Robert McCabe
Director, Health Care Solutions
HTS Chicago

Improved Air Quality and Energy Efficiency through Air Handler Filtration System Upgrade

Biography

Robert McCabe has been involved in commercial building HVAC and infrastructure for 22 years. As Director of Health Care Solutions for HTS Chicago, Robert is dedicated to the education of the health care marketplace with regards to critical airflow control. Robert has Bachelor of Science degrees in Biology from the University of Wisconsin-Madison and in Electrical Engineering from Marquette University, and an MBA from the Kellogg Graduate School of Management at Northwestern University.

HTS Chicago is a proven provider of custom HVAC solutions for critical Health Care and Laboratory environments. HTS Chicago attributes its success in the region to integrity, industry focus and the longevity of partnerships with premier system manufacturers.

Presentation: Improved Indoor Air Quality and Increased Efficiency through Air Filtration System Upgrade

Theme

Building owners and occupants expect more from their buildings today – including both better indoor air quality (IAQ) and less energy consumption. However, maintaining optimum IAQ often seems to be in conflict with minimizing operating and energy costs. This need not be the case.

Goal

The goal of the presentation is to provide participants with knowledge of an alternative to standard air filtration technologies that will reduce energy consumption, reduce maintenance labor and material costs, eliminate most odors, and contribute to LEED and Green initiatives.

Key Topic Areas

* Standard air cleaning technologies, pros and cons
* Polarized filtration, pros and cons

Key Take Away Points

* Standard air cleaning filtration consumes energy and requires frequent maintenance
* Polarized filtration saves energy and has 1/3 the life cycle cost of standard filtration

Health Care Indoor Environments
Air Filtration Options

Robert McCabe

Objective

Evaluate available technologies for reducing airborne contaminants, principally particulate, in Health Care environments

Overview

- Contaminant levels must be controlled for the people and processes in any building, especially a health care facility
- Contaminants impact:
  - Building occupants
  - Infection Rates
  - Computers/ Electronics
  - Medical Equipment
- Filtration
  - Different methods
  - Different efficiencies
  - Different costs

The Problem

Buildings generate and concentrate pollutants

- **EPA:**
  - **Indoor air can be 7 to 10 times more polluted than outdoor air.**
- **AMA:**
  - **Respiratory problems are the 3rd largest cause of death in the US**
- **ASHRAE**
  - **Control the contaminants in the building**

What's in the air?

Particulate:

- Smoke, vehicle exhaust, dust, man-made mineral fibers, etc

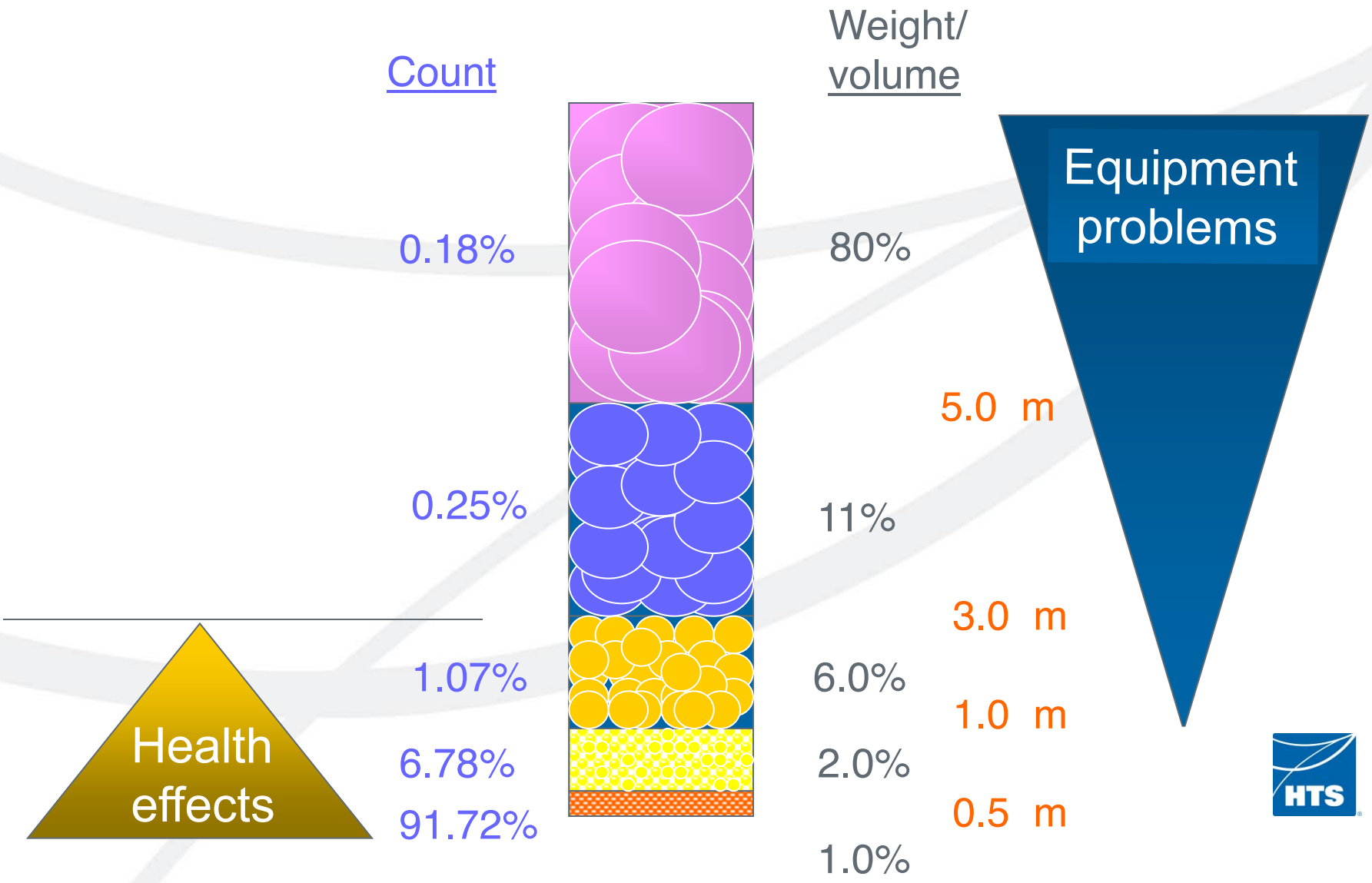
Biological:

- Molds, viruses, bacteria

Gas Phase:

- CO_2, CO, Volatile Organic Compounds

Typical Atmospheric Dust Sample



Ultrafine Particles

- Smaller than 0.1 micron
- Dominate particle number concentrations and surface area
- Capable of carrying large concentrations of adsorbed or condensed toxic air pollutants
  - oxidant gases
  - organic compounds
  - transition metals
- Major source for introducing cardiovascular and pulmonary stressors into the body
- Deposit on electronic components and lead to premature failure

FILTRATION

Passive Filters

Passive Filters

- Most widely used technology
- Essentially sieves - the tighter the grid, the more effective the filter
- Rely solely on mechanical capture
  - no electrostatic attraction
- Typical configurations:
  - 1” to 4” panel filters with pleated media
  - Bag filters
  - Box and rigid filters
  - HEPA filters
  - Roll filters

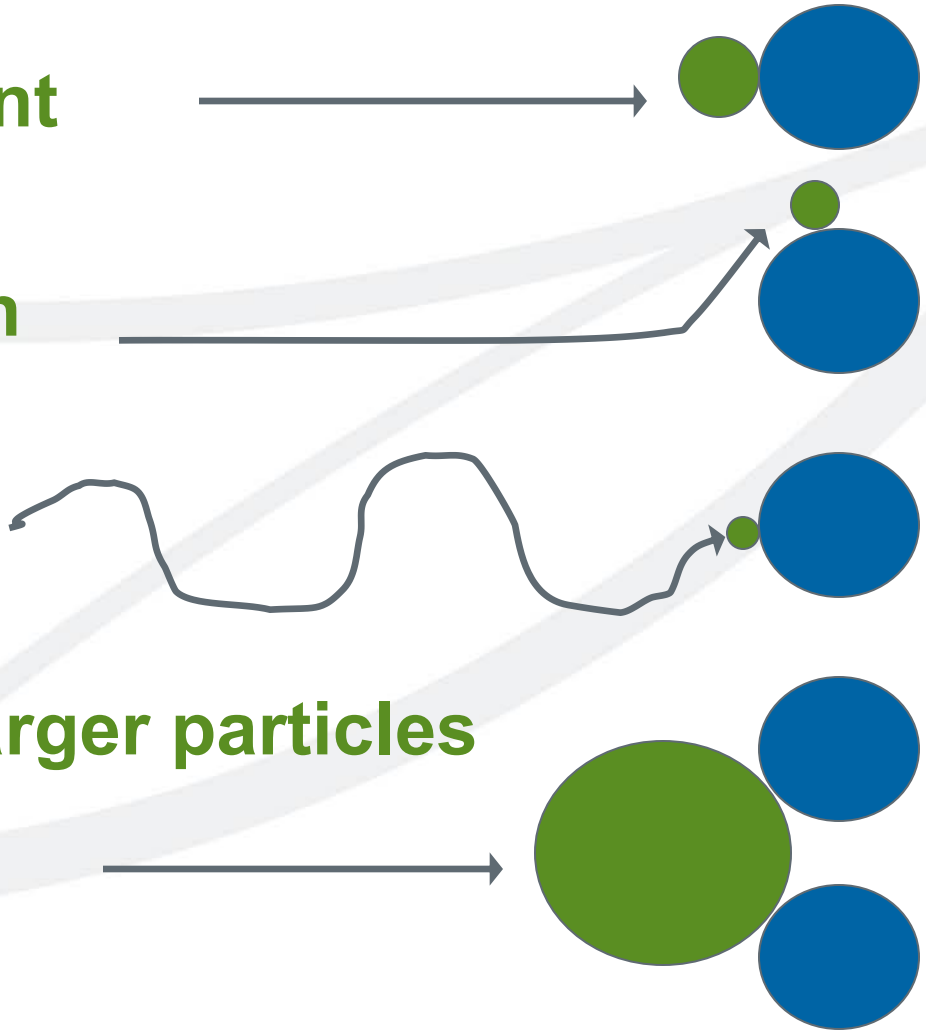
Mechanisms of Passive Filtration

Impingement

Interception

Diffusion

Straining-larger particles



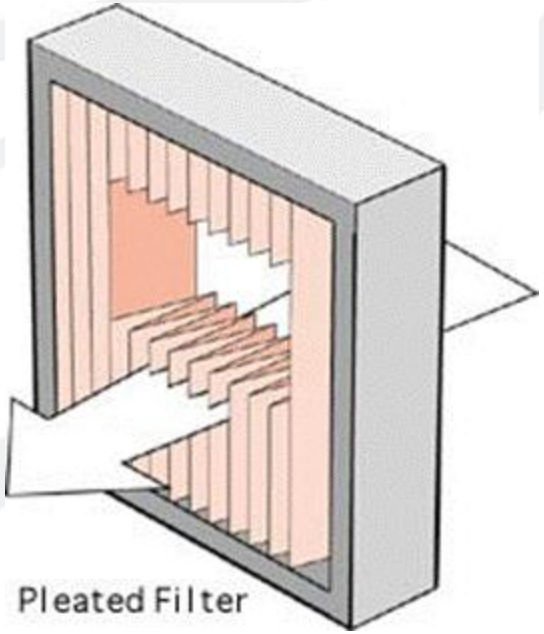
Passive Filters

Operational Considerations

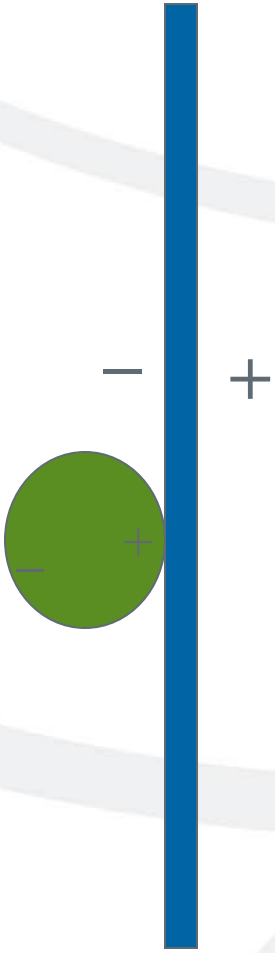
+ Low first cost
+ Widely available
+ Proven approach
+ Most particle sizes can be addressed

- No effect on Volatile Organic Compounds (VOCs)
- As filter effectiveness increases energy efficiency decreases
- Captured particles can shed

Passive-Electrostatic Filters



Passive-Electrostatic Filters



- Media fibers have *one-time* factory induced or applied electrostatic orientation
- Many particles in the air have net ambient charge and/or relative charge sites
- Charge on media gives it greater efficiency than comparable passive media by attracting charges particles
- Effect is short-lived as fibers become coated
- Often high pressure drop

Electrostatic Precipitators (ESPs)

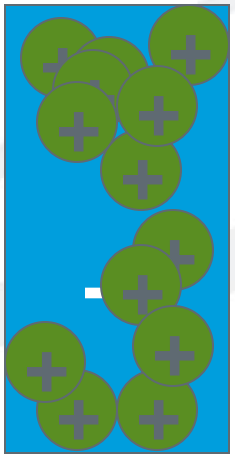
- 50+ year-old technology based on electrostatic attraction
  - opposites attract
- Industrial applications
  - stack cleaning
  - welding
- Not widely used in general applications

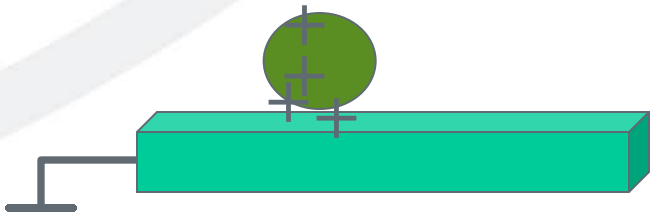
Mechanisms of Electrostatic Precipitators

- High DC Voltage applied to thin wires creates corona of positive ions
- As particles go through corona, ions attach themselves to particles- ionizing them
- Ionized particles are attracted to oppositely charged plates

Ionizing Section
12-20,00 vdc

Oppositely charged collection cell





Grounded surface, e.g. ducts, walls, ceilings, people

Electrostatic Precipitators

Operational Considerations

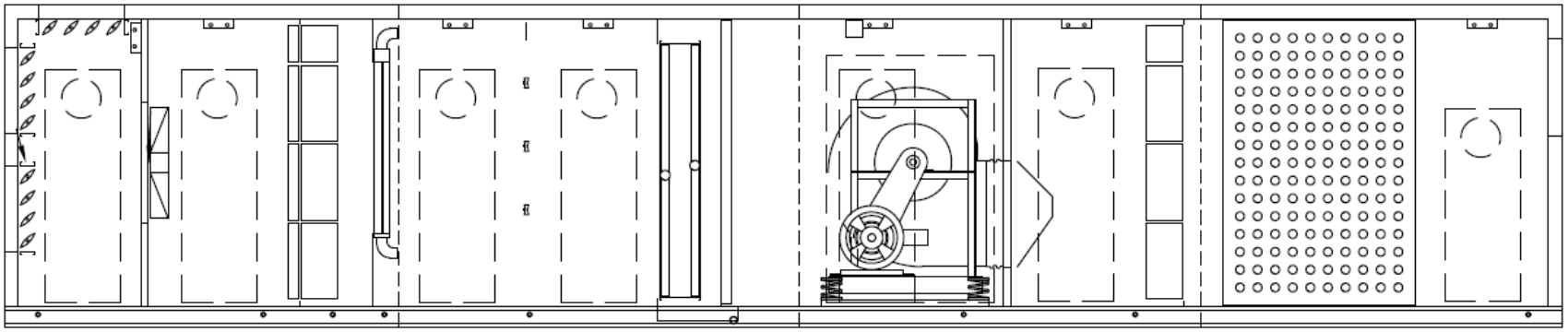
- Collection grids can become coated quickly
  - When collection cells fill, ions go elsewhere
  - Frequent maintenance is mandatory, or effectiveness plummets
- Captured particles shed

Typical Health Care Passive Filter Configuration

30% Pre Filter

65% Mid Filter

95% or HEPA
Final Filter



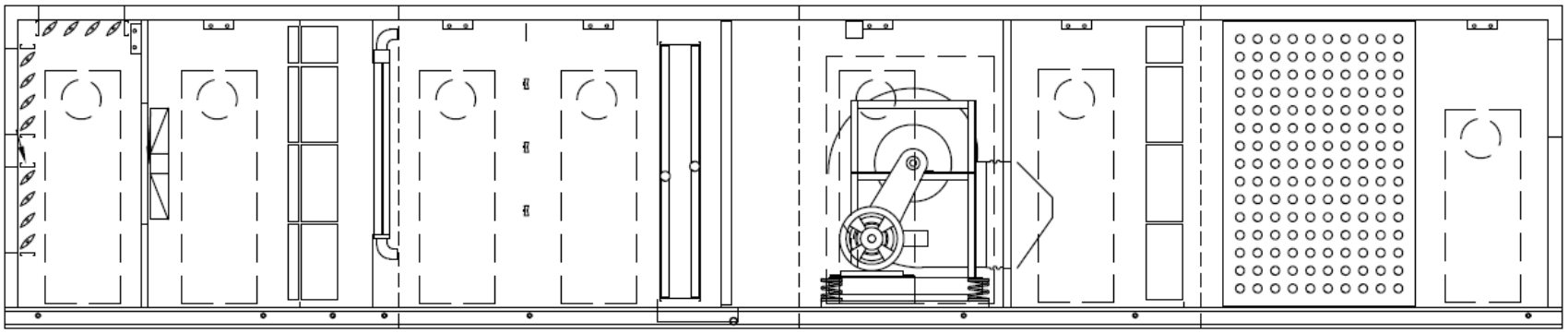
+ HEPAs in Critical User Spaces……

Typical HC Filtration Pressure Drop (Clean/Dirty)

30% Pre Filter
.25” / 1.0”

65% Mid Filter
.25” / 1.25”

95% or HEPA
Final Filter
1.0” / 2.0”

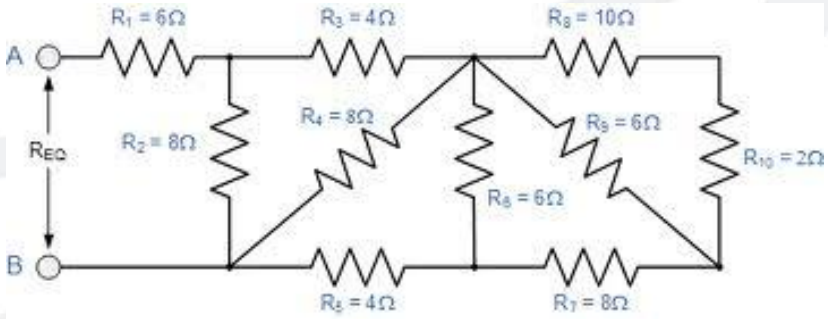


HEPAs in critical user Space
1.0” / 2.0”

Typical Supply AH designed for 8” SP loss

- ***Filtration is over 50% of the loss when dirty, by design***

Other Forms of Similar Resistance to Flow



There are Costs to this Approach…

Polarized Media Air Cleaner

Polarized Media Air Cleaner

- Combines characteristic of passive filters and electrostatic precipitators
- Active electrostatic field *constantly* polarizes fibers of the media pad and particles passing through the field
- Polarized particles are drawn to the polarized fibers ***and to each other***

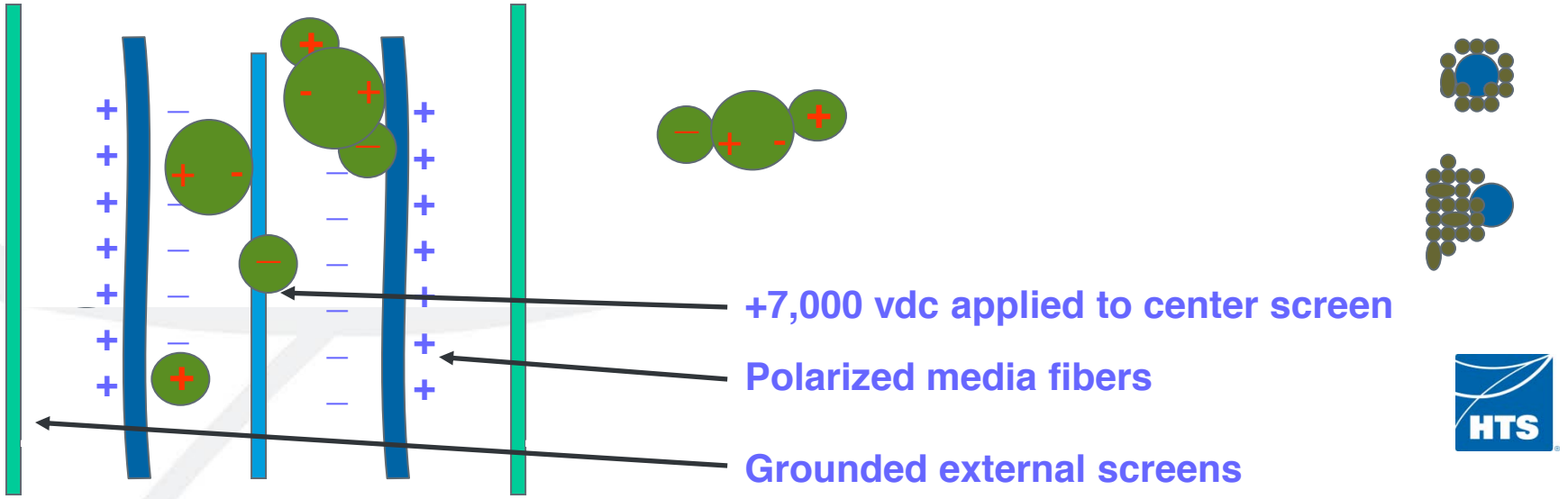
Mechanisms of Polarized Media

Passive mechanisms: There is media, so there is passive collection

Polarization and electrostatic attraction:

- **polarized fibers**
- **charged center screen**

Agglomeration: Natural process greatly accelerated by the field inside the air cleaner. Polarized particles attract each other and charged particles to form bigger clusters that are more easily captured



Impact of Polarization on Ultrafine Particles

- Ultra-fine particles adsorb and absorb gas phase contaminants
- Polarization agglomerate and captures ultrafine particles
  - Reduce gas phase contaminants
- Removal rates stay constant

Electrostatic vs Polarized Media Air Cleaners
Important Distinctions

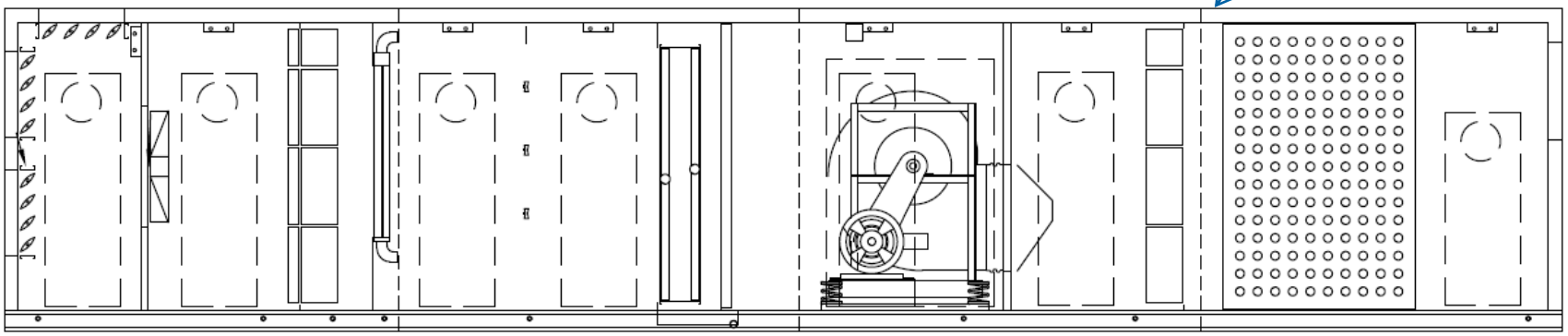
	Electrostatic	Polarized
		
Ionize Particles	X	
Polarize Particles		X
Reorganize Surface Charges		X
Eliminate Odors		X
Create Ozone	X	
Particles adhere to grounded surface	X	
Uneven media loading	X	
Low P Drop		X
Long Service Interval		X

Polarized HC Filtration Pressure Drop (Clean/Dirty)

30% Pre Filter
.25” / 1.0”
.13” / .27”

65% Mid Filter
.25” / 1.25”
0” / 0”

95% or HEPA
Final Filter
1.0” / 2.0”
.31” / .51



HEPAs in critical user Space
1.0” / 2.0”

Typical Supply AH designed for 8” SP loss

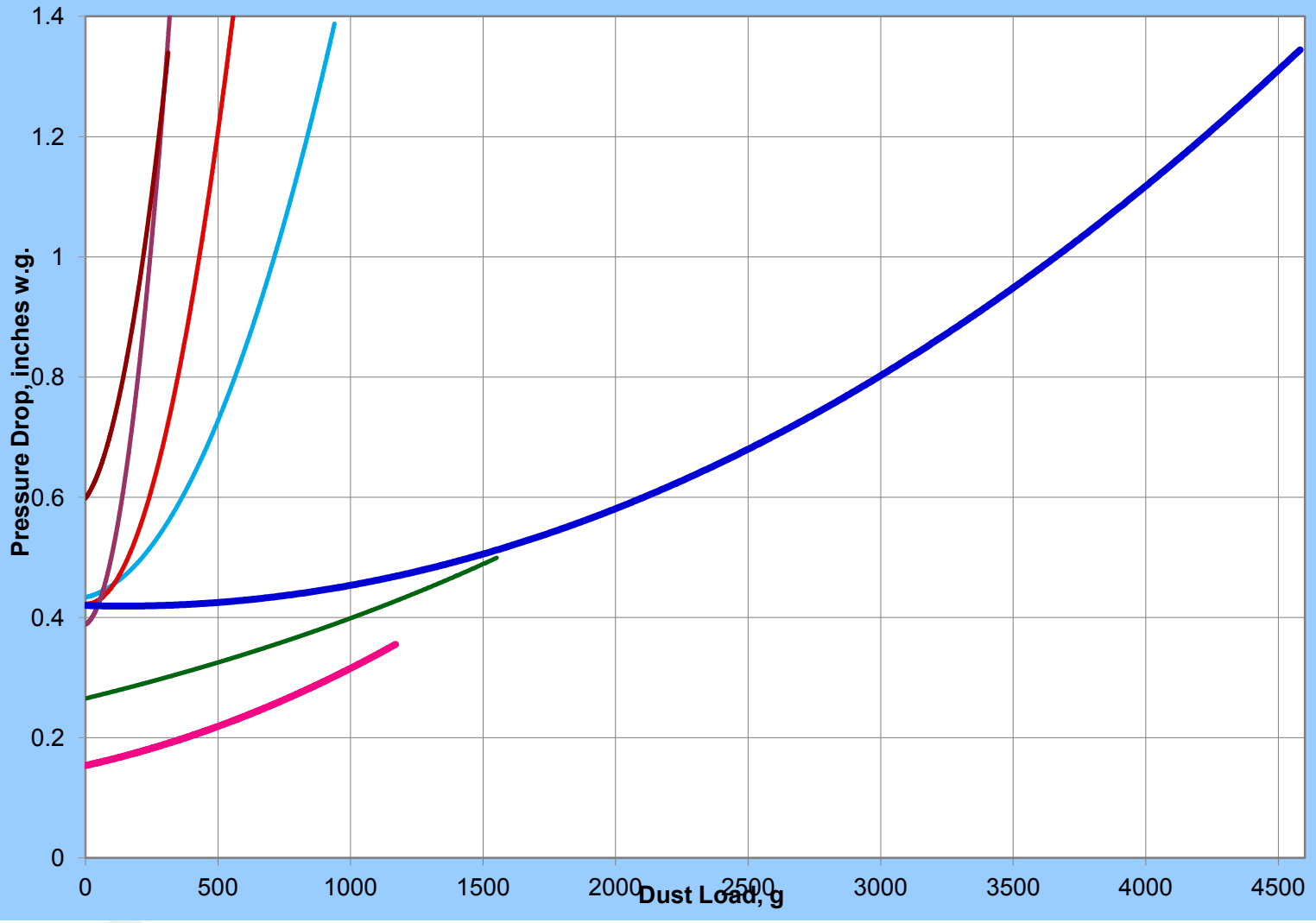
- ***Polarized Filtration is < 10% of design loss, not 50%***

Performance Comparison

Measurement	30%	65%	95%	HEPA	Polarized
MERV Rating	8	11	14	17	15+
Static Pressure - Clean	.25	.33	.6	1.5	.31
Static Pressure - Dirty	1.0	1.2	1.2	2.0	.51
Dust Cap Mid-Life (g)	170	300	300	300	2600
Media replacement frequency (months)	3	12	12	12	48

Air Flow thru Face Area
Of Filter Bank = 500fpm

Filter Pressure Drop vs Dust Load
SAE Fine Dust



Local Case Study

- Baseline – 30% Prefilters, 65% bags
- Retrofit – Polarized filter bank

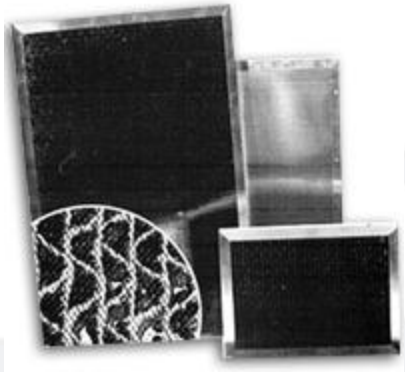
	Baseline Conditions	Post-Retrofit Conditions	Benefit
Measured Flow rate	33200	32500	
Measured Voltage per leg	418	418	
Measured Motor Amps	82	57.8	29%

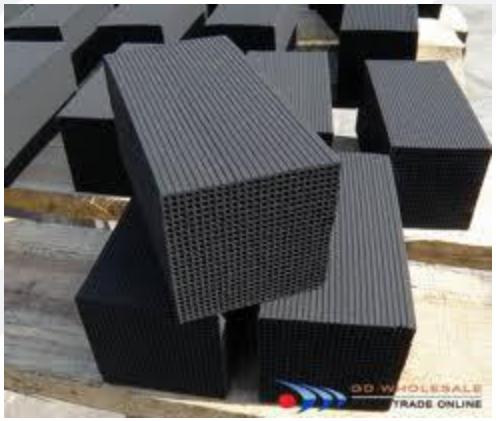
Power savings	17.5 kw
Energy Savings	153,477 kwh
Energy $ Savings	$15,348
Media Savings	$1,135
Labor Savings	$710
Total Annual Savings	$17,193

Other Air Cleaning Technologies

Activated Carbon and ad/absorbing media:

- Very effective against VOCs and other gas phase contaminants
- New configurations using honeycomb matrices have brought down the impediments for using carbon





Other Air Cleaning Technologies

Germicidal UVC

- Properly applied can inactivate surface and airborne biologicals
- Care must be taken with exposure to equipment and personnel

Other Air Cleaning Technologies

Ionizer Filter Enhancers

- Cause more problems than they solve
- Generate ions that adhere to particles so they will adhere to surfaces – air handlers, walls, people

Ozonators

- EPA – O3 has little potential to remove indoor contaminants
- O3 is a lung irritant

Questions

Thank You