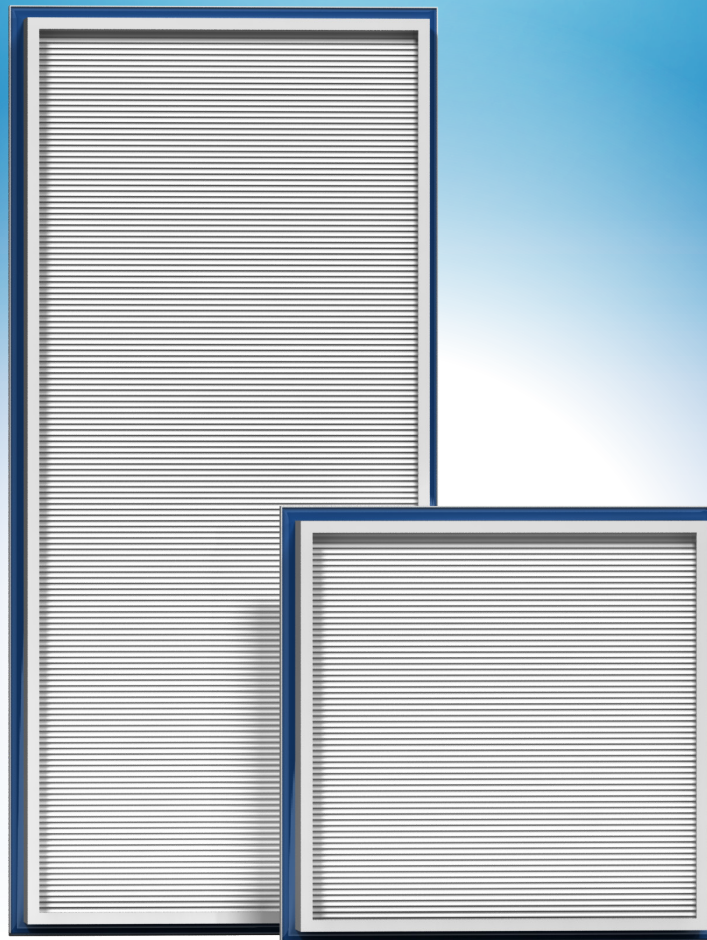




Vanguard

High Efficiency Filters



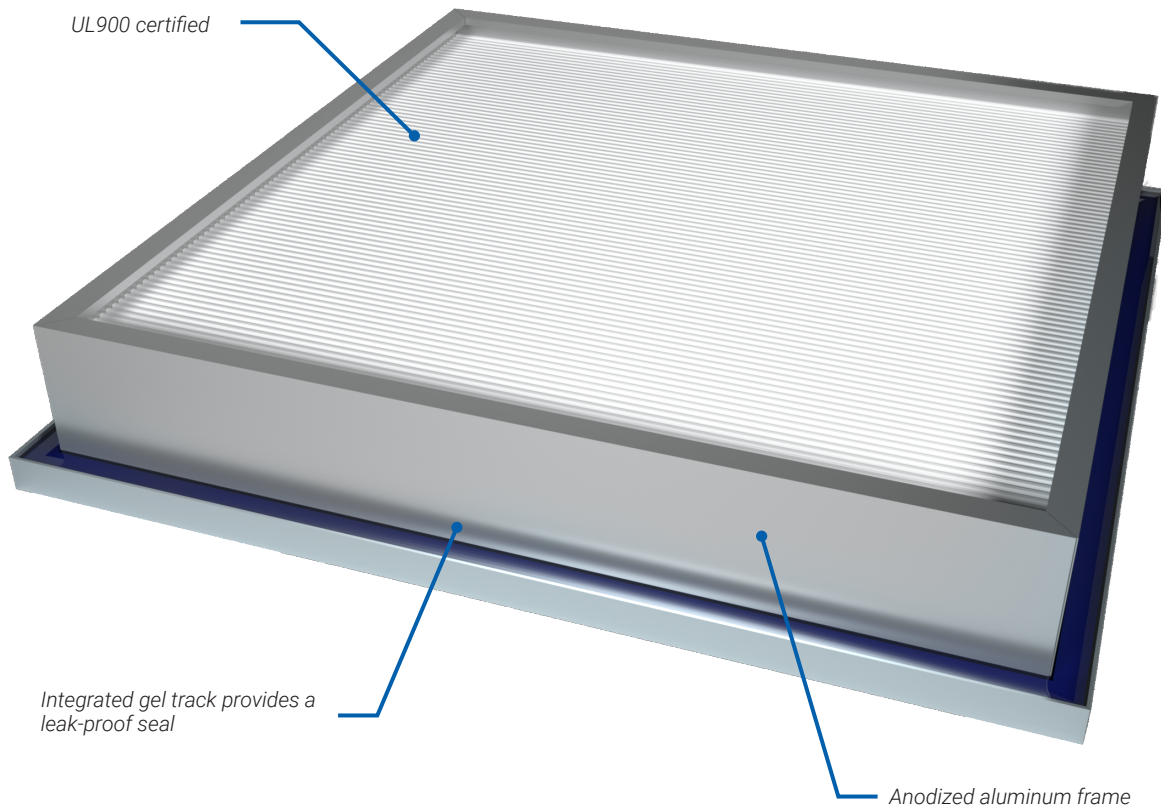
CATALOG

v002 – Issue Date: 03/20/26

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Vanguard High Efficiency Filters

High efficiency Vanguard filters are suitable for use in all Keystone® filtered products and are available in HEPA or ULPA efficiencies. Vanguard filters for current and legacy diffusers are in stock and available to ship with short lead times.



Filter Grades

HEPA

- Minimum efficiency of 99.99% when tested in accordance with IEST-RP-CC001.

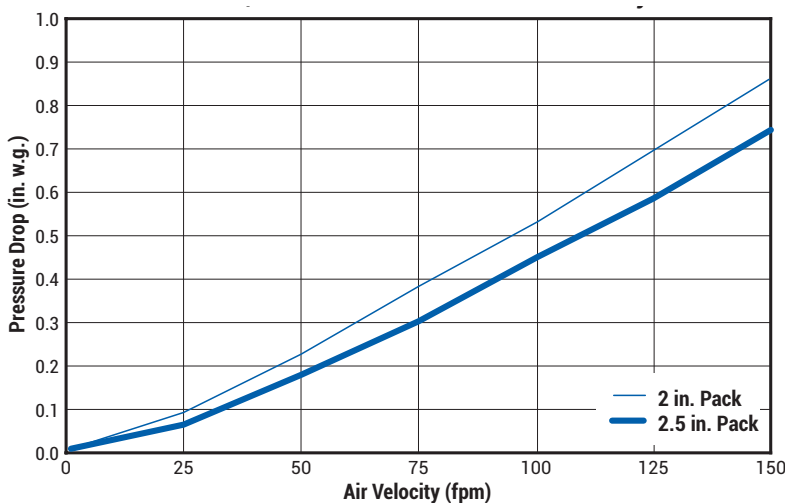
ULPA

- Minimum efficiency of 99.9995% when tested in accordance with IEST-RP-CC007.

Performance

- The use of pre-filters in the air-handler ductwork or diffuser is recommended to extend filter life.
- Filter replacement schedule is dependent on customer preference and room cleanliness. Filters are typically replaced when pressure drop exceeds 1.5-2.0x the clean filter pressure drop.

HEPA Filter Pressure Drop



Note: Pressure drop shown is factory maximum allowable at equivalent air flow based on effective filter media area.

TYPICAL APPLICATIONS

HEPA and ULPA filters are used where room cleanliness and contaminant control are of the utmost importance including cleanrooms, laboratories, microelectronics manufacturing, pharmaceutical compounding and protective environment isolation rooms.

CONSTRUCTION

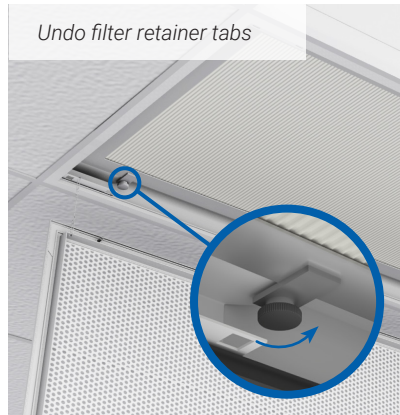
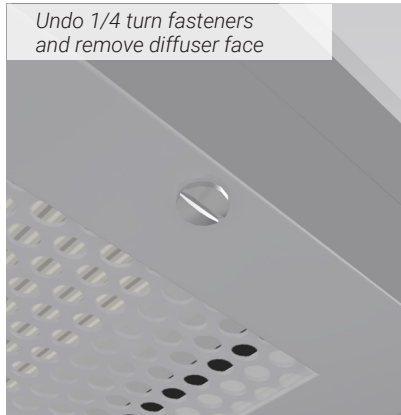
- Application
 - Room-side removable
 - Benchtop replaceable
- Efficiency
 - HEPA (99.99%)
 - ULPA (99.9995%)
- Depth
 - 2 in.
 - 2.5 in.

COMPATIBLE PRODUCTS

- Krown Fan Filter Series
- Aspire Laminar Flow Series
- Arc Radial Flow Series

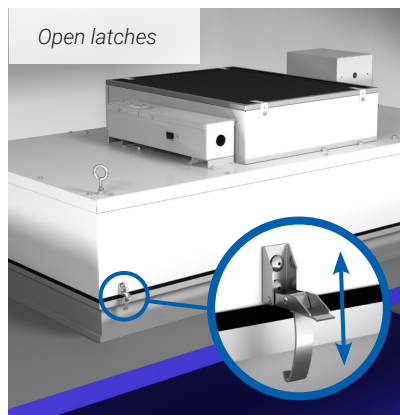
Room-side Removable Filters

- Room-side removable filters feature a self-healing gel track that works with the diffuser knife-edge to provide a leak-proof seal between the filter and housing while allowing for tool free installation and replacement from the room-side.



Benchtop Replaceable Filters

- Maximize active filter face area to allow for the highest airflow capacity.
- Less pressure drop and energy consumption compared to room-side removable filters.
- Filter replacement requires removal of the unit from the ceiling grid.
- Only available on supply style fan filter units.

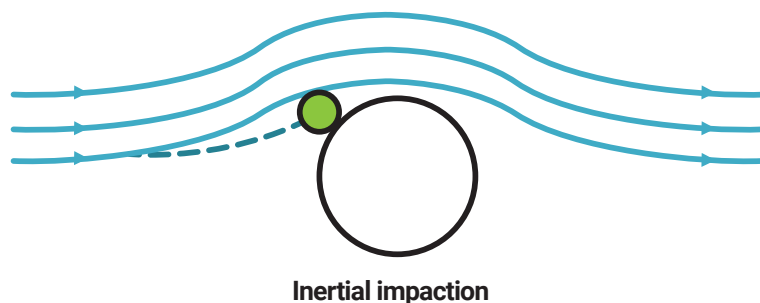


Filtration Mechanisms

HEPA filter media is a fibrous media that is typically made of borosilicate glass microfiber elements. Filter media is manufactured so that it creates a tight labyrinth of fibers, while maintaining a massive amount of free area. As air passes between and around the tightly wound fibers the velocity of the air decreases until the particles are ensnared by the glass fibers. There are four main mechanisms of HEPA filtration.

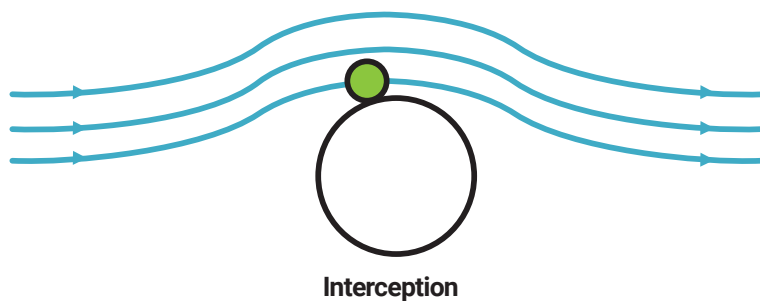
Inertial impaction

- Predominantly occurs on larger particles. Large particles have high inertia and as the air flows around the fibers, the particles continue along their trajectory and crash into the fibers instead of following the airstream.



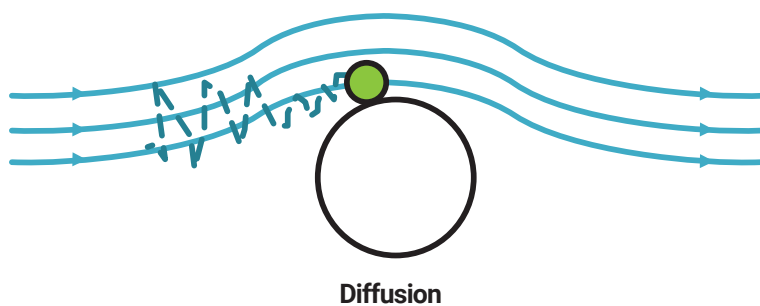
Interception

- Occurs when the airstream carries particles within one radius of the fiber, causing a collision between the particle and the fiber, and trapping the particle in place.



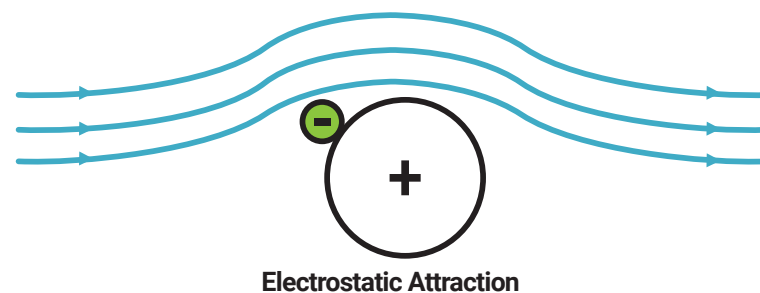
Diffusion

- Affects very small particles; $0.1\ \mu\text{m}$ and under. Small particles continually bump into each other as they travel through the air, causing for a very chaotic or random zigzagging path. This motion is referred to as Brownian motion. Brownian motion causes particles to collide with fibers and become trapped.



Electrostatic Attraction

- Occurs when particles are attracted to the fibers by electrostatic adhesion. In HEPA filters, this mechanism contributes the least to the efficiency of the filter.



Particle Size and Efficiency

With an efficiency rating indicating a Most Penetrating Particle Size (MPPS), a common misconception is that HEPA and UPLA filters do not remove particles smaller than the MPPS. This is untrue because HEPA filters do not act like a sieve where particles above a certain size are prohibited from flowing through while smaller particles are allowed to pass through, but rather use the four aforementioned mechanisms of filtration to trap particles of varying sizes.

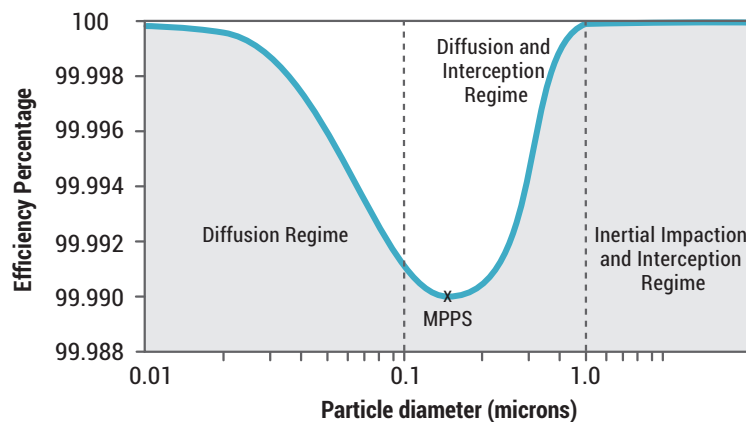
- Filtration efficiency percentage is a function of the ratio of upstream particle concentration compared to the downstream concentration that has passed through the filter and is defined by the equation below.

$$\text{Percent Efficiency} = \left[1 - \frac{\text{Downstream Concentration}}{\text{Upstream Concentration}} \right] \times 100$$

- Filter performance is sometimes displayed as penetration percentage instead of percent efficiency. Like efficiency, penetration is also a function of upstream particle concentration compared to downstream concentration that has passed through the filter and is defined by the equation below.

$$\text{Penetration Efficiency} = \left[\frac{\text{Downstream Concentration}}{\text{Upstream Concentration}} \right] \times 100$$

- Percent efficiency is the minimum filtration efficiency. Large particles are removed by interception and inertial impaction while smaller particles are removed via diffusion, resulting in the lowest filter efficiency in the median size particle range. Comparing filter efficiency percentage to particle size clearly indicates that median sized particles are the most penetrating particle size (MPPS), as shown on the graph below.



- HEPA and ULPA filtration rely on airflow to be effective, thus airflow rate has an effect on filter performance. A change in airflow rate shifts the filter efficiency curve and alters the MPPS. For expected filtration results and efficiency it is important to always follow the manufacturers recommendations for airflow.
- Airflow direction does not affect the efficiency of HEPA or ULPA filters, thus the same filter can be used for either supply or exhaust airflow devices.



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