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Air Filters: New Facilities, New Standard

Advances in testing procedures, coupled with greater pressure for better IAQ, leads to a new standard

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The latest standard addressing facilities' indoor air quality (IAQ) — ASHRAE Standard 52.2-1999 — represents a quantum leap in the precision and accuracy of air-cleaner ratings. Standard 52.2, the result of more than 10 years of development in the field of filter testing, is aimed at the filter media required for today's modern workplace. Its testing protocol includes the reliable and consistent testing of filter performance on particles of nominal 3-10 microns in diameter.

Although the new standard is applicable to the testing of any type of air cleaners, it has been primarily tailored to high-efficiency dry filters used in hospitals, laboratories and clean rooms.

Today's challenges

The responsibility of today's maintenance and engineering managers to maintain a clean indoor air environment has increased markedly in recent decades. Employees are more concerned about health, they are more aware of allergic conditions, and they are more familiar with — and aware of the effects of — chemicals in the workplace. Last but not least, workers have better access to legal expertise and are more likely to litigate.

As computers have become standard office equipment, they have left the imprint of their own requirements on the building HVAC system. Dust in the workplace eventually will foul the heat sinks found in personal computer (PC) power supplies, causing over-heating and failure. Dust also can cause reading errors on hard drives and digital tape heads.

Finally, the fabrication of integrated circuit boards is setting the pace for air-filtration standards found only in exotic aerospace assembly labs a decade ago.

Enter a new standard

In the works since 1987, ASHRAE Standard 52.2 features two important improvements over previous standards. For more on these standards, see the accompanying sidebar.

The first improvement is the substitution of chemically generated potassium chloride (KCl) dust for the test dust used in previous standards. The use of KCl allows the efficient and consistent generation of particles down to an average size of 0.3 microns and less and enables the repeatable testing of filter media performance on very small particles, and testing with even smaller particles as future needs dictate.

The second improvement is the de-coupling of filter loading from filter arrestance. The new standard requires the use of standard test dust to load filters, which simulates the normal increases in efficiency and pressure drop that occur as a dry-media filter becomes impacted with fibers and particles.

A subject filter is loaded with test dust in six stages, from clean to maximum pressure drop. After each stage of loading, the filter is tested for its ability to arrest KCl particles of 0.3-10 microns. This testing provides an accurate and clear description of arrestance at each stage, rather than the average produced by the earlier ASHRAE 52.1 arrestance and dust-spot tests.

Standard 52.2 rates filter arrestance differently than the 52.1 protocol, which used either weights or times to generate a ratio, or efficiency. This efficiency was an easy way to describe a filter’s performance.

Thus, a 50 percent filter would stop a nominal 50 percent of the particles in the air stream as averaged over the test period. Unfortunately, this average over time told a user nothing about performance for a specific particle size at a specific stage in a filter’s life.

Dry-media filters exhibit an increase in efficiency as they collect material. This increase in efficiency corresponds to a decrease in open area as collected fibers and particles cover the media. The increased efficiency, however, might not be enough to accomplish the required mission in a dust-critical environment, which can’t wait for the efficiency to increase to a suitable level. The “average” is not the issue.

As a result of these problems, 52.2 defined the minimum efficiency reporting value (MERV) to describe filter performance. The MERV is based on the worst-case performance of a filter through all six stages of dust loading and all particles 0.3-10 microns. Because the rating represents the worst-case performance, specifiers can use it to assure performance in applications where a maximum particle count must be maintained over the filter’s entire life.

MERV vs. dust spot

MERV ratings are not listed in many filter catalogs available today, except for higher-end products. Eventually, the ratings will be a part of all catalog listings, so managers will need to become familiar with them.

For managers working with high-efficiency particulate air (HEPA) filters and ultra-low penetration air (ULPA) filters, a working knowledge of 52.2 soon will become vital. The old standard 52.1 is rapidly becoming outdated for describing filter performance at this level.

Standard 52.2 lists approximate dust-spot efficiencies and corresponding MERV values. For example:

- MERV values of 8 and higher correspond to dust-spot efficiencies of more than 30 percent.
- MERV values of 13 and higher correspond to dust-spot efficiencies more than 80 percent.
- MERV values of 15 and higher correspond to dust-spot efficiencies more than 95 percent.

As a result of these equivalencies, a manager could expect that a facility’s current stock of 30 percent pre-filters to eventually be replaced with filters with a MERV rating of 8. Similarly, existing 80 percent filters will have a new rating of MERV 13, and 95 percent filters a new rating of MERV 15.

Ratings explained

A typical MERV rating tells a specifier the arrestance rating of the filter at three particle sizes of 0.3-10 microns at a certain face velocity. For example, a rating of MERV 10 at 0.93 indicates a filter with a MERV 10 arrestance when operated at an airflow of 0.93 cubic meters per second, which is a little less than 500 feet per minute, or 2,000 cubic feet per minute (cfm) for a standard 2-foot-square filter.

A rating of MERV 10 corresponds to 50-65 percent efficiency for particles 1-3 microns and above 85 percent efficiency for particles 3-10 microns.

A rating of MERV 13 corresponds to less than 75 percent arrestance efficiency for particles 0.3-1 microns, above 90 percent efficiency for particles 1-3 microns, and above 90 percent efficiency for particles 3-10 microns.

A rating of MERV 15 corresponds to 85-95 percent arrestance efficiency for particles 0.3-1.0 microns, above 90 percent efficiency for particles 1-3 microns, and above 90 percent efficiency for particles 3-10 microns.

Arrestance efficiencies are based on particle counts taken upstream and downstream of a test filter with an optical, or laser, particle counter. The entire list of MERV ratings based on particle arrestance efficiency is found in Table 12-1 of Standard 52-2.

Although the standard only lists arrestance efficiencies for MERV values to 16, continuously higher ratings can be easily added. In fact, the table lists ratings up to MERV 20. Ratings of MERV 16 to MERV 20 correspond to HEPA and ULPA filters.

Standard 52.2 is designed to start a shift away from an arbitrary concept of average efficiency and toward the concept of arrestance based on particle size.

Air-filter applications will be based on critical aspects of the process involved, such as circuit dimensions or microbial size, that resolve themselves into target particle sizes.

The required MERV rating for filters will follow directly from the maximum allowable particle concentrations in the three bands of 0.3-1.0 microns, 1.0-3.0 microns and 3.0-10.0 microns.

Putting the standard to work

If Standard 52.2 is going to require more thought in filter selection, the good news is that maintenance and engineering managers will have more control over tailoring the quality of the facility’s air supply. They can use the following tips to help transition to the MERV ratings and better indoor air quality:

- Work with factory representatives to obtain documentation showing the new MERV ratings for their existing products. These ratings will be coming out in the next several years.
- Look for new MERV ratings that will appear along with the old dust-spot or DOP rating on filters and filter packaging. Use these equivalencies to better understand the new ratings.
- Create a new strategy for evaluating filters in terms of target particle sizes. MERV ratings encourage filter selection based on particle size requirements.
- Inspect filter installations for good sealing. No filter can stop particles that bypass the media.
- Confirm that filters have manometers to indicate the time for change-out, and monitor filters regularly.

Managers using these tips and Standard 52.2 are likely to have a better chance of creating and maintaining a healthy and productive indoor work environment in their facilities.

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The Evolution of Air Filtration Standards

ASHRAE Standard 52.2 grew out of ASHRAE Standard 52.1-1992, Gravimetric and Dust Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter. Standard 52.1, in turn, developed out of Standard 52-1968, which was the culmination of efforts by the National Institute of Standards and Technology and the Air Filter Institute.

Prior to Standard 52-1968, air filters used in facilities were large mesh “furnace filters” that kept large fibers from fouling heating and cooling coils. These filters would have had ASHRAE Standard 52.1 dust-spot efficiencies of about 10 percent and arrestance ratings of about 50 percent initially, growing to 80 percent or better as the filter filled with material.

Most fine dust passed through these filters directly into the facility. Facilities tolerated this situation because the resulting IAQ was at least as good as the outside air, and the outside air seemed a good de-facto standard of acceptable air quality.

But the accelerating use of forced-air HVAC systems in new buildings brought further problems. The fine dust that escaped the single-panel arrestance filters discolored ceilings and other surfaces. Over time, black streaks appeared, radiating out from air supplies. Fine dust also created a cleaning problem on office furnishings.

So during the 1970s and 1980s, Standard 52.1-1992 was developed, including both arrestance and dust-spot tests. The latter test actually simulated the discoloration of a test filter as a basis for rating the product.

For both tests, performance was measured with a standard test dust containing a mixture of fine and course materials. But even the finest constituents of test dust were not small enough to match the needs of today’s hospitals, laboratories and clean rooms.

— *Ron Wilkinson*