Kimberly-Clark
Filtration Products

HVAC Filtration 101

Basics of HVAC Filtration

What is HVAC?

- Heating, Ventilation, and Air Conditioning (HVAC) is also known as comfort air conditioning. It describes "the process of treating air to control simultaneously its temperature, humidity, cleanliness, and distribution to meet the comfort requirements of the occupants of the conditioned space."[1] That space may be an office, school, hospital, factory, residence, or other human occupied space.
- HVAC filtration is the primary process of ensuring the cleanliness of this conditioned air.

1997 ASHRAE Fundamentals Handbook

Principles of Filtration

- Filtration is the process of separating or removing contaminants from a fluid stream; For the purpose of this presentation, the fluid stream is air.

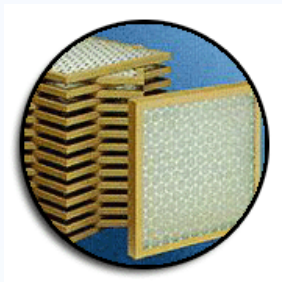
- Many processes are involved in capturing and removing contaminants. These processes are discussed in more detail in the presentation ***Filtration 101*** in the Resource Center on our Web site at www.kcfiltration.com.

Types of HVAC Filters

- Impingement Filters
- Extended Surface Filters
- Gas Phase Filters
- Electronic Air Cleaners
- HEPA & ULPA Filters

Impingement Filters

- Impingement filters are generally low cost filters designed to remove coarse contaminants from the air
- Common impingement filter types are
  - Panel filters (aka: throwaway filters)
  - Roll media filters



- Impingement filters typically employ a single, deep bat of spunglass, coarse synthetic fiber, or foam media for particle capture
- Adhesive (also know as a tackifier) can be applied to the media to aid in particle capture and retention

Extended Surface Filters

- The most common types of filters used in HVAC today are extended surface filters
- An extended surface filter is designed to have more filter media area than the area of the filter itself
- Increasing media area decreases media velocity and adds dust capacity to a filter design
- Common types are:
  - Pleated filters
  - Pocket or bag filters
  - Rigid cell filters
  - Mini-pleated filters

Extended Surface Filters

Aluminum Separator

Pleated Filter

Rigid Cell

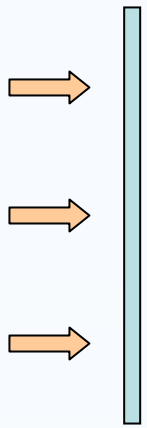
V-bank

Bag or Pocket Filter

Why Extended Surface Works

Panel Filter
Media Area = 4 ft²

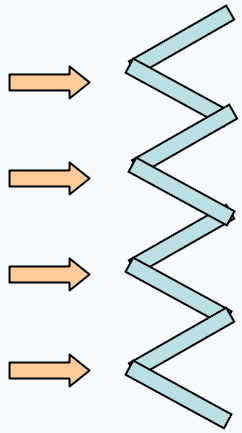
Face Velocity =
300 fpm



Media Velocity =
300 fpm

Pleated Filter
Media Area = 12 ft²

Face Velocity =
300 fpm



Media Velocity =
100 fpm

Extending media area within a filter lowers media velocity and increases a filter's capability to capture particles from the airstream

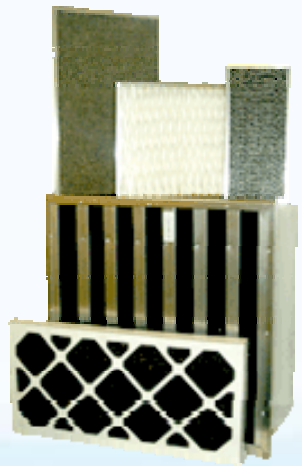
Illustration Only

Gas Phase Filters

- Corrosive gases, irritant gases, and odorous gases may be removed through gas phase filtration
- Three basic methods are recommended for removing gaseous contaminants:
  - Source Control - Removing the source of the contaminant (put the wet dog outside)
  - Ventilation Control - Introducing clean air to dilute the concentration of the contaminant (open the windows)
  - Removal Control - Filtering out the contaminant

Gas Phase Filtration

- Adsorption, Chemisorption, and Catalysis are the primary mechanisms of gaseous contaminant removal
- Gas phase filters are typically deep bed filters loaded with particulate such as activated carbon, potassium permangenate, or other agent that removes the particular gas that is targeted



- Once spent, gas phase filters must be replaced or, in some cases, they can be regenerated

Electronic Air Cleaners

- Not to be confused with electrostatic filter media, electronic air cleaners use an active external power source to capture particles passing through the filter
- Electronic air cleaners have been demonstrated to capture very fine particles not readily collected by some media filters
- Their efficiency can be greatly reduced if they are not regularly maintained to remove particle build-up on the collectors
- They are also not recommended for high humidity environments or where combustible or explosive gases are present

Measuring Filter Performance

Primary measures of a filter's performance

- Efficiency
  - Tested by certified test labs under ASHRAE test protocols
  - Based on the ability of a filter to remove particles of a specified size from a fluid stream
  - See ASHRAE 52.1 and 52.2 Standards
- Pressure Drop
  - Measures the airflow resistance of a filter
  - Reported in initial and final (terminal) pressure drop
- Dust Capacity
  - The accumulated mass of dust removed by a filter when it reaches its terminal pressure drop

ASHRAE Standard 52.1-1992

- ASHRAE's original HVAC filter test standard
- Reports filter efficiency in Atmospheric Dust Spot Efficiency % (opacity measure)
  - Did not report efficiency by particle size
  - No attempt to measure a filter's minimum efficiency
- Reports Synthetic Dust Weight Arrestance %
- Reports Dust Holding Capacity
- Still used to test coarse filters in the range of MERV 1 through 4

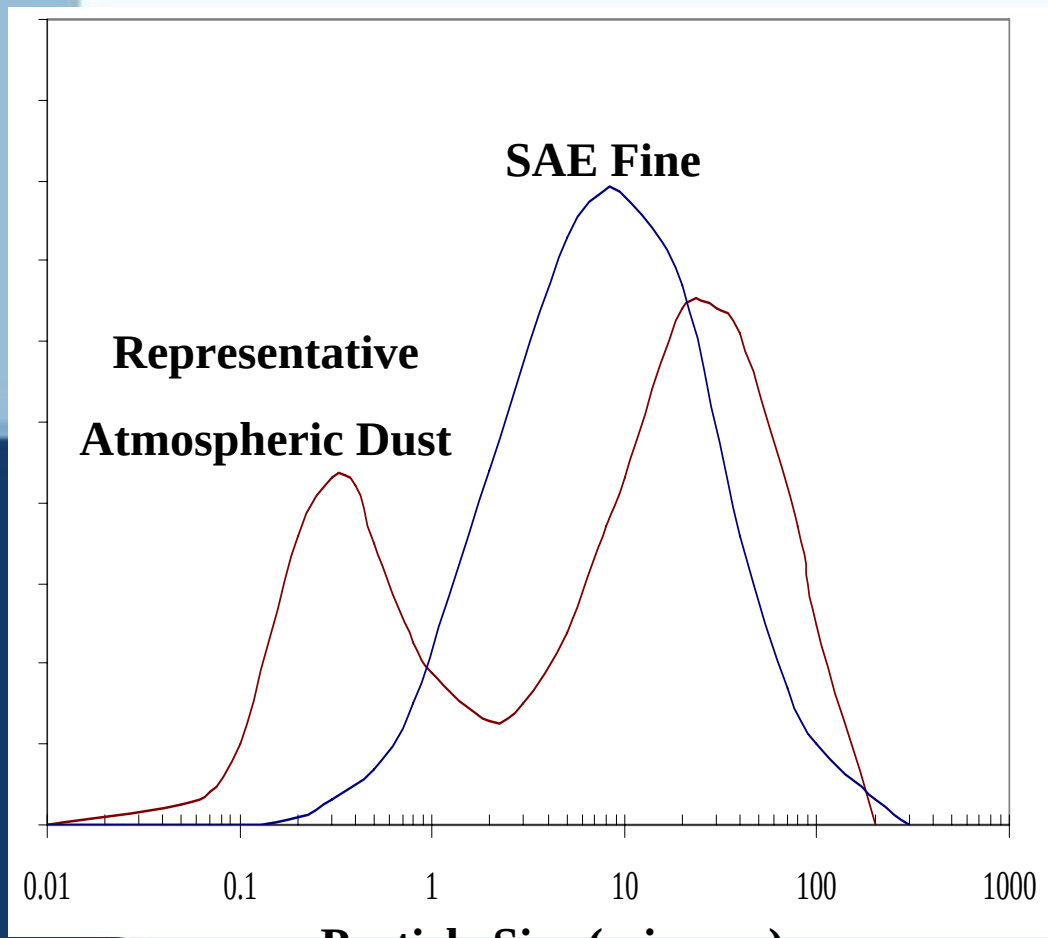
ASHRAE Standard 52.2 - 1999

Test Measurements:

- Fractional Efficiency
- Composite Minimum Efficiency Curve
- Minimum Efficiency Reporting Value
- Pressure Drop
- Weight Gain

ASHRAE Test Dust

Particle Size Distributions

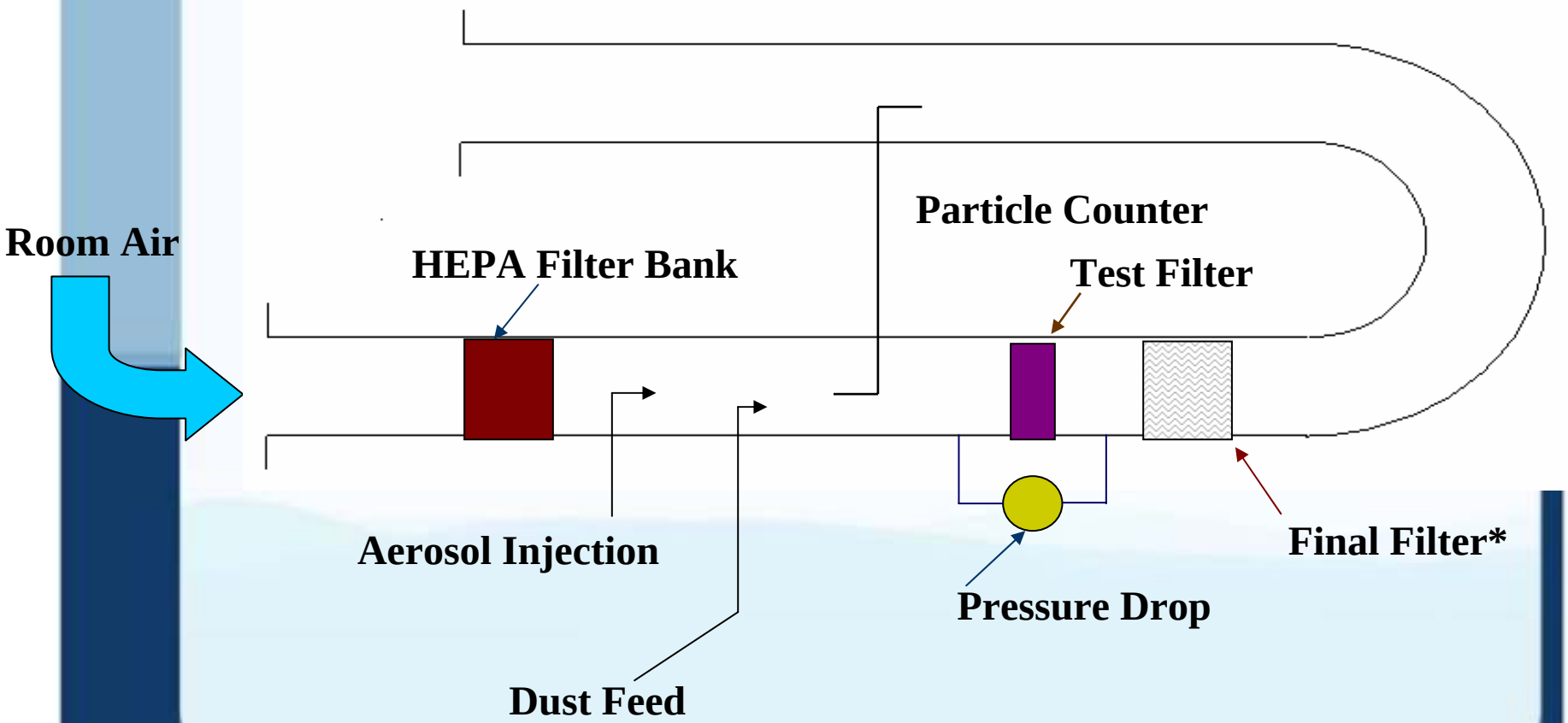


ASHRAE Test Dust

72% SAE Fine
23% Carbon
5% Linters

Used for filter loading as part of efficiency testing

ASHRAE 52.2 Test Duct



* Final Filter Installed Only During Dust Loading

ASHRAE 52.2 MERV

Particle Size (microns)	52.2 Efficiency Range
0.3 - 1.0	E_1
1.0 - 3.0	E_2
3.0 - 10.0	E_3

MERV: Minimum Efficiency Reporting Value

Typical 52.2 Test Report

LMS TECHNOLOGIES, INC.
6423 Cecilia Circle
Bloomington, MN 55439
(952) 918-9060, Fax: (952) 918-9061

Test Report-ASHRAE Test Standard 52.2

Report #: **782**
Test Date: **08/24/04**

Test Requested By:	**Kimberly-Clark**
Manufacturer:	
Product Name:	**95% Aluminum Separator**
Model Number:	**INTREPID 984L**
Dimensions:	**24x24x12**
Number of Pleats:	**120 sq ft media**
Filter Description:	**White synthetic minipleat filter**
How Filter Obtained:	**Provided by manufacturer**

Product Information

Test Results

Test Air Flow Rate(CFM)/Velocity (FPM)	**1968cfm / 492fpm**
Initial Resistance (in. WG)	**0.426**
Final Resistance (in. WG)	**1.4**
Minimum Efficiency Rating Value **(MERV)**	**MERV 15 @ 1968cfm**
Minimum Average Efficiency 0.3 to 1.0 Microns **(E1)**	**86.6**
Minimum Average Efficiency 1.0 to 3.0 Microns **(E2)**	**97.3**
Minimum Average Efficiency 3.0 to 10 Microns **(E3)**	**99.8**
Dust Fed to Final Resistance(grams)	**269.0 grams**

Test Result Summary

Test Description

Temp & Humidity:	**70 @ 35%**
Particle Analysis:	**Hiac/Royco FE-80**
Test Dust:	**ASHRAE 52.1 Dust**
Test Aerosol:	**KCL Neutralized**

Test Description

Test Engineer :	**Mick Flom/Tom Atef/Kian Imani/Emile Tadros**
Approved By:	**K. C. Kwok, Ph.D.**

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52.2 Efficiency Report

□P (" H_2O)	0.426in.	0.466in.	0.710in.	0.953in.	1.197in.	1.400in.	*CME
Size Range (□m)			Fractional Efficiency (%)				↓
0.3-0.4	**78.0**	83.3	87.1	91.7	95.6	98.6	**78.0**
0.4-0.55	**84.4**	88.5	91.6	94.5	96.9	99.4	**84.4**
0.55-0.7	**89.8**	93.8	95.0	96.0	98.1	99.9	**89.8**
0.7-1.0	**94.0**	96.0	97.1	98.1	98.9	100.0	**94.0**
1.0-1.3	**95.8**	97.6	98.5	99.2	99.9	100.0	**95.8**
1.3-1.6	**96.9**	98.7	99.3	99.8	100.0	100.0	**96.9**
1.6-2.2	**97.9**	99.5	99.9	100.0	100.0	100.0	**97.9**
2.2-3.0	**98.7**	99.9	100.0	100.0	100.0	100.0	**98.7**
3.0-4.0	**99.3**	100.0	100.0	100.0	100.0	100.0	**99.3**
4.0-5.5	**99.8**	100.0	100.0	100.0	100.0	100.0	**99.8**
5.5-7.0	**100.0**	100.0	100.0	100.0	100.0	100.0	**100.0**
7.0-10.0	**100.0**	100.0	100.0	100.0	100.0	100.0	**100.0**

← **Composite Minimum Efficiency**

E1 = 86.6%

E2 = 97.3%

E3 = 99.8%

E1, E2 and E3 used in ASHRAE lookup table to determine MERV

Filter Performance by Type

MERV	Particle Size	Application	Filter Type
17 – 20	<= 0.3µm	Cleanrooms	HEPA/ULPA filters
13 – 16	0.3 to 1.0µm	Hospitals and superior quality commercial buildings	Rigid pleat and bag filters
9 – 12	1.0 to 3.0µm	High quality commercial buildings and superior residential	Bag filters and high quality Pleats
5 – 8	3.0 to 10.0µm	Commercial buildings and better residential	Pleated filters
1 – 4	>10.0µm	Minimal commercial and residential applications	Panel and roll filters

Other Filter Testing

- Room Air Cleaner performance is established under the Association of Home Appliance Manufacturers (AHAM) Standard ANSI/AC1-1998, which reports performance in Clean Air Delivery Rate (CADR)
- HEPA and ULPA filter performance is determined in the US by the Institute of Environmental Sciences and Technology (IEST) standard RP-CC001 and in Europe by the EDANA standard EN-1822
- Fire resistance of filters is established by the Underwriters Laboratories under ANSI/UL 900-1995 for HVAC filters, and by ANSI/UL 586-1990 for HEPA and ULPA filters

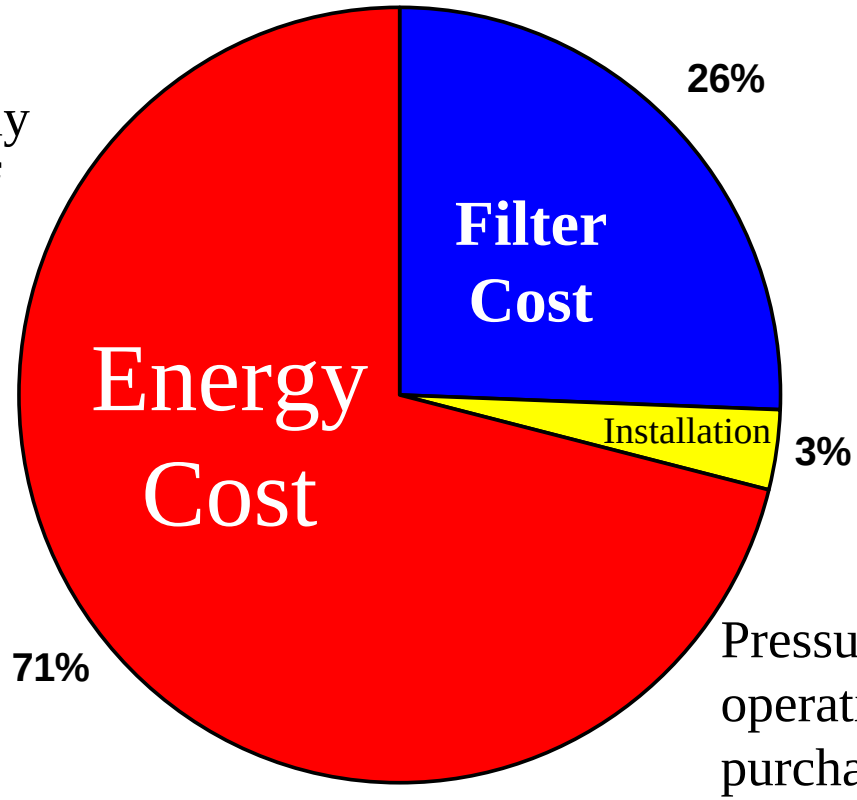
Filter Operating Costs

- All filters, no matter how good, cause some airflow restriction as they clean the air you breathe
- Typically, the higher the efficiency of a filter, the higher is it's resistance to airflow
- HVAC systems use significant amounts of energy to condition and distribute air within a facility
- It is important to consider the energy cost when making a filter purchase decision … Pressure drop is an indicator of energy consumption

Filter Operating Cost Components

Fact:

Energy cost is nearly 3 times the cost of a typical filter high efficiency glass filter



Pressure drop influences operating cost more then purchase price in many filter installations

Energy Cost Analysis

- Kimberly-Clark Filtration's Web site contains an online operating cost calculator for determining the full cost of your filter selection
- Go to www.kcfiltration.com and click on Resource Center to learn more about energy cost savings

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