How to Select a Carbon Filter

Match the contaminant media construction and carbon mass to the application

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

Executive summary

Select a carbon filter by identifying the gas to be removed, defining the required outlet concentration, and matching the adsorbent chemistry and filter construction to actual operating conditions. A black filter, a high MERV rating, or the word carbon alone does not establish gas-removal performance. MERV describes particle removal; gas-phase performance requires separate evidence. [1]

Untreated activated carbon is useful for many organic vapors and odors. Other contaminants require chemically treated carbon, activated alumina, or another targeted medium. Carbon-loaded roll media, pleated filters, mini-pleat filters, loose-filled honeycomb filters, cassettes, and trays offer different combinations of capacity, resistance, space requirements, and maintenance. [2-10]

Carbon has finite capacity. Keep it protected from liquid water, provide sufficient usable adsorbent mass, prevent bypass, and replace it before the required removal performance is lost. Service life must be established for the actual contaminant and operating conditions rather than a universal calendar interval. [10-12]

Start with the removal objective

• Identify individual contaminants and sources. An odor description or total VOC reading may not identify the chemistry that controls media selection.

• Determine normal and peak inlet concentrations, required outlet levels, airflow, operating hours, temperature, and relative humidity.

• Distinguish comfort odor control from corrosion protection, process protection, or an occupational exposure requirement.

• Record available space, fan capacity, pressure-drop allowance, housing seals, and access for media replacement.

Use source control and appropriate ventilation along with filtration. Carbon HVAC filters do not replace required outdoor air, source exhaust, or a purpose-designed emergency gas-control system. [1]

Adsorption and chemical removal

In physical adsorption, gas molecules collect on the internal surfaces of porous activated carbon. Chemically treated media use target-specific reactions as well as adsorption. The useful capacity and speed of removal vary with the gas, media chemistry, concentration, moisture, and contact conditions. [1, 4, 11]

Let the contaminant determine the media

The table is a starting point for selection, not a universal removal guarantee. Specify the exact media grade and obtain target-gas test data at relevant conditions. Activated alumina and other reactive sorbents may be appropriate even when the requested product is informally called a carbon filter.

Contaminant or challenge	Media commonly considered	Selection consideration
Toluene benzene xylene and many solvent vapors	Untreated activated carbon; grade selected for the target VOCs. [1, 13]	Capacity differs by compound and concentration; a toluene test does not establish removal of all VOCs.
Formaldehyde and difficult aldehydes	Targeted reactive media, including permanganate-treated activated alumina or a validated carbon/reactive blend. [4, 5]	Do not assume ordinary carbon provides adequate sustained capacity.
Ammonia and amines	Acid-treated activated carbon or another base-removal sorbent. [3, 14]	Select for alkaline gases; general VOC carbon is not automatically suitable.
Hydrogen sulfide	Specialty alkaline or catalytic carbon; validated reactive alumina/carbon media. [2, 4, 5]	Compare capacity and removal at the specified humidity and outlet limit.
Sulfur dioxide	Acid-gas treated carbon, reactive alumina, or a validated blend. [2, 4]	Acid-gas capacity differs from generic VOC capacity.
Hydrogen chloride and hydrogen fluoride	Alkaline-treated acid-gas carbon or a validated specialty sorbent. [2]	Confirm compatibility, capacity, and downstream performance for each gas.
Nitrogen dioxide	NO2-specific treated carbon, permanganate media, or a validated blend. [2, 4, 5]	Verify the exact nitrogen oxide; NO2 data do not establish NO removal.
Ozone	Activated carbon or a catalytic molecular medium validated for ozone. [5, 15]	Use ozone-specific efficiency and service-performance evidence.
Chlorine	Chlorine-targeted treated carbon or reactive sorbent; validated blends. [5]	Identify concentration and duty; routine HVAC odor control differs from emergency scrubbing.
Mixed outdoor or indoor gases	Separate media stages or a validated blend of carbon and reactive sorbent. [5, 10]	Check capacity for each target gas and competing contaminants.
Carbon monoxide and carbon dioxide	Ordinary HVAC activated carbon is not an appropriate primary control. [1, 13]	Use source control, ventilation, and application-specific technology.

Mixed odors may contain compounds needing different chemistry. More of the wrong media does not solve a chemistry mismatch. Choose media stages or a tested blend based on the actual gas mixture. [5, 10]

Choose the filter construction

Construction controls how much media fits in the housing, how air contacts it, and how it is serviced. Compare actual usable adsorbent mass and gas performance at the same airflow; nominal dimensions and appearance are insufficient.

Product family	Construction and usual advantage	Limitation to address
Carbon roll media	Carbon-coated or carbon-loaded sheet, foam, or nonwoven supplied in rolls and cut to fit. Flexible and economical for suitable light-duty odor control. [6]	A thin flat pad may contain little carbon. Specify carbon coating weight separately from support weight and seal cut edges.
Pleated carbon products	Carbon-loaded sheet folded into a disposable panel. More sheet area within a given face size; some products also provide particle filtration. [9]	Gas capacity varies with loading and media area. Particle efficiency does not establish gas performance.
Mini-pleat impregnated products	Closely spaced carbon-loaded pleats in compact or V-bank filters. High media area; engineered products can carry substantial carbon mass. [7, 14]	Pleat count alone does not establish capacity. Verify carbon mass, shedding, target chemistry, and pressure drop.
Honeycomb loose-filled disposable filters	Granules retained in cellular packs, often arranged as panels or a V-bank. Provides contained bulk media and convenient module replacement. [8]	Verify full filling, retention, orientation, seals, and disposal provisions. These are distinct from carbon-coated or solid honeycombs.
Loose-filled cassettes	Enclosed modules holding granular or pelletized adsorbent. Supports target-specific media and staged systems; some designs are refillable. [10, 15]	Check bed geometry, packing, handling weight, dust control, sealing, and whether the exact cassette is disposable or refillable.
Loose-filled trays	Perforated reusable trays containing bulk sorbent. Media can be selected for the gas and renewed while retaining compatible hardware. [9]	Refilling adds labor and housekeeping. Prevent settling, uneven fill, channeling, and leakage around trays.

Two meanings of impregnated

Carbon-impregnated media commonly means carbon embedded in, bonded to, or coated onto a supporting sheet. **Chemically impregnated carbon** means carbon treated with a reagent to target particular gases. Loose-fill carbon can be chemically impregnated too. Specify the support construction and adsorbent chemistry separately. [2, 3, 6, 7, 14]

Do not assume all honeycomb products are loose-filled. Request a section drawing or construction description identifying whether the cells contain granules or the carbon is bonded into or onto the structure. [8, 9]

Carbon impregnated media versus loose fill

The comparison below describes common design tradeoffs. A heavily loaded engineered mini-pleat can differ substantially from a thin carbon pad. Neither family is inherently best for every application. [6-10, 14]

Selection factor	Carbon loaded sheet pleat or mini pleat	Loose granular or pellet media
Advantages	Compact; convenient replacement; immobilized carbon can reduce settling and dusting; may combine gas and particle filtration.	Allows substantial sorbent inventory, target-specific grades, and dedicated media stages; reusable trays or cassettes can retain hardware.
Disadvantages	Thin low-loading sheets may exhaust quickly; binder and support design affect access to carbon; spent disposable assemblies require replacement.	More handling mass and potential refill labor; fines, settling, channeling, and bypass must be controlled.
Capacity and service life	Depends on carbon loading multiplied by media area and the usable capacity for the gas. Some mini-pleats carry high carbon mass.	Often selected for higher loading or longer service; actual life still depends on grade, bed design, exposure, and outlet limit.
Airflow resistance	Often attractive where space and fan pressure are limited; obtain tested resistance at actual flow.	Depends on particle size, bed thickness, face area, and flow path; engineered large-area designs can limit resistance.
Cleanliness	Bonding may limit shedding; request evidence for sensitive processes.	Retaining screens and downstream particulate filtration may be needed according to product design.
Maintenance	Usually replace the complete pad, panel, or pack; some systems have replaceable elements.	Replace disposable modules or refill only approved reusable hardware using the specified media and filling procedure.

Contact with the media matters

Air must contact available adsorbent surfaces long enough to meet the removal objective. Media area, bed volume, air distribution, and adsorption kinetics all matter. For a granular bed, empty-bed contact time is bed volume divided by volumetric airflow; it is a design descriptor, not a universal performance guarantee. [10, 11]

A seal failure lets untreated air bypass either construction. Select compatible gasketing and retention hardware, seal the housing, and confirm that modules cannot move or leave an open path around the media.

Protect carbon from water and condensation

Wet carbon loses available gas removal capacity

If carbon gets wet, it can lose effectiveness for gas-phase contaminant removal. Water can occupy the pore space needed for physical adsorption, reducing available capacity for organic vapors. Liquid wetting is therefore an operating fault that must be evaluated, not a normal maintenance condition. [11, 12]

High relative humidity can also reduce VOC adsorption without visible droplets. EPA describes competition between water vapor and VOCs for adsorption space. The magnitude depends on carbon properties, the contaminant, concentration, and temperature; no single humidity cutoff applies to every medium. [11, 12]

Normal humidity and liquid wetting are different

Some chemically reactive media require or benefit from moisture in the air. Their published operating ranges may permit high relative humidity. That does not establish that a disposable assembly is washable or that liquid saturation leaves its performance unchanged. Follow the exact product limits for humidity, condensation, and liquid-water exposure. [2-4, 11]

A water-resistant frame or water-stable support is not proof of unchanged gas capacity when wet. The media chemistry and the mechanical assembly both need evaluation.

Control the moisture source

• Protect intake housings from rain, roof leaks, and water intrusion.

• Prevent cooling-coil carryover; maintain drainage and install suitable droplet control where needed.

• Locate the molecular stage where temperature and dew point do not produce condensation on or in the media.

• Keep carbon away from humidifier spray, steam carryover, coil-cleaning liquid, and washdown.

• Store replacement media sealed and dry as specified by the manufacturer.

Respond to a wet filter

Correct the water source and inspect the media, support, seals, and housing. This paper recommends replacing wet disposable pads, pleats, and packs unless the manufacturer provides an approved assessment and reuse procedure. Evaluate reusable cassettes and trays under the media supplier's instructions before returning them to service.

Do not assume air-drying regenerates spent carbon or restores its original gas capacity. Drying may remove moisture, but it does not establish removal of adsorbed contaminants, restoration of consumed reagent, or recovery of damaged media. Do not wash ordinary disposable HVAC carbon filters unless expressly permitted.

How long does carbon last

There is no reliable universal three-month, six-month, or annual life for carbon. Service ends when the required outlet concentration or removal efficiency can no longer be maintained, or when moisture, physical damage, or operating limits require replacement. Airflow, gas type and concentration, temperature, humidity, and media quantity all influence life. [10]

Weight is great: the more mass of carbon, the higher the service life of carbon. This principle applies when comparing the same suitable carbon grade under equivalent exposure, usable-capacity, contact, and breakthrough conditions. More usable mass generally provides more contaminant-holding capacity; it does not guarantee proportional life between different products.

Count **active adsorbent mass**, not total filter shipping weight. Frames, support fabric, binders, packaging, absorbed water, and previously captured contaminants add weight without establishing remaining capacity. For blends, identify the mass and role of each medium. [6, 8]

A simple mass balance

Estimated service hours = media mass x usable capacity / average captured contaminant mass per hour

Use consistent mass units. Usable capacity must correspond to the target gas and the chosen breakthrough endpoint under actual conditions. The captured load is based on airflow and the difference between inlet and outlet concentrations. This simplified estimate does not model mass-transfer limits, varying loads, or competing gases. [11, 12]

Illustrative assumption	Smaller carbon inventory	Larger carbon inventory
Same suitable carbon grade	2 kg	10 kg
Assumed usable capacity	0.05 g contaminant/g carbon	0.05 g contaminant/g carbon
Usable contaminant inventory	100 g	500 g
Average captured load	0.2 g/hour	0.2 g/hour
Calculated operating life	500 hours	2,500 hours
At 16 operating hours/day	About 31 operating days	About 156 operating days

These are calculated examples, not product ratings or typical service lives. The assumed 5% capacity is not a default design value. Five times the inventory gives five times the calculated life only because every other assumption is held constant.

What shortens useful life

Higher captured gas load, unsuitable chemistry, humidity effects, liquid wetting, increased temperature, inadequate contact, channeling, bypass, and competing contaminants can shorten or undermine service. A heavier filter with the wrong chemistry can perform worse than a properly selected lighter one. [10-12]

Specify performance and verify replacement timing

What to request from the supplier

1. Target contaminants, normal and peak concentrations, the required outlet limit, and whether the objective is comfort, corrosion control, or process protection.

2. Exact adsorbent grade and treatment; carbon source or type where relevant; and the amount of active media in each finished filter.

3. For sheets and pleats, carbon loading per unit media area, total media area, and total carbon mass. For loose fill, media mass, bed dimensions, particle size, and packing method.

4. Gas-specific initial removal and breakthrough data at stated airflow, challenge concentration, temperature, and humidity. Request relevant ISO 10121 or ASHRAE 145.2 evidence; particle MERV data alone are insufficient. [15]

5. Clean and expected operating pressure drop at design airflow, permitted operating range, and fan compatibility.

6. Limits for humidity, temperature, condensation, and liquid-water exposure; plus shedding, support, sealing, and handling requirements.

7. A service-life estimate stating its assumptions and endpoint, with a sampling or monitoring plan and replacement instructions.

Establish a measurable changeout trigger

Record the installation date, media grade and quantity, airflow, temperature, humidity, and baseline inlet/outlet gas concentrations. Use target-specific measurements or suitable remaining-life media analysis at intervals selected for the application. Set an action limit below the maximum acceptable outlet concentration. [10-12]

Pressure drop measures resistance, not remaining adsorption capacity. A carbon filter can pass gas while still appearing clean and maintaining normal airflow. Odor observations can identify a concern, but smell alone does not establish safe gas concentration or remaining life. [1, 11, 12]

Replace at the earliest applicable trigger: validated breakthrough or outlet action limit, insufficient remaining capacity, supplier operating limit, unacceptable resistance, wetting, or physical damage. For refillable hardware, remove spent media and refill to the specified grade, quantity, packing, and orientation; do not merely top off an exhausted bed.

Compare total cost over the service interval

Compare purchase cost, usable capacity, verified changeout frequency, fan energy, labor, disposal, and any reusable hardware. Thin pads may be appropriate for limited odor polishing; substantial or difficult gas challenges may justify engineered mini-pleat media, a loose-filled honeycomb module, or dedicated cassettes and trays. Select from demonstrated performance, not a universal ranking of constructions.

References and evidence notes

Sources reviewed October 19, 2026. EPA publications describe adsorption principles and limitations. Manufacturer literature establishes examples of media chemistry and product construction. No original filter testing was performed.

[1] US Environmental Protection Agency. Residential Air Cleaners A Technical Summary. Third edition, July 2018. Gas-phase media, finite capacity, source control, and limitations of particle ratings. Source

[2] Camfil. Impregnated Carbon for Acids. Manufacturer data sheet. Target gases include hydrogen sulfide, sulfur dioxide, nitrogen oxides, hydrogen chloride, and hydrogen fluoride. Source

[3] Camfil. Impregnated Carbon for Bases. Product information for ammonia and amines. Source

[4] Purafil. Purafil Select Media Product Bulletin. Permanganate-treated activated alumina; target gases, removal capacities, and operating humidity range. Source

[5] Camfil. Blends. Manufacturer descriptions of activated-carbon and reactive-media combinations for formaldehyde, sulfur gases, ozone, nitrogen dioxide, chlorine, and mixed contaminants. Source

[6] Permatron. Activated Carbon Media Specification Sheet. Carbon-coated roll media; separate polyester, carbon coating, and total product weights. Source

[7] MANN+HUMMEL. Carbon Mini Pleat Filters. Thin-line and V-bank products using carbon-impregnated polyester media; manufacturer carbon-mass listings. Source

[8] Filtration Group. AEROSTAR Purafilter Gas Phase Specification Information and product overview. Granular sorbent in honeycomb packs; media and shipping weights; disposable construction. Source

References and evidence notes continued

[9] Air Filters Inc. Activated Carbon Air Filters. Pleated carbon, flocked honeycomb, and refillable tray construction. Product descriptions are not universal performance guarantees. Source

[10] Camfil. CamCarb CM Cylindrical Molecular Filters. Media selection, vibratory packing to limit settling, service-life variables, and remaining-capacity analysis. Source

[11] US Environmental Protection Agency. Field Methods to Measure Contaminant Removal Effectiveness of Gas-Phase Air Filtration Equipment Phase 1. EPA-600/R-97-092, 1997. Sections on removal mechanisms, humidity, and velocity. Source

[12] US Environmental Protection Agency. Carbon Adsorbers, Air Pollution Control Cost Manual, seventh edition. Industrial adsorption design, working capacity, and moisture competition. These principles are not product-specific HVAC life ratings. Source

[13] Camfil. USA Product Catalog. Activated-carbon adsorption guide for selected organic vapors and limitations for carbon dioxide. Source

[14] Camfil. GigaPleat. Embedded adsorbents in pleated three-dimensional nonwoven media; carbon, ion-exchange, and chemically treated media options. Source

[15] Camfil. Molecular Filters. Construction families, media options, and manufacturer statement of ISO 10121 and ASHRAE 145.2 testing. Source

Application notes

The contaminant table identifies media to evaluate, not an engineered guarantee, exposure limit, or approved emergency-control design. Confirm performance for the exact finished filter, gas mixture, concentration, outlet criterion, flow, humidity, and temperature. Recommendations on wet-filter replacement and purchasing are maintenance guidance in this paper.

The mass-and-life statement applies to equivalent suitable carbon and comparable operating conditions. The numerical example is a simplified calculation with explicitly assumed usable capacity; it is not a forecast for a specific installation. Product construction and active-media loading can vary substantially within each family.