

Air Filtration Technology

Presented by:

MIRZA ADNAN

Area Manager Sales
MIA CORPORATION (PVT) LTD



ASHRAE

ASHRAE Application Handbook-Chapter 28: **Air Cleaners for Particulate Contaminants**

ASHRAE Standard 52.1: Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices

ASHRAE Standard 52.2: Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

Contents

- 1. What is Air Filtration.**
- 2. Source of Containmantion**
- 3. Particle Sizes and Size Distribution.**
- 4. Physics of Air Filtration Technology.**
- 5. Filter Terminology.**
- 6. Filter selection criteria**

What is Filtration ??

Filtration: Mechanical or physical operation use for separation of solids from fluids

Not to confuse **filtration** with **sieving**

Sieving – Single layer of medium involved

Filtration – Multilayer of medium involved

Source of Containmantion

Basically, there are three major types of contaminant:

- **Solid particle**
- **Liquid particle**
- **Gaseous (Molecules)**

Solid Particulate Contaminants

Natural and man-made dust, fumes, smoke

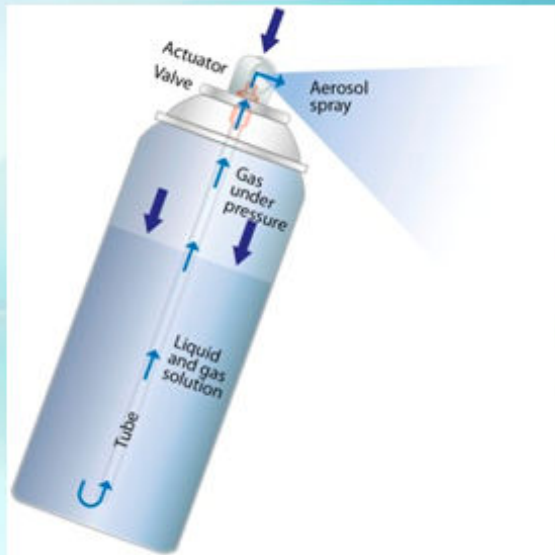
- Synthetic and natural lint
- Fungal spores and pollen
- Bacteria and virus
- Silicates (sand)
- Fly ash
- Carbon dust
- Oil and tobacco smoke



Liquid Particle Contamination

Includes contaminated and suspended liquids

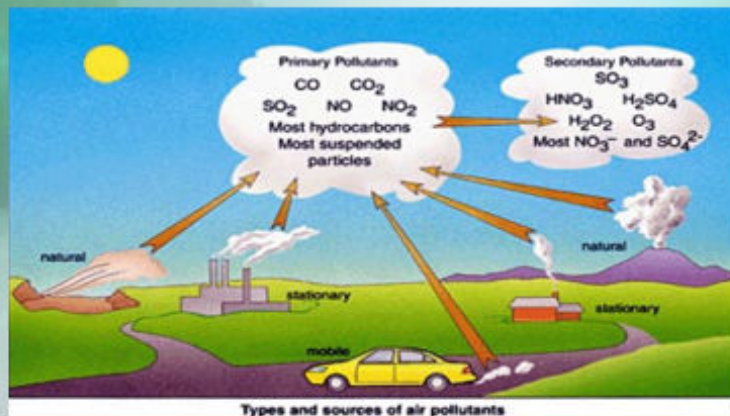
- Aerosols
- Mist and fogs



Gaseous (Molecules) Contamination

Includes contaminated and suspended liquids

- Ozone
- Sox and Nox
- NH₃ and amines
- Mineral acids
- Condensable hydrocarbons and silicones
- Organo-phosphates, arsenates, solvents



Particle Sizes and Size Distribution



How Small is a Micron?
1 Micron = 1/25,400 of an inch

318 Human Hairs	= 1 inch
Head Pin	= 1500 microns
84,667 Smoke Particles	= 1 inch
33 Smoke Particles	= 10 microns
	(smallest size visible with naked eye)

Figure 1

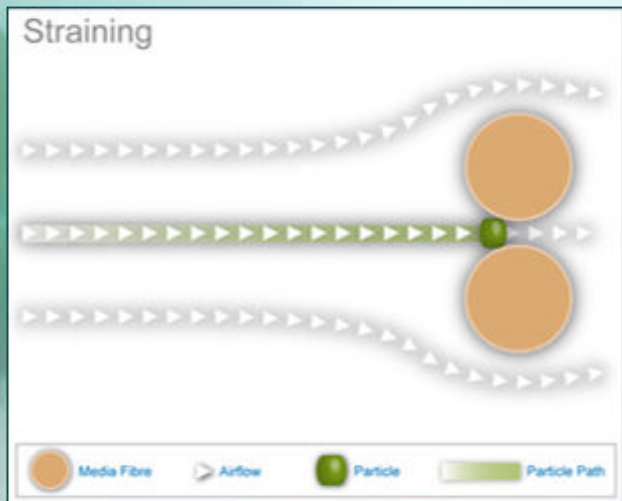
Physics of Air Filtration

There are 6 basic physical phenomena

- **Sieving / Straining**
- **Inertial separation**
- **impingement / Impaction**
- **Interception**
- **Diffusion**
- **Electrostatic charged filtration**

Physics of Filtration Technology

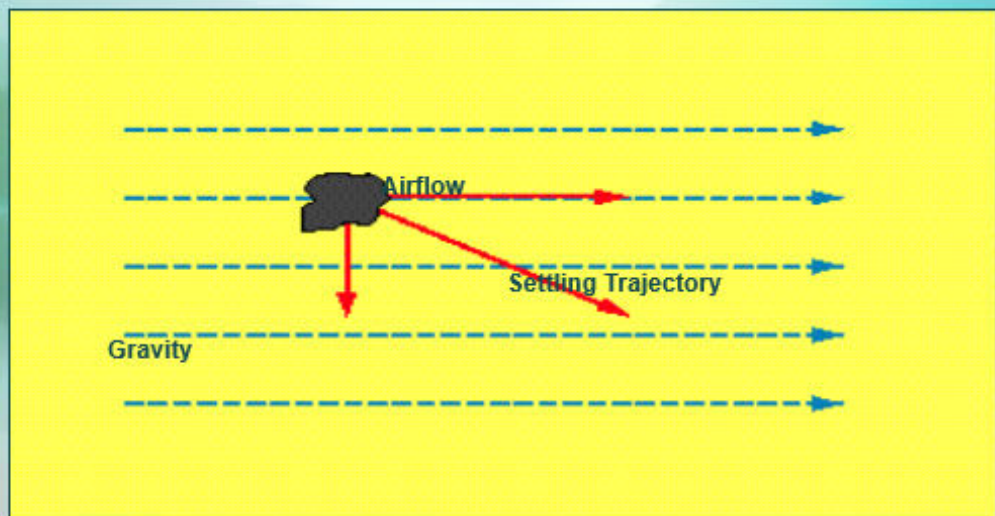
Sieving / Straining



Physics of Filtration Technology

Inertial separation

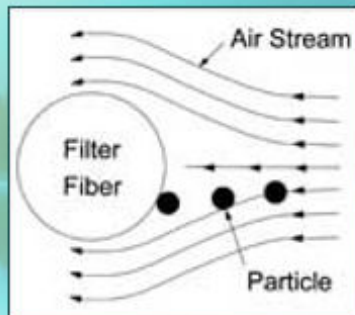
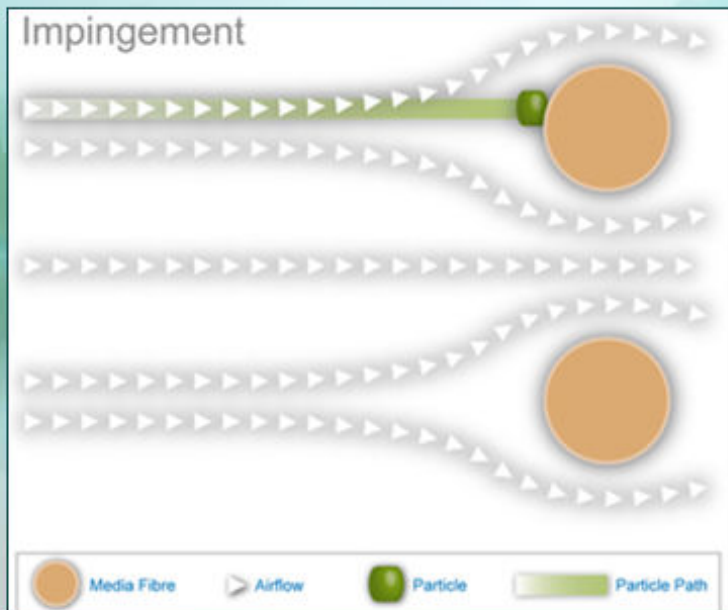
- by gravitational forces



Physics of Filtration Technology

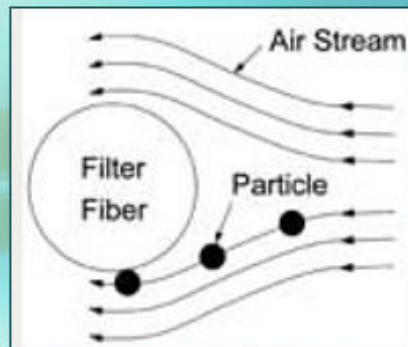
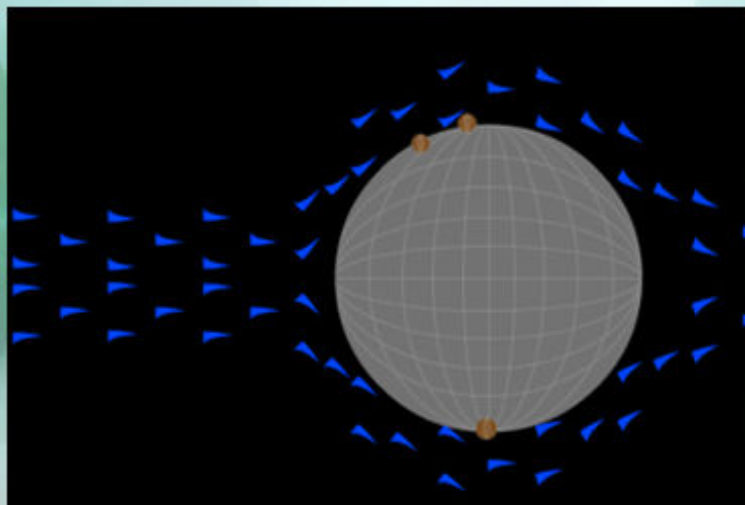
Impingement / Impaction:

- Colliding (impinging) and sticking to filter media



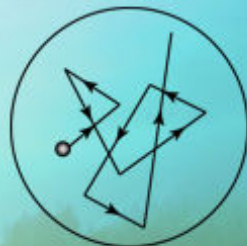
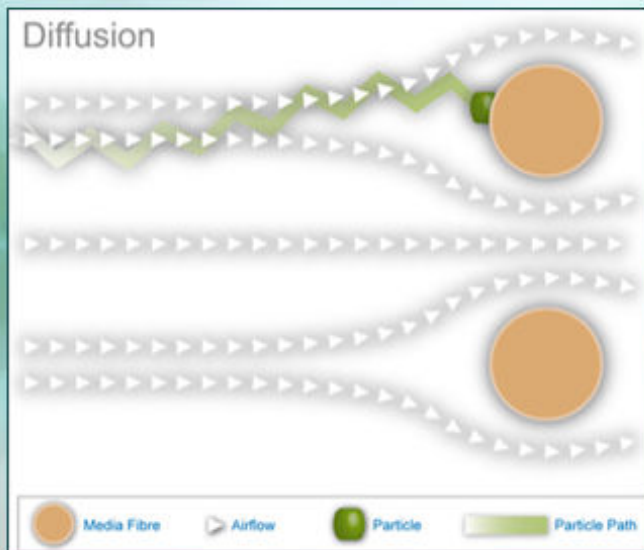
Physics of Filtration Technology

Interception

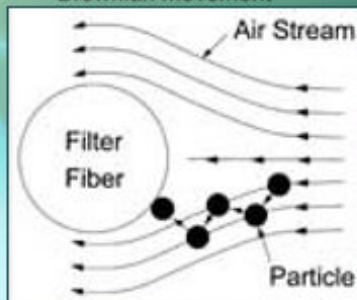


Physics of Filtration Technology

Diffusion



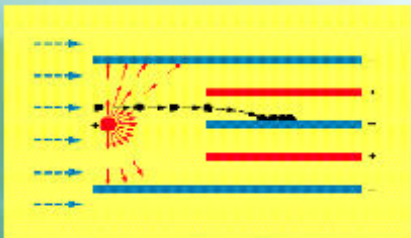
Brownian Movement



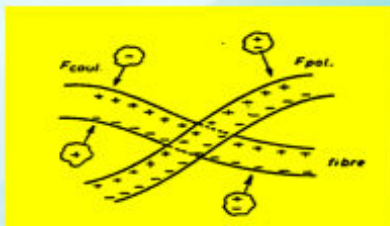
Physics of Filtration Technology

Active electrostatic charged filtration

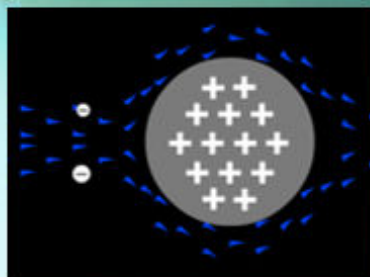
- Oppositely charged plates & viscous adhesive coating



Active Electrostatics
Charged Filtration

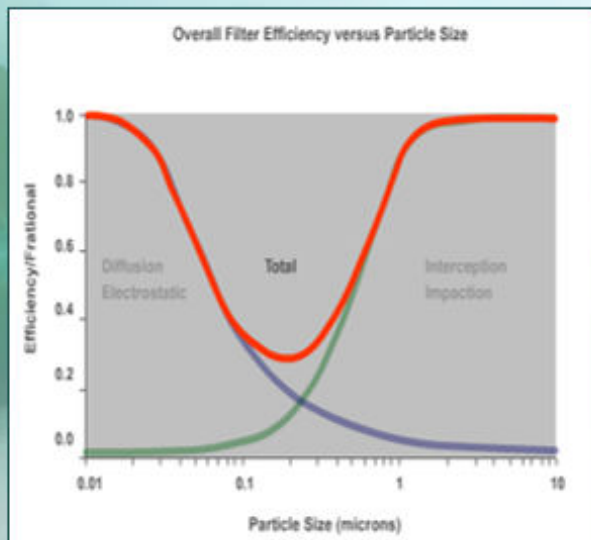


Passive Electrostatics Charged Filtration



Use for tobacco smoke, welding fumes and oil mist

Physics of Filtration Technology



- Large particles above $0.4 \mu\text{m}$, **Impaction and Interception** (Coarse filter)
- Small particles, below $0.1 \mu\text{m}$, **Diffusion and Electrostatics** (HEPA filter)
- Medium particles, the 0.1 to $0.4 \mu\text{m}$, **All four mechanisms.** (Medium Efficiency filter)

Filter Terminology

1. Filter Pressure Drop
2. Dust Holding Capacity
3. Arrestance
4. EN 779
5. Efficiency
6. EN 1822

Filter Pressure Drop

- Filter provide resistance to airflow
- Initial resistance: Resistance of clean filter at specified airflow (example: 2000 cfm @ 1" w.g.)

Dust Holding Capacity (DHC)

- Amount by weight of standard dust that the filter will hold until it reaches the final resistance

Arrestance

- Ability of an air filtration device to remove synthetic dust.
- The arrestance describes how well filter removes larger particles such as dirt, lint, hair, and dust.

EN 779

Filter Class	Average Arrestance of Synthetic Dust (%)	Average Efficiency of 0.4 micron (%)
G1	$50 \leq Am < 65$	-
G2	$65 \leq Am < 80$	-
G3	$80 \leq Am < 90$	-
G4	$90 \leq Am$	-
F5	-	$40 \leq Em < 60$
F6	-	$60 \leq Em < 80$
F7	-	$80 \leq Em < 90$
F8	-	$90 \leq Em < 95$
F9	-	$95 \leq Em$

Efficiency

- The efficiency describes how well an air filter removes ***microscopic particles*** such as dust, dust mites, pollen, mold, bacteria, and smoke
- Filter efficiency is the ratio of particles trapped by a filter over the total number of particles found in the air upstream of the filter

$$\frac{\text{(Particles Trapped / Particles Upstream)} \times 100}{\text{Filter Efficiency}}$$

EN 1822

Filter Class	Overall Efficiency (%)	Penetration (%)
H10	85	15
H11	95	5
H12	99.5	0.5
H13	99.95	0.05
H14	99.995	0.005
U15	99.9995	0.0005
U16	99.99995	0.00005
U17	99.999995	0.000005

What are the criteria in your filter selection?

Criteria In Choosing The Right Filter:

1. Identify the stage/type of filter: Pre / Secondary / Semi-Hepa @ Hepa
2. Filter Efficiency.
3. Sustainable Air Flow.
4. Low IR for Low Operating Cost.
5. Filter Size (Surface Area & Construction).
6. Filter Price

Identify The Stage/Type of Filters

• Pre-Filter → Secondary Filter → Hepa Filter

• Pre-Filter:

- To filter large particles (particle size $> 10\mu\text{m}$).
- It is usually measured in terms of (% Arrestance)

• Secondary & Hepa Filter:

- To filter microscopic/micron sized particles (particle size range from $0.1\mu\text{m}$ to $10\mu\text{m}$).
- It is usually measured in terms of (% Efficiency)

What are the criteria in your filter selection?

Criteria In Choosing The Right Filter:

1. Identify the stage of filtration: Pre / Secondary / Semi-Hopa @ Hops
2. Filter Efficiency
3. Sustainable Air Flow
4. Low IR for Low Operating Cost
5. Filter Size (Surface Area & Construction)
6. Filter Price

Identify Filter Efficiency

Coarse Filters (G Class)	Filter Type		EN 779 CLASS	ASHRAE 52.2	
	Gas Phase		G1	Am < 65	MERV 1
	Permanent Metal Filters		G2	65 ≤ Am < 80	MERV 2-4
	Washable Filters				
	Media Pads & Rolls				
	Gas Phase		G3	80 ≤ Am < 90	MERV 4-5
	Permanent Metal Filters				
	Washable Filters				
	Disposal Panel Filters				
	Supported Pocket Filters		G4	90 ≤ Am	MERV 6-7
Media Pads & Rolls					
Washable Filters					
Disposal Panel Filters					
Disposal Pleated Filters					
Supported Pocket Filters					
Media Pads & Roll					

Panels

← G1 – G4 Class (EN 779) →



METAL FILTER



PLEATED
WASHABLE
FILTER



SUPPORTED
POCKET
FILTER

DISPOSABLE
PLEATED
FILTER

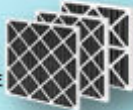


FILTER MIDEA
ROLL



MIDEA PAD 8

GA S PHASE



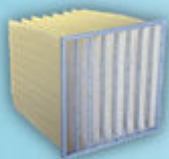
Identify Filter Efficiency

Fine Filters (F Class)

Internal Wire Frame Ring Panel Filters		F5	$40 \leq Em < 60$	MERV 8-11
Disposal Panel Filters				
Washable Filters				
Disposal Pleated Filters				
Non-Supported Pocket Filters				
Box Style Filters		F6	$60 \leq Em < 80$	MERV 11-12
Media Pads & Rolls				
Supported Pocket Filters				
Non-Supported Pocket Filters				
Box Style Filters		F7	$80 \leq Em < 90$	MERV 13-14
Mini-Pleat Filters				
Supported Pocket Filters				
Non-Supported Pocket Filters				
Box Style Filters		F8	$90 \leq Em < 95$	MERV 14-15
Mini-Pleat Filters				
Gas Phase				
Supported Pocket Filters				
Non-Supported Pocket Filters				
Box Style Filters		F9	$95 \leq Em$	MERV 15-16
Mini-Pleat Filters				
Cartridge/Cylindrical Canister				
Box Style Filters				
Mini-Pleat Filters				

Deep Pleats & Bags

F5 – F9 Class (EN 779)



Non Supported pocket Filter



Box style Filter



MINI PLEAT FILTER



MINI PLEAT FILTER



Disposable Pleated Filter



Disposable Pleated Filter

Mini-Pleated

F5 – F9 Class (EN 779)



MINI PLEAT FILTER



Gas phase



MINI PLEAT FILTER



Identify Filter Efficiency

HEPA & ULPA Filters (H & U Class)	Filter Type		EN 1822 CLASS	TEST RP-CC-001.3
			$E_{\%@0.3\mu m}$	$E_{\%@0.3\mu m}$
			$E_{\%@MPPS}$	$E_{\%@0.3\mu m}$
	Box Style Filters		≥95	
	Mini-Pleat Filters		≥98	
	Box Style HEPA Filters		≥99.95	TYPE C
	Mini-Pleat HEPA Filters		≥99.99	TYPE C
	Ceiling Module/HEPA Filters			
	Box Style HEPA Filters			
	Mini-Pleat HEPA Filters		≥99.999	TYPE D
	Ceiling Module/HEPA Filters			
	Box Style HEPA Filters			
	Mini-Pleat ULPA Filters		$E_{\%@0.12\mu m}$	$E_{\%@0.12\mu m}$
	Ceiling Module/ULPA Filters		≥99.9995	TYPE F
	Mini-Pleat ULPA Filters		≥99.99995	TYPE F
	Ceiling Module/ULPA Filters		≥99.999995	TYPE F
	Mini-Pleat ULPA Filters		≥99.999995	TYPE F
	Ceiling Module/ULPA Filters		≥99.999995	TYPE F

HEPA / ULPA Filters

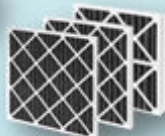
H10 – U 17 (EN 1822)



Gas-Phase Filtration



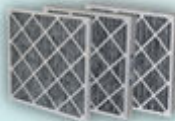
FLAT
FILTER



Carbon Pre
Filter



Front & Side
Access
Housings



Carbon Pre
Filter



Box Filter



Carbon filter
Cassettes
& Media



DEEP PLEATS FILTER



AIR PURIFIER

What are the criteria in your filter selection?

Criteria In Choosing The Right Filter:

1. Identify the stage of filtration: Pre / Secondary / Semi-Hepa @ Hepa
2. Filter Efficiency
3. Sustainable Air Flow
4. Low IR for Low Operating Cost
5. Filter Size (Surface Area & Construction)
6. Filter Price

Identify Filter Size (W x H x D)

Pre or **Secondary Filter** will use either Nominal or Actual Size

Nominal Size will be indicated in unit (inches)

Actual Size will be indicated in unit (mm)

- Plastic frame (width (W) & height (H) - 18mm)
- Metal Frame (width (W) & height (H) - 16mm)

Hepa Filter will ONLY use Actual Size (mm)

Depth (D): 1"(22mm), 2"(44mm), 4"(95mm), 6"(149mm),
12"(292mm)

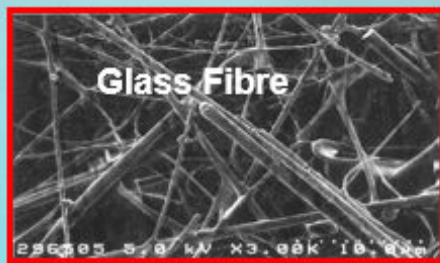
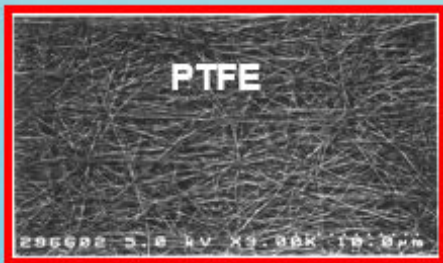
FILTER PRICE



Disposable Filter

PTFE Filter (Poly-Tetra-Fluoro-Ethylene) – SEM Microscopic Diagram

PTFE membrane has smaller pore size and fiber diameter than glass media. These characteristics combine maximum efficiency with lowest pressure drop



	PTFE Media	Glass Fiber Media
Average pore size	0.7 μm	3.0 μm
Fiber diameter	0.05 - 0.2 μm	0.5 - 1.0 μm

Durability



Chemical resistance means
no media degradation from
alkaline, acid and organic
substances

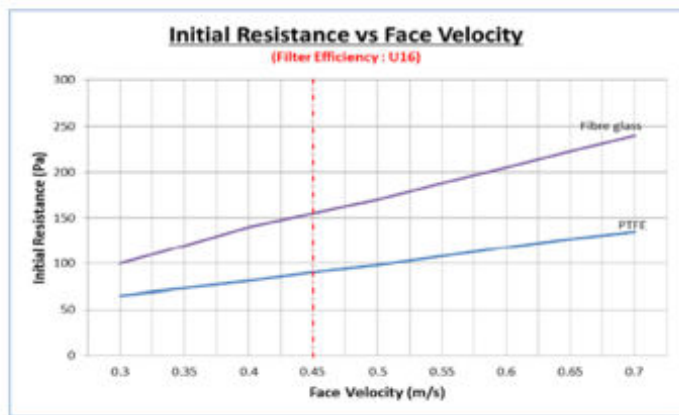
PTFE is not damaged by Hydrogen
-Flouride

The Glass Fiber ULPA media is
damaged by Hydrogen-Flouride

Pressure Drop vs Face Velocity

Technical Experiment - PTFE vs Fibreglass 2014.pdf - Adobe Reader

PTFE vs Fibreglas Initial Pressure Drop



PTFE vs Fibreglas Power Consumption

Power Consumption vs Face Velocity

Filter Testing TECHNOLOGIES

Auto Scanner



- Auto Scan applicable for leak testing, efficiency, pressure drop, air velocity distribution testing and failure analysis

ASHRAE Test Duct



- ASHRAE 52.1 Test duct
- Test duct applicable for filter efficiency and dust holding capacity (DHC) test

Din Scan Machine Facilities



- DIN Scan applicable to perform visual smoke testing



THANK YOU