O2 Armor Nose Filter Performance & Mechanics

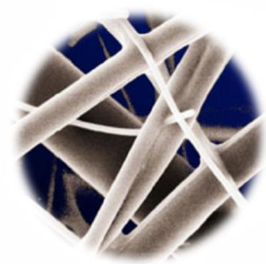
Concealed Filtration

Introduction

Non-electrostatically charged filters (mechanical filters) rely on physical phenomena like inertia, velocity, and collision to capture airborne particles. Particles in the air have to "run into" filter fibers on a one-dimensional surface to become successfully tethered to the filter fibers. When tested against electrostatically charged filters, known as "electret media", these factors can lead to a decrease in mechanical filters' performance.[1] Electrostatic filtration technology is analogous to how a magnet attracts iron particles. Somewhat surprisingly, due to principles of electrostatics, electret filter performance is enhanced as its mechanical properties are enhanced, when particles adhere to charged filter fibers, enlarging the fibers' surface area. This enlarged "charged" surface area continues to attract particulates as they encounter the filter media.[2] Airborne particles that transport viruses and bacteria, referred to by academia as "droplet nuclei", are typically composed of the pathogen itself enveloped in sneeze or cough droplets.[3,7] Average sizes for human-produced droplet nuclei are between 0.5 to 12 microns in diameter.[4,5] O2 Armor's use of 3M's patented AEM (Advanced Electret Media) provides users of its nasal filtration products up to 99% protection from airborne contaminants, including viruses and air pollution. [6]

Measuring Filtration Efficiency

Filter performance, or efficiency, is expressed in percentage terms and enumerates the relationship between particle size, particle concentration, and velocity. O2 Armor's products filter performance is verified by 3M testing and LMS Technologies, Inc. Filter performance data is listed in Figure 3. The ability of charged filter fibers to attract and hold sub-micron particulates offsets the necessity for dense filter construction, allowing good airflow without compromising particle capture. Hence, AEM filters are an appropriate use for personal nasal filter devices.



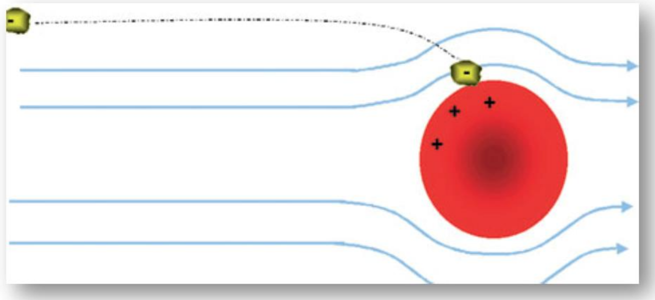
Capture Ratios

3M 's patented AEM™ (Advanced Electret Media) filter technology relies on the principles of electrostatic attraction[1], or the creating of electrical charges on filaments, to produce ionically charged filter fibers constructed in a 3- dimensional format. The high capture ratios and extended breathability attributed to 3M's AEM filters are due to the fibers' high charge, uneven charge distribution, and less dense media construction, allowing airborne particles to be captured within the filter throughout several layers of media. Because the charged filter fibers act as "magnets" and not merely "walls" to attract and secure airborne particulates, the less dense format of fiber filters does not adversely impact the filter's ability to retain particulates—especially in the <5-micron size range. **This design is the first and only personal nasal insert available with 3M AEM filtration technology.**

Applications

Common applications of 3M's patented Advanced Electret Media filter technology include pulmonary units within healthcare institutions, HVAC systems, and air cabin filtration.

Electrostatic Attraction



Hazardous Dust Particles
Smaller dust particles can be hazardous for humans. In many jurisdictions dust fractions at specified particle sizes in working environments are required to be measured.

Inhalable Dust
Airborne particles which can enter the nose and mouth during normal breathing. Particles of 100 microns diameter or less.

Thoracic Dust
Particles that will pass through the nose and throat, reaching the lungs. Particles of 10 microns diameter and less. Referred to as PM_{10} in the USA.

Respirable Dust
Particles that will penetrate into the gas exchange region of the lungs. A hazardous particulate size less than *5 microns*. Particle sizes of *2.5 micron ($PM_{2.5}$)* are often used in USA.

The total allowable particle concentration – building materials, combustion products, mineral fibers and synthetic fibers (particles less than 10 μm) – specified by EPA (U.S. Environmental Protection Agency)

- 50 $\mu g/m^3$ (0.000022 $grain/ft^3$) – allowable exposure per day over the course of 1 year
- 150 $\mu g/m^3$ (0.000022 $grain/ft^3$) – allowable exposure over 24 hours

The Condensation Effect
All airborne contaminates can be expected to, dependent on condition, take on some water vapor. This condensation effect, more prevalent at high humidity, can continue until contaminates trapped in the water, now a fog, mist or larger droplets, fall to the earth. The very smallest particulates, when trapped in water, take on H_2O increasing their perceived size by minimally 80% and as much as 1000% or even more dependent on conditions; as an example, a 2.5 μm size particle dry will be filtered wet at approximately 4.5 μm minimum in size or larger. The amount of water that condenses on any one or group of particles is dependent on size and is as variable as the weather conditions. This process significantly increases the effectiveness of the 3M filtration material by enlarging the size of particles that otherwise would pass through more easily.

This same process also increases the effectiveness of the 3M filtration material with viruses and other airborne pathogens. Airborne viruses and bacteria (2 μm and larger wet) need moisture to live; airborne infection is dependent on moisture. Viruses and bacteria are released into the air in water droplets, normally in groups larger than a single virus (droplet sizes as described above) and either quickly fall to the ground, take on more water, or begin to dry, dependent on conditions.

Filtration Efficiency vs.

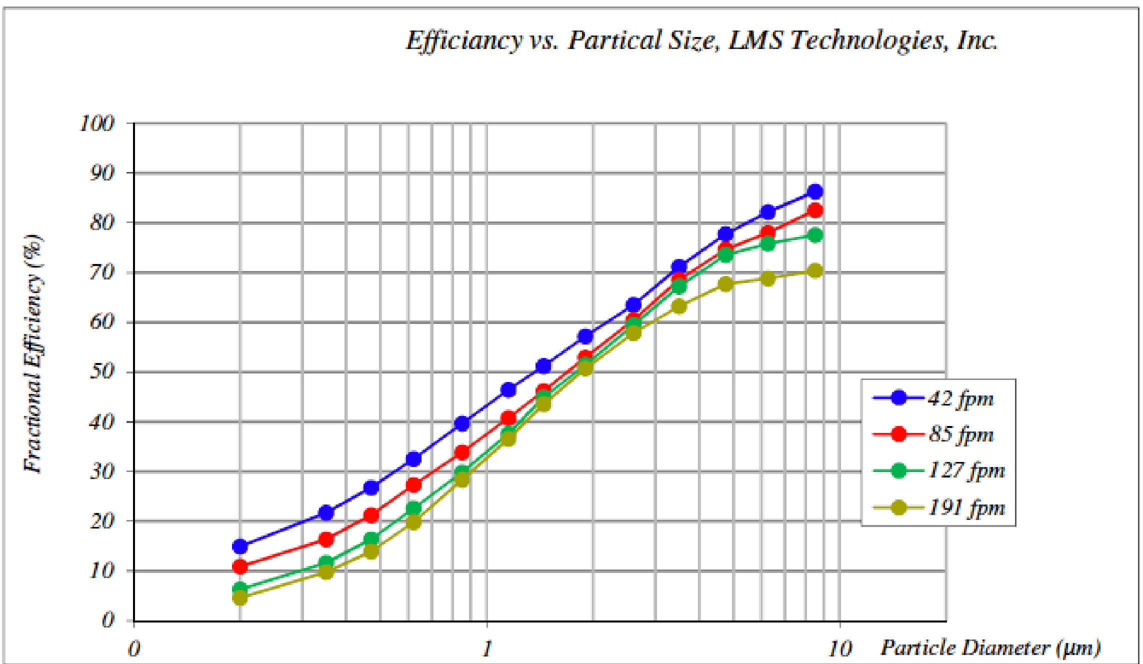
Particle Size - LMS Technologies, Inc., Bloomington, MN – Fractional Efficiency, modified - ANSI / ASHRAE 52.2*

Test Samples: 3M GSU – 20, $10g/m^2$ PP, spun-bound, plus $20g/m^2$ electret fiber, bipolar charged

Purpose: Obtain independent 3rd party filtration efficiency vs particle size data. Compare a wide range of common airborne particulates.

* Test modifications made to test fixtures, procedures and analysis are ANSI recommended for low flow applications. Air flow (face velocities) modeled human nasal breathing during common tasks.

Results: Data verified by LMS Calibration Filter* Patent Pending



3M Filter Performance Test Results

3M™ Air Filter Media Type G

PTI ISO 12103-1, A2 Fine Test Dust was used to challenge filter media in a test duct using a test similar to SAE J1669.

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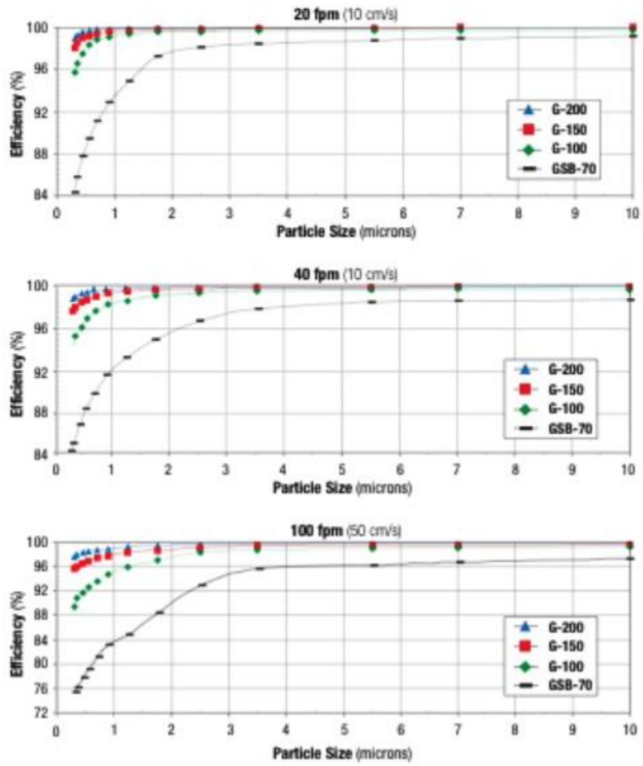
Efficiency vs. Particle Size



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Particle Sizes

The size of contaminants and particles are usually described in microns, a metric unit of measure where one micron is one-millionth of a meter. There are 25400 microns in one inch. The eye can see particles to about 40 microns. The size of some contaminants and particles are indicated in the table below. When airborne, The Condensation Effect significantly increases the typical size of most particles. The sizes in the following chart are the "Dry" Particle size. The very smallest particulates, when trapped in water, take on H_2O increasing their perceived size by minimally 80% and as much as 1000% or even more dependent on conditions; as an example, a 2.5 μm size particle dry will be filtered wet at approximately 4.5 μm minimum in size or larger.

Particle	Dry Particle Size *(microns)*
one inch	25400
dot (.)	615
Eye of a Needle	1230
Glass Wool	1000
Spanish Moss Pollen	150 – 750
Beach Sand	100 – 10000
Mist	70 – 350
Fertilizer	10 – 1000
Pollens	10 – 1000
Cayenne Pepper	15 – 1000
Textile Fibers	10 – 1000
Fiberglass Insulation	1 – 1000
Grain Dusts	5 – 1000
Human Hair	40 – 300
Dust Mites	100 – 300
Saw Dust	30 – 600
Ground Limestone	10 – 1000
Tea Dust	8 – 300
Coffee	5 – 400
Bone Dust	3 – 300
Cement Dust	3 – 100
Ginger	25 – 40
Mold Spores	10 – 30
Starches	3 – 100
Red Blood Cells	5 – 10
Mold	3 – 12
Mustard	6 – 10
Antiperspirant	6 – 10
Textile Dust	6 – 20

Particle	Dry Particle Size *(microns)*
Gelatin	5 – 90
Spider web	2 – 3
Spores	3 – 40
Combustion-related – motor vehicles, wood burning, open burning, industrial processes	up to 2.5
Fly Ash	1 – 1000
Milled Flour, Milled Corn	1 – 100
Coal Dust	1 – 100
Iron Dust	4 – 20
Smoke from Synthetic Materials	1 – 50
Lead Dust	2
Face Powder	0.1 – 30
Talcum Dust	0.5 – 50
Asbestos	0.7 – 90
Calcium Zinc Dust	0.7 – 20
Paint Pigments	0.1 – 5
Auto and Car Emission	1 – 150
Metallurgical Dust	0.1 – 1000
Metallurgical Fumes	0.1 – 1000
Clay	0.1 – 50
Humidifier	0.9 – 3
Copier Toner	0.5 – 15
Liquid Droplets	0.5 – 5
Insecticide Dusts	0.5 – 10
Anthrax	1 – 5
Yeast Cells	1 – 50
Carbon Black Dust	0.2 – 10
Atmospheric Dust	0.001 – 40
Bacteria	0.3 – 60
Radioactive Fallout	0.1 – 10
Burning Wood	0.2 – 3
Oil Smoke	0.03 – 1
Tobacco Smoke	0.01 – 4

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2) ASHRAE Report: Investigation of Mechanism and Operating Environments that Impact the Filtration Efficiency of Charged Air Filtration Media, 1189-TRP.

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5) Yang, Shinhao, Lee, Grace, W.M., Chen, Cheng-Min, Wu, Chih-Cheng, Yu, Kuo-Pin. 2007. The size and concentration of droplets generated by coughing in human subjects. Journal of Aerosol Medicine 20: 484-494.

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