smaller are the particles it can remove. Particles are measured in microns (human hair is about 70 microcons in diameter). Their removal is measured under the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) Standard 52-76. Standard filters commonly remove particles above 10 microns in size, which include some disease-causing bacteria. Anything smaller than that requires an upgraded filter or system (see Figure 1). Among the more difficult particles to remove are animal dander (does your customer have pets?), insecticide dust (are you surrounded by working farms?), atmospheric and household

dust (see it on the furniture?), cooking smoke and grease, tobacco smoke, and viruses.

Here's a rundown of the types of air cleaners available for home applications:

Standard filters. Most home builders, and consequently, most home buyers, rely on these very basic filters in hvac systems. Usually made of woven fiberglass, with vinyl or cardboard frames, or of steel mesh, the filters slide into the standard filter openings in ductwork or furnace return plenums. These low-cost, throwaway filters register a mere 3 to 5% efficiency under ASHRAE Standard 52-76.

Homeowners should check the filters every 30 to 60 days, depending on conditions where they live. Rural areas with high pollen counts may require more frequent cleanings (vacuuming or washing) or replacement. Homeowners also should understand that the higher the level of indoor activity—in a house with children and pets, for instance—the more dust there is in the air, and the greater the need for frequent checks.

Common atmospheric and household dust is too small for these filters to trap. Use of standard filters is likely, over time, to lead to a buildup of dust in ductwork, particularly if the filters are left in place long after replacement intervals. Such buildups can be inches thick and contain irritants, allergens, and organisms (see "Cleaning Ducts the Safe Way").

Self-charging "electrostatic" filters. These are filters that use static electricity to enhance their air-cleaning abilities. The filters do not draw current. Instead, they self-charge, relying on static charges built up by the filter media: vinyl, polyester, or, increasingly, polystyrene plastic. Ever notice how the plastic wrapper sticks to a stack of polystyrene foam drinking cups? That's a result of static electricity. Now, you may understand the workings of the self-charging electrostatic filter. The static charge is intended to trap particles smaller than a standard filter could.

Something so simple can work well, within limits. Efficiencies for self-charging filters using the ASHRAE Dust Spot Method are 15 to 20%. That's considerably better than standard filters, but it falls far short of more sophisticated filters.

Electrostatic filters are simple to install because they replace standard filters and require no additional ductwork. They typically cost less than \$300, and, with some models, less than \$80. Since they are not throwaways, the cost is one-time-only.

The biggest disadvantage is consumer inconvenience. Because the filters are renewable, they must be hosed off or cleaned in a tub. Once they are clean, they will quickly renew their charge.

Extended media filters. Few homes come equipped with extended media filters. Every air filter on a car or truck engine is an extended media filter, i.e., a filter made of material so dense that it blocks not only the flow of small particles in the air, but also much of the air itself. That's why media filters are "extended" or folded in an accordion shape just as car filters are. The pleating exposes a much greater surface area of the filter, allowing more air to pass through. Wohlford of Honeywell says a media filter may have 65 to 70 feet of media in a 4-inch-thick area measuring 20x25 inches.

Media filters, according to the Air

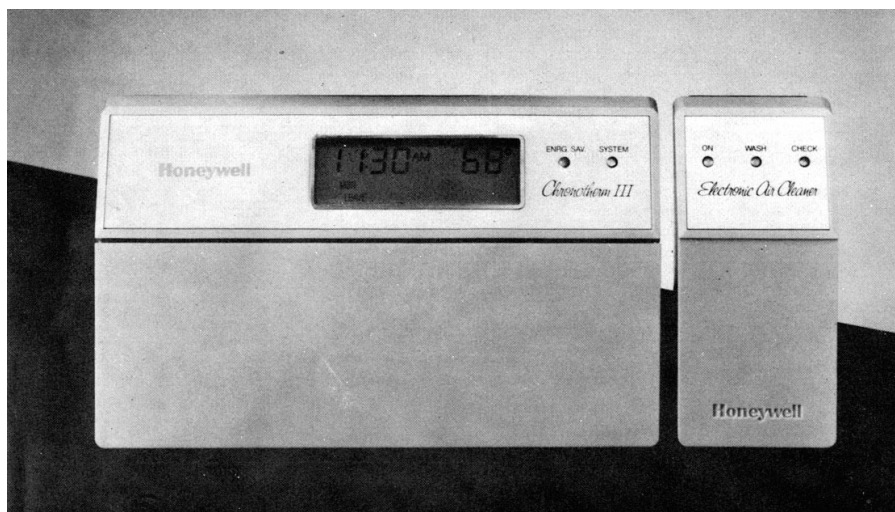


Figure 2. For homeowners who have trouble remembering their electronic filters, Honeywell offers a \$20 Performance Indicator that mounts beside the thermostat. It lights when servicing is needed.

Conditioning and Refrigeration Institute, a group representing manufacturers, are 25 to 35% efficient. This makes them capable of removing such particles as some atmospheric dust, animal dander, insecticide residue, some cooking and tobacco smoke, and most bacteria. Like most standard filters, media filters are throwaways. They last about a year, however, rather than the 30 to 60 days of standard filters. Replacement cost is generally \$30 to \$100, depending on the brand and source. The cost of the entire upgrade is likely to cost \$200 to \$300.

If you do sell a media filter as an option, you'll need a minor modification to the ductwork to accommodate it. A media filter is typically four or more times thicker than a conventional 1-inch-thick filter, so it may need a wider-than-standard receptacle. Once it's in place, the media filter is periodically checked and replaced by the homeowner. Keep in mind, though, that your buyer may want to check that filter much sooner the first year, since the new filter is likely to trap a lot of the sawdust, plaster dust, and air-blown dust from the new home and nearby construction sites. (More than one engineer has noted that it's also bound to trap the discarded sandwich and snack wrappers of building crews.)

Electrostatic precipitators. Also

called electronic air cleaners, these units are the most efficient air cleaners that are practical for home construction. They are more than just a filter; they are a system. A prefilter traps larger particles, much as a standard filter does. But smaller particles, down to 0.1 microns in size, may be trapped by the secondary filter. Almost all tobacco smoke particles and many viruses are big enough to be trapped by this filter. Unlike other filters, electronic air cleaners draw current for their operation. Electronic systems use the current to place a high-voltage charge on particles that pass through it. Collector plates receive an opposite charge and attract the minuscule particles, helping to achieve an efficiency rating of up to 96% on particles measuring .03 microns.

Electronic systems require trade-offs for their efficiency. The first is cost; typically they add \$500 to \$700 to the price of a new home. Maintenance costs are minimal, but maintenance is not. In fact, electronic systems may require more maintenance by the homeowner than any other common system. They require monthly checks and, more importantly, cleaning. The filters must be hosed or rinsed in a bath or utility tub. This isn't difficult, but it is an inconvenience that not every move-up home buyer may want. The

filter cartridge in some models is dishwasher-safe. For homeowners who can't remember to clean the filter, some makers offer an electronic indicator that hangs with the thermostat (see Figure 2).

Electronic air cleaners, besides producing cleaner air, produce an unwanted byproduct: ozone. Ozone is an oxygen molecule with an extra atom. In the upper atmosphere it screens out harmful ultraviolet rays from the sun. But in the lower atmosphere, close to the earth's surface, ozone is unwanted. Its presence at the surface, when combined with light, creates smog and in high concentrations, it causes respiratory irritation.

How much ozone is bad for you? Bob Axelrad of the Environmental Protection Agency explains that the EPA has no indoor air quality standards. It does have outdoor air standards which specify that the air in cities should not exceed .12 parts per million (ppm) of ozone. Nor should they exceed .5 ppm for any 24-hour period, the level at which Los Angeles' first alert for ozone sounds.

Tests show that exposure to high ozone levels—above the .12 outdoor limit, but below .5 ppm, reduces lung function. The effects of long-term exposure to slightly elevated levels are not known.

Cleaning Ducts the Safe Way

Air ducts, over time, build up dirt. Pounds and pounds of dirt. Sometimes tons of dirt. The mixture is a litany of things nobody wants in the house: dust, pollen, lint, mold, mildew, viruses, and bacteria.

What's the answer? Get rid of them, says John Sumerlin, president of Pringle Power Vac of Walla Walla, Wash. His truck-mounted vacuum systems are one way to do it. The vacuums create 15,000 cubic feet per minute of suction.

Sumerlin has a problem with cleaning ducts with chemicals. He believes far too many people have allergic reactions to chemical cleaners to make them practical for cleaning ducts. A new trend disturbs him even more. Some cleaning companies simply vacuum out as much as they can reach and then spray in a glue-like material to seal what they can't reach. "That's b.s.,"

Sumerlin says bluntly. What's the sense, he asks, of introducing formaldehyde-based substances into ductwork which will be spread through the house?

Jim Wohlford, an engineer with Honeywell who is well-versed in hvac systems, relies on periodic vacuuming to clean the ducts in his home. While he hasn't read any technical reports on the sealing method, he says, "If they're using formaldehyde, the idea stinks."

When Sumerlin does use chemicals, it's to retard bacterial or microbial growth and kill what's there. He says he uses nly EPA-approved substances such as Sylguard and Oxine.

To get at dust that can't easily be reached, Sumerlin cuts into duct work to insert the vacuum line. To find dirt in inaccessible areas, some companies use tiny fiber-optic cameras. The cam-

eras send back televised pictures of dirt lining the ducts.

Who gets into duct-cleaning work? Often chimney sweeps find it a way to make their work less seasonal. Full-service hvac firms, such as Sumerlin's, find that it generates other work. One spring, he says, one of his vacuum operators uncovered 12 cracked heat exchangers. Sumerlin's firm contracted to repair seven of them.

But one thing's certain, "Our business is based on repeat work," he says. Many customers schedule annual cleanings. Costs for duct cleaning vary by locality and company, but a \$125 to \$150 base cost is typical, with a \$5 charge per vent.

One other certainty: Ducts don't get as dirty when they're protected by air-cleaning systems or filters.

—G.M.

The ozone generated by a quality electronic air cleaner is well below the EPA ambient limits. Wohlford of Honeywell says, "If you've got electric trains, you're probably generating more ozone than an air cleaner will." Other common ozone generators are hair dryers, kitchen blenders, and power tools. But in all cases, he says, much of the ozone breaks down quickly, because ozone is highly unstable.

EPA scientist Les Sparks says that the more power an electric air cleaner consumes, the more likely it is to generate ozone. But because of the high airflow rates they're handling, "the dilution of ozone will usually get down to an insignificant level."

The key to keeping the ozone levels down, Sparks says, is to install and maintain the units according to manufacturers' instructions. "We've made some measurements," he says. "We're of the opinion that if the machine is installed properly according to manufacturer's instructions, it will generate ozone at levels that are not a problem. If servicing is done, it should be done by somebody who knows what he's doing."

HEPA filters. Unless your customer needs hospital-level cleanliness, High Efficiency Particle Arrestants (HEPA) filters are not practical for home application. HEPA filters top 99% efficiency, but their cost is sky high, adding perhaps \$3,000 to the cost of a home. They are about the size of a furnace because they require their own fan to blow air into the furnace. The auxiliary fan is needed to overcome the density of the filters. The pre-filter must be replaced a couple of times a year, and the HEPA filter itself yearly. The HEPA filter replacement alone runs about \$300.

Installation

A quality air cleaner that's installed to specifications should cause no problems. Any filtering system, however, will impede flow. For instance, the Space-Gard extended media filter from Research Products Corp., of Madison, Wis., recognized as a quality performer,

creates .10 inches of resistance (water gauge) at 1,000 cfm, according to the manufacturer.

Jim Enright of Research Products explains that there is usually no increase in blower horsepower needed. For many single-speed blower motors, you can set the rpms by choosing one of three different settings, called power-level taps, to increase rpms. Remember, however, that on furnace motors with three power-level taps, the highest speed is normally the level at which manufacturers obtain their resistance ratings. That's important in com-

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paring manufacturers' performance claims. You'll also have to make sure the rating is calculated at the proper cfm figure.

Filters often are made to fit a standard 20x22-inch ductwork opening, but not all are the standard 1-inch thickness (see Figure 3). That will take some adjustment, but the ductwork to accommodate thick filters and electronic systems is available from air cleaner manufacturers. They can be installed in a variety of positions (see Figure 4).

Inadequately trained people who make repairs or modifications can cause trouble. Sparks of EPA recalls, "We ran across one unit that was repaired by an electronics whiz. He overpowered it." By boosting an elec-

tronic cleaner that was designed to operate at 10 kilovolts to run at twice



Figure 3. This electronic air cleaner from Honeywell is typical in size. It can be duct-mounted with transitional ductwork.

tronic unit should avoid problems, and encouraging homeowners to use qualified repair services should assure continued safe operation.

Air Cleaners As Options

Kermit Carr, vice president of sales for J.R. Scanlon Supply Co., a Utica, N.Y.-based hvac supply house, sees a steady increase in air cleaner sales. "The average builder offers them as an option," Carr says. What goes into a house depends on a lot of variables: just how clean a buyer wants his air to be, how much he wants to pay, and how much he wants to do to maintain that clean air.

Because of the one-time cost of electrostatic filters, they've been a popular choice. That choice comes despite the fact that they are only about 25% as efficient as the electronic cleaners. "Our sales of electrostatics are up 25 to 30% over last year," Carr says. The choice of electrostatic filters sits well with builders, because electrostatic filters are the option that requires the least amount of installation work.

"There's no muss and no fuss," Carr says, because the electrostatic filter slides right into the opening for a standard filter. The work falls to the homeowner, who must clean the filter monthly.

While the electronic air cleaners are more efficient, they are less popular because they cost more and need monthly cleaning. While they are more efficient at their peak, that efficiency decreases as dirt builds up on the filter. (It builds up quickly because they're so efficient.)

The strain on equipment is a consideration. If not properly cleaned, Carr warns, "An electrostatic will impede air flow. Eventually, you won't get any air through it." Honeywell is so concerned about dirt buildup in improperly filtered and maintained hvac systems that it will pay half the homeowner's cost of vacuuming dirty air conditioner coils, Drake says. That's to save its equipment on warranty.

Dan Lewis of KLR Engineering in Keene, N.H., which designs hvac systems, says he hesitates to put high-efficiency systems in homes. They're good at removing particles, he notes, but not at removing substances such as formaldehyde that leaches from glue-impregnated building materials. He says of the electronic air cleaners, "We've been reluctant to specify them because of ozone production."

He thinks a better way to go is an efficient media filter, but he notes, "The trouble is, you have to remember to change the filter, and people often don't."

What's lacking in the whole equation is cost versus performance. It's hard for a builder to advise a customer on what eats the most dirt for the least money. While there's no impartial data on the subject, this may change. Sparks says EPA is likely to conduct such tests (on types, not every brand) over the next year to 18 months. Axelrad says the EPA was also getting comment this summer from interested parties—manufacturers, the Consumer Product Safety Commission, and others—on a "fact sheet" on air cleaners. It will contain basic information on the known attributes of air cleaners, Axelrad says. In the meantime, you'll have to sift through a pile of literature available for the asking, or at nominal cost.

For More Information

For further information on air cleaning systems, the following can be contacted:

- Air Conditioning & Refrigeration Institute, 1501 Wilson Blvd., Sixth Floor, Arlington, VA 22209.
- Airguard Industries Inc., P.O. Box 32578, Louisville, KY 40232.
- Carrier Corp., P.O. Box 4808, Syracuse, NY 13221.
- Electro Air Division, Emerson Electric Co., 303 North Industrial Park Road, Harrison, AZ 72602.
- Honeywell, Inc., 1985 Douglas Drive North, Golden Valley, MN 55422-3992.
- Lake Air International, Inc., P.O. Box 4150, Racine, WI 53404.
- Lennox Industries, Inc., P.O. Box 80900, Dallas, TX 75380-9000.
- Research Products Corp., 1015 E. Washington Ave., P.O. Box 1467, Madison, WI 53701-1467.
- Trion, Inc., P.O. Box 760, Sanford, NC 27331-0760. ■

Gary Mayk is editor of the Eastern edition of *The Journal of Light Construction*.

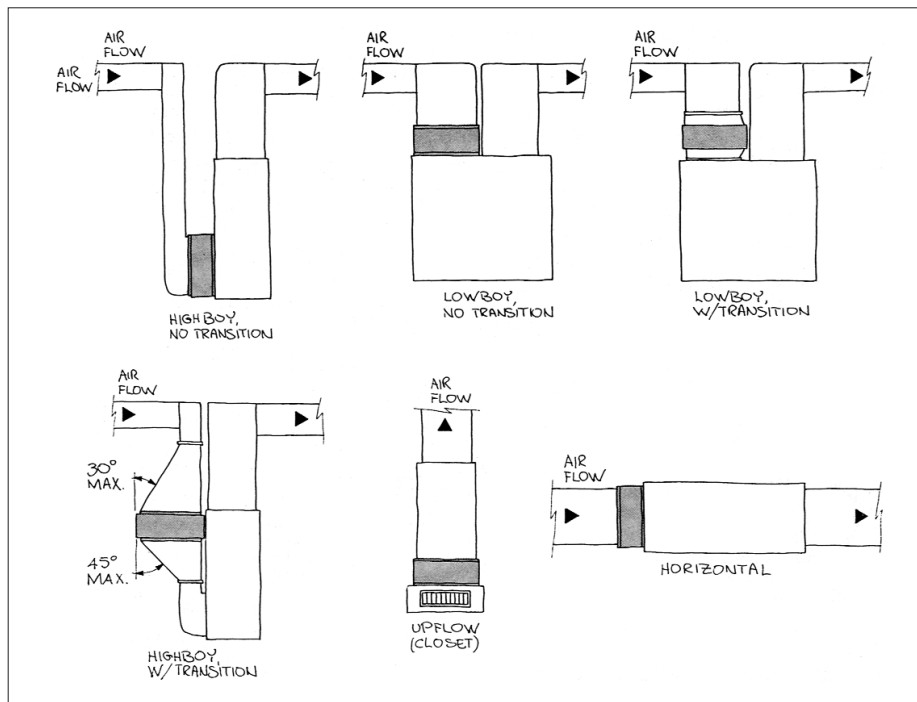


Figure 4. Air cleaners can be adapted to a number of mounts in ductwork.