Electrostatically Charged and Mechanical HVAC Filter Media

Particle removal efficiency and performance throughout service

For commercial buildings, schools, health care facilities, and industrial HVAC systems

Executive summary

Mechanical media provides particle capture without depending on an applied electrostatic charge. Under normal dry loading, intact mechanical media generally maintains or increases its collection efficiency. Electrostatically charged media, also called electret media, combines mechanical capture with electrostatic attraction. It can provide strong initial efficiency with relatively low resistance, but some products lose efficiency as the electrostatic contribution becomes less effective. [1, 2]

Do not assume a charged-media MERV 13 pleated filter will maintain MERV 13 performance throughout service. Charge-dependent efficiency can decline below the rated level. [1, 2] When sustained MERV performance is required, media type and conditioned efficiency are essential selection criteria.

How the media captures particles

Mechanical capture occurs through interception, impaction, and diffusion. Interception brings a particle into contact with a fiber; impaction occurs when inertia prevents a particle from following airflow around a fiber; diffusion increases the chance that small particles encounter fibers. Electret media adds electrostatic attraction to these mechanisms. Passive electret filters do not require an external power supply and are different from powered electrostatic precipitators. [3]

Mechanical describes a capture mechanism, while synthetic describes a material. Synthetic fibers can provide mechanical filtration. Fine glass-fiber media is a common mechanical option, but coarse fiberglass filters do not automatically provide high fine-particle efficiency. [1, 3]

Selection factor	Electrostatically charged media	Mechanical media
Capture mechanism	Mechanical collection plus electrostatic attraction.	Collection without dependence on an applied charge.
Initial resistance	May be lower at comparable efficiency.	Depends on fiber structure, media area, and filter design.
Performance during loading	Can decline before accumulated dust increases capture.	Generally stable or increasing if intact and properly operated.
Evidence to request	Initial, conditioned, and application-relevant efficiency.	Efficiency, loaded resistance, and complete-filter performance.

Comparison summarizes general behavior, not a guarantee for every product. [1–3]

Read particle efficiency behind the MERV rating

ASHRAE Standard 52.2 evaluates general ventilation filters by particle size. MERV is derived from minimum measured efficiencies during a prescribed laboratory sequence, rather than only from a clean-filter measurement. The three reporting bands are E1 at 0.3–1.0 microns, E2 at 1.0–3.0 microns, and E3 at 3.0–10.0 microns. [4]

The table shows selected classification thresholds. These are size-band averages, not efficiencies guaranteed at every diameter. [5]

MERV	E1 0.3–1.0 µm	E2 1.0–3.0 µm	E3 3.0–10.0 µm
8	No minimum	≥20%	≥70%
10	No minimum	≥50%	≥80%
11	≥20%	≥65%	≥85%
12	≥35%	≥80%	≥90%
13	≥50%	≥85%	≥90%
14	≥75%	≥90%	≥95%
16	≥95%	≥95%	≥95%

A MERV 13 label alone does not establish MERV 13 performance throughout service. Charged media can fall below that level as electrostatic capture becomes less effective. [1, 2] Mechanical media must also meet the required efficiency: a stable MERV 8 filter does not meet a MERV 13 requirement.

What a lower rating means

MERV is an ordinal classification, not a percentage scale. A decline from MERV 13 to MERV 10 is not a 3% loss in removal. It means the measured performance meets a different class. Examine E1 and E2 data to understand the practical change, particularly when fine particles are the concern. [4, 5]

Use conditioned efficiency in product selection

Optional Appendix J conditioning under ASHRAE 52.2 challenges the filter with fine particles and reports MERV-A, helping reveal efficiency loss that may occur in service. [4] For a sustained MERV 13 target, request MERV 13-A or higher for the exact product at the specified airflow. A lower A rating does not demonstrate retained MERV 13 performance. MERV-A is a screening tool, not a lifetime field guarantee.

Pressure drop measures resistance, not capture efficiency. A filter can pass fine particles while still allowing normal airflow. Maintenance decisions should therefore combine efficiency documentation with airflow, condition, and resistance measurements. [2, 7]

Documented examples of efficiency decline

Published MERV comparisons

Evidence	Reported comparison	Interpretation and limits
Manufacturer laboratory example [2]	MERV 13 → performance level of MERV 10	AAF describes accelerated fine-particle conditioning. The article does not provide a full report, model, airflow, or service duration.
New versus conditioned filter [6]	MERV 12 → MERV 8-A	Product marketed as MERV 11. E1/E2/E3 changed from 37/80/93% to 13/51/74%. This is a laboratory comparison.
Commercial building samples [6]	New MERV 11 → reported MERV 10	Three used filters: 1, 1.5, and 4 months. Same factory, methods, and materials; different filters and operating locations.

Blue Heaven Technologies tested the commercial samples at 492 fpm. Used-filter MERV values were supplier-reported classifications from initial-efficiency tests after field loading, not a new full loading sequence. The sample does not establish typical decline. [6]

The laboratory and commercial comparisons involve different sample sets. The supplier also reported residential samples performing above the conditioned result. Conditioning is not a guaranteed field endpoint. [6]

Peer reviewed field comparison of the two media types

Raynor and Chae monitored 30 uncharged glass-fiber filters and 30 charged polyolefin-fiber filters in nearly identical outdoor-air handling units for more than 19 weeks. Glass-fiber efficiency remained almost constant. At 0.6 microns, charged-filter efficiency fell from 85% to 45% after 11 weeks, then recovered to 65% by the end of the test. [7]

That is a 40-percentage-point reduction at one particle size. It is not a reported MERV change or a PM2.5 mass-efficiency measurement. The study also found greater pressure-drop growth for the glass-fiber filters, demonstrating that stable efficiency does not automatically mean lower resistance. These results apply to the tested products and exposure; they do not describe all current electret media. [7]

These examples show why purchasers should not rely on a nominal MERV rating alone. Mechanical capture avoids dependence on an applied charge; electret efficiency loss varies by product and exposure. The evidence establishes a risk of falling below the rated level, not that every charged filter necessarily does so.

Selection for occupied buildings and industrial HVAC

The following are practical selection recommendations. They do not replace a project specification, a process risk assessment, or the applicable building and health care requirements.

Application	What to prioritize
Commercial buildings	Retained fine-particle efficiency, rack sealing, adequate airflow, and total operating cost.
Educational facilities	Consistent capture during occupied hours; verify fan capability before upgrading filtration.
Medical facilities	Room-specific filtration and system requirements, documented performance, and installation integrity. Do not substitute a general MERV target for the facility specification.
Industrial HVAC	Match filtration to the actual particle sizes and process contaminants. General HVAC filtration does not replace source capture or application-specific exhaust controls.

CDC recommends MERV 13 or better for central HVAC air-cleanliness upgrades when compatible with the system, and emphasizes correct sizing, maintenance, and reduced bypass. For health care, ASHRAE/ASHE Standard 170 addresses facility ventilation; the applicable edition and requirements vary by jurisdiction and space. Confirm them with the facility's design and infection-prevention teams. [8, 9]

What to request from the filter supplier

1. The complete-filter test report for the exact product, dimensions, and rated airflow, including MERV and E1, E2, and E3 efficiencies.
2. A MERV-A result meeting the target MERV level, plus available service-performance evidence. Identify the conditioning method; other methods are not automatically interchangeable with Appendix J.
3. Initial and loaded pressure drop at the required airflow, the recommended final resistance, and the equipment's permitted operating limits.
4. Media type and its reliance on electrostatic enhancement. A mechanical-media label alone is insufficient; require complete-filter efficiency documentation and fit, seal, and installation requirements.

Evaluate efficiency and resistance together

Mechanical media's stability advantage does not justify operating beyond its replacement limit. Excessive loading can reduce airflow or increase bypass. Compare total cost over the service interval, including filter purchases, labor, disposal, and fan energy, while maintaining the required capture performance. [1]

For a sustained MERV 13 objective, specify MERV 13 and a minimum MERV 13-A result at the required airflow, identify the media type, and request supporting service-performance evidence and operating limits. This is a purchasing recommendation, not a lifetime guarantee. Documented mechanical efficiency reduces dependence on charge; charged media needs evidence that retained performance meets the target.

References and evidence notes

Sources reviewed October 19, 2026. This paper separates peer-reviewed research, manufacturer statements, supplier-reported tests, and selection recommendations. No original filter testing was performed.

[1] U.S. Environmental Protection Agency. Residential Air Cleaners A Technical Summary. Third edition, 2018. Table 1 and discussion of fibrous media, loading, airflow, and bypass. Source

[2] AAF International. Electrostatic or Mechanical? Choosing the Right Filter Media. August 13, 2026. Manufacturer explanation and MERV 13-to-10 conditioning example; the public article is not a complete laboratory report. Source

[3] NIOSH. Guidance for Filtration and Air-Cleaning Systems to Protect Building Environments from Airborne Chemical, Biological, or Radiological Attacks. Publication 2003-136. Particle capture mechanisms and filtration technologies. Source

[4] ASHRAE. Standard 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size. Technical explanation draws on publicly accessible 52.2-2017, Sections 10–12 and Informative Appendix J. ASHRAE lists 52.2-2025 as its published edition; specify the applicable edition and addenda in procurement. Source

[4a] ASHRAE. Read-Only Versions of ASHRAE Standards. Current edition listing. Source

[5] U.S. Environmental Protection Agency. What is a MERV rating? Selected classification thresholds. Source

[6] Tex-Air Filters. What Happens to the Electret Charge on a MERV 11 Pleated Filter in Service? 2017. Supplier-reported conditioning and field comparisons, including its commercial-building tests performed by Blue Heaven Technologies. Used-filter results are reported classifications based on initial-efficiency measurements after field loading. Source

[7] Raynor, P. C., and Chae, S. J. The long-term performance of electrically charged filters in a ventilation system. Journal of Occupational and Environmental Hygiene 1(7):463–471, 2004. DOI 10.1080/15459620490467783. Quantitative findings verified from the published abstract. Source

[8] CDC/NIOSH. Improving Air Cleanliness. General HVAC upgrade, installation, and maintenance guidance. Source

[9] ASHE. ANSI/ASHRAE/ASHE Standard 170-2025, Ventilation of Health Care Facilities. Scope and explanation of differing jurisdictional adoption. This paper does not reproduce room-specific requirements. Source