RTI International

Air Filter and Air Cleaner Testing Services

List of Available Tests

ASHRAE 52.2

ASHRAE 52.2 Variations

- Initial efficiency (Ei) tests
- Efficiency test -- for used filters
- Efficiency test -- media
- Efficiency test -- ESPs, electronic air cleaners, mixed media air cleaners
- Partial 52.2 tests
- Conditioning steps
- Dusts -- alternate loading dusts
- Aerosols -- e.g., oleic acid
- Nanoparticle filtration
- Other airflows

Conditioning Tests

- KCl conditioning
- IPA (isopropyl alcohol) conditioning
    - IPA spray
    - IPA dip

EPA Method 319

- Modified Method 319 tests
    - Single efficiency test
    - Flow rates
    - Nanoparticle filtration

Gas-phase Air Cleaner Tests

Swatch, Fabric, and Media Tests

ASHRAE 52.2

ASHRAE 52.2* is the standard test method to determine the efficiency of clean and dust-loaded residential and commercial HVAC filters. Briefly, filters or other air cleaners are placed in a 24- x 24-inch duct with a well-defined airflow. The clean filter is tested with a solid aerosol (KCl) covering the particle size range from 0.3-10 μm. Upstream and downstream particle counts in each of 12 differently sized bins are collected and the efficiency is calculated from these numbers.

After the initial efficiency (Ei) is calculated, the filters are loaded with ASHRAE dust (a standardized test dust consisting of carbon black, ISO fine dust, and cotton linters) in a series of five steps to a chosen final pressure drop. After each dust load, the efficiency of the filter is determined.

The test report for ASHRAE 52.2 tests include:

- Description of the filter
- Test parameters
- Clean filter efficiency data (table and graph)
- Dust-loaded filter efficiency data (table and graph)
- Pressure drop curve for the clean filter at various air flow rates
- Minimum efficiency values averaged for the smallest (E1), medium (E2), and largest (E3) particle sizes
- Minimum Efficiency Reporting Value (MERV)

RTI includes a filter weight gain value for customers who request it. A photo of your filter will be included as well, if requested.

RTI emails these reports as four-page PDF files usually within one day of the test completion. An example of this report is available from Kathleen Owen at mko@rti.org. Modified tests based on the methodology of ASHRAE 52.2 are readily available. If you don't see your idea listed on this Web page, please ask about it.

Contact

- Kathleen Owen, mko@rti.org

* ASHRAE Standard 52.2-2007, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size, American National Standards Institute/American Society of Heating, Refrigerating and Air-Conditioning Engineers Atlanta, GA. (The test method itself may be purchased from ASHRAE.)

ASHRAE 52.2 Variations

RTI offers many variations on the standard ASHRAE 52.2 test*. Our most common options are listed below. Please ask if you need a test that isn't listed. We may already perform that test or we can work with you to develop a new methodology.

Initial Efficiency (Ei) Tests
This is simply the first step of the ASHRAE 52.2 test. It produces an efficiency curve from 0.3-10 μm and a pressure drop curve for a clean filter and is useful for quick comparisons of filters or in media development.

Efficiency Test: Used Filters
This test is exactly the same as the initial efficiency test but for a retrieved from in-field use filter. It is useful in determining if your filter has or has not improved during use.

Efficiency Test: Media, Other
This test is exactly the same as the initial efficiency test except that we test flat sheet (up to 24x24") or other media not already in a final filter design. Often used for experimental media that isn't yet being made into pleated, boxed filters. Also used for other media where filtration is important even though the media isn't used in a ventilation filter.

Efficiency Test: ESPs, Electronic Air Cleaners, Mixed Media Air Cleaners
This test is essentially the same as the initial efficiency test except that we test unusually shaped or electrically powered air cleaners. Let us know your needs; we can probably come up with a way to test it for you. For ESPs and other air cleaners where a full 52.2 test isn't applicable, this is a good option for getting data to compare with the initial efficiency of an ASHRAE 52.2 test.

Partial 52.2 Tests
This tests to the first, second, third (etc.) dust load. It is quicker than a full test and may be sufficient for your internal needs. These do not give official MERVs.

Conditioning Steps
In lieu of the current first dust load, we can perform the conditioning step with ultrafine (nanometer) KCl aerosol as described in the pending informative appendix to 52.2. We can also do conditioning based on IPA or other exposures.

Dusts
We perform tests similar to ASHRAE 52.2 with alternate loading dusts. Dusts we have used include ISO fine, ASHRAE dust without carbon, and actual duct dust. Dust without carbon is especially important for testing ESPs because the carbon black of the regular ASHRAE dust may short out the unit. Dust loading with alternate dusts may be done in conjunction with efficiency tests or simply to get weight gains or dust-holding capacities for air cleaners or media.

Aerosols: Oleic Acid
Oleic acid (a food oil and common DOP surrogate) is used for tests that need a liquid particle (e.g., grease or paint filters). Since solid-phase aerosol allows particle bounce and liquid phase enables greater particle capture, the oleic acid test may give a best-case efficiency result. Any test above may

be performed with oleic acid as the aerosol. Other aerosols are available.

Nanoparticle Filtration
For smaller particles (nanoparticles), we can test your filters with a scanning mobility particle sizer (SMPS). This instrument measures particles down to approximately 20 nm and up to approximately 500 nm. We can cover this whole size range or some fraction of this. This test is very useful for showing that your filter actually improves below its most penetrating particle size (MPPS).

Other Airflows
ASHRAE 52.2 only recognizes seven face velocities for MERV evaluations. We can test at many other airflow rates.

ASHRAE-Variation Test Reports

Test reports are very similar to our ASHRAE 52.2 reports but may be modified substantially to meet customer needs. These include, as appropriate:

- Description of the filter
- Test parameters
- Clean filter efficiency data (table and graph)
- Dust-loaded filter efficiency data (table and graph)
- Pressure drop curve for the clean filter at various air flow rates
- Minimum efficiency values averaged for the smallest (E1), medium (E2), and largest (E3) particle sizes
- MERV estimates
- Conditioning times and method
- Filter weight gain

RTI emails these reports as PDF files usually within one day of the test completion.

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* ASHRAE 52.2 is a standard test method to determine the efficiency of clean and dust-loaded residential and commercial HVAC filters. It may be purchased from ASHRAE.

Conditioning Tests

ASHRAE 52.2 currently has a conditioning step in the form of a small ASHRAE dust load. Alternate conditioning steps are being discussed and developed. An informative appendix to ASHRAE 52.2 is in development to replace the current conditioning procedure to one using a KCl-conditioning aerosol. This step is not required, but may give useful information that is not obtained through a 52.2 test. Other conditioning steps including several using isopropyl alcohol (IPA) are in use, especially in Europe.

KCl Conditioning
This is a conditioning test with submicron, ~40 nm, KCl aerosol as described in the pending informative appendix to ASHRAE 52.2. It starts with an efficiency test per 52.2 of a clean filter. The filter is then exposed to the submicron aerosol until the efficiency measurements stabilize or the maximum CT is reached. The goal of this method is to mimic efficiency drops seen in real use for some electrostatically charged filters; it does not remove all charge from the filter. This conditioning may be followed by the other dust loads of ASHRAE 52.2, a single dust-load, or not dust-loading as the customer chooses.

Isopropyl Alcohol (IPA) Conditioning
These tests are aimed at removing all charge from a filter. They also start with an efficiency test per 52.2 of a clean filter. After the filter dries out, another efficiency test is performed. Again, this step may be followed with dust loading.

- **IPA spray --** filter is sprayed until it is visibly saturated then allowed to dry for 24 hours before the post-conditioning efficiency test.
- **IPA dip –** filter or media swatch is submerged in IPA, then dried for 24 hours.

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EPA Method 319

EPA Method 319* is a test method aimed at testing paint overspray arrestors for the aerospace industry. It is easily adapted for any similar filters. Briefly, filters or other air cleaners are placed in a 24- x 24-inch duct with a well-defined airflow. Three clean filters (or filter systems) are tested with a solid aerosol (KCl) and three identical filters are tested with liquid aerosol. Use of the solid- and liquid-phase aerosols is designed to account for the likelihood that paint overspray would include both phases of aerosol and brackets arrestor performance. Method 319 requires a face velocity of 120 fpm.

The aerosols cover the particle size range from 0.3-10 μm as used in ASHRAE 52.2. In Method 319, the results are reported by aerodynamic diameter with somewhat different size channels. Upstream and downstream particle counts in each size of bin are collected and the efficiency is calculated from these numbers.

The test report for Method 319 tests include:

- Description of the filter
- Test parameters
- Efficiency data for both solid and liquid aerosols (table and graph)
- Average efficiency data compared to NESHAP efficiency requirements
- Pressure drop measurements for each filter at the test flow rate
- Efficiency data for all tests in tabular form

RTI includes a photo of your filter or filter system, if you request it. RTI emails these reports as PDF files usually within 1 day of the test completion.

Modified Method 319

Modified tests based on Method 319 are readily available. Possibilities include:

- Single efficiency test -- just one filter or one filter with each aerosol (useful for filter development)
- Flow rates -- other flow rates may be used
- Nanoparticle filtration -- for smaller particles (nanoparticles), we can test your filters with a scanning mobility particle sizer (SMPS). This instrument measures particles down to approximately 20 nm and up to approximately 500 nm. We can cover this whole size range or some fraction of this. It is very useful for showing that your filter actually improves below its MPPS (most penetrating particle size).

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* Method 319, *Determination of Filtration Efficiency for Paint Overspray Arrestors*, was published October 29, 1996 in the Federal Register (61FR55842). EPA proposed that this method be used by filter manufacturers to certify the efficiency of their filters for meeting the filtration efficiency requirements, which were also proposed in the same Federal Register. The National Emission Standards for Hazardous Air Pollutants (NESHAP) for Aerospace Manufacturing and Rework Facilities was promulgated in the Federal Register on September 1, 1995 as Subpart 66 of 40CFR Part 63.

Gas-Phase Air Cleaner Tests

Several options for gas-phase air cleaner testing at RTI are currently available. ASHRAE and ISO are developing standard tests which RTI will add to its offering as they become available. More tests may be added if customer need exists.*

Typical test:

- Challenge gas: 40 ppm toluene
- Temperature: 75°F
- Relative humidity: 45%
- Airflow rate: 1000 cfm
- Test duration: 2 hours with challenge, 1 hour desorption

Test reports may include:

- Description of the filter/device
- Test parameters
- Filter/device efficiency data table and graph of efficiency vs. time
- Breakthrough times, if test is run to an appropriate endpoint
- Desorption concentrations (table and graph)
- Pressure drop curve for the clean filter
- Photo of your filter, if you request it

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* Most tests will be performed in our ASHRAE 52.2 test rig; thus, the velocity and aerosol uniformity already meets the QA specifications of that test method. Our test rigs also provide temperature and humidity control as well as options for air cleanup and single-pass or recirculation options.

Swatch, Fabric, and Media Tests
Performance of Aerosol Penetration Measurements of Fabrics

Swatch Test Apparatus and Procedures

The swatch tests are performed on a small scale (e.g., 4-inch diameter samples, flowrates under 1 cfm) by challenging fabric swatches with a polydisperse aerosol while measuring the aerosol concentrations upstream and downstream of the fabric. The apparatus is based on ASTM Standard F1215-89 for determining the filtration efficiency of flat-sheet filter media.

Test Parameters

- **Temperature**
  - Fabrics to be worn by people may be tested at 90°F
  - Media swatches for HVAC may be tested at 75°F
  - Range 70 - 90°F
- **Humidity**
  - Fabrics to be worn by people may be tested at 60%
  - Media swatches for HVAC may be tested at 45%
  - Range: 0 - 60%
- **Airflow rate** -- fabrics may be tested for a specified pressure drop (e.g., 0.1 in H_2O) or a specified flow rate (up to ~18 Lpm)
- **Aerosols**
  - Liquid aerosol, usually oleic acid, a low-volatility oil
  - Solid aerosol, usually KCl, a salt
  - Nanoparticles, SiO_2
- **Aerosol generators** -- collisons, spray nozzle, others
- **Particle counters**
  - Optical particle counters (OPCs) or aerosol spectrometer covering the particle diameter size range from 0.3 to 3 μm in 10 particle-sizing channels
  - Scanning mobility particle sizer (SMPS) covering the particle diameter size range from 20 to 450 nm
- **Swatch diameter** -- variable from approximately 2 to 4 inches

Aerosol Penetration

Aerosol penetration is based on the ratio of downstream to upstream aerosol concentrations computed on a channel-by-channel basis to compute the fractional penetration at the mean particle diameter of each channel. Penetration velocity may be determined by multiplying the penetration by the face velocity. Penetration velocity is used when comparing results from constant pressure drop tests of fabrics having different air permeabilities.

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