Energy Exchange

Federal Sustainability for the Next Decade

U.S. Department of Energy

The Basics of HVAC Filters and Savings

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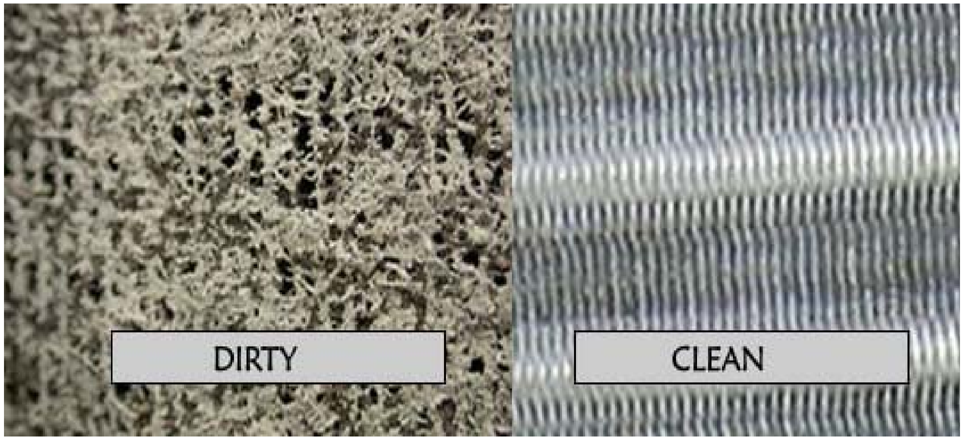
Overview

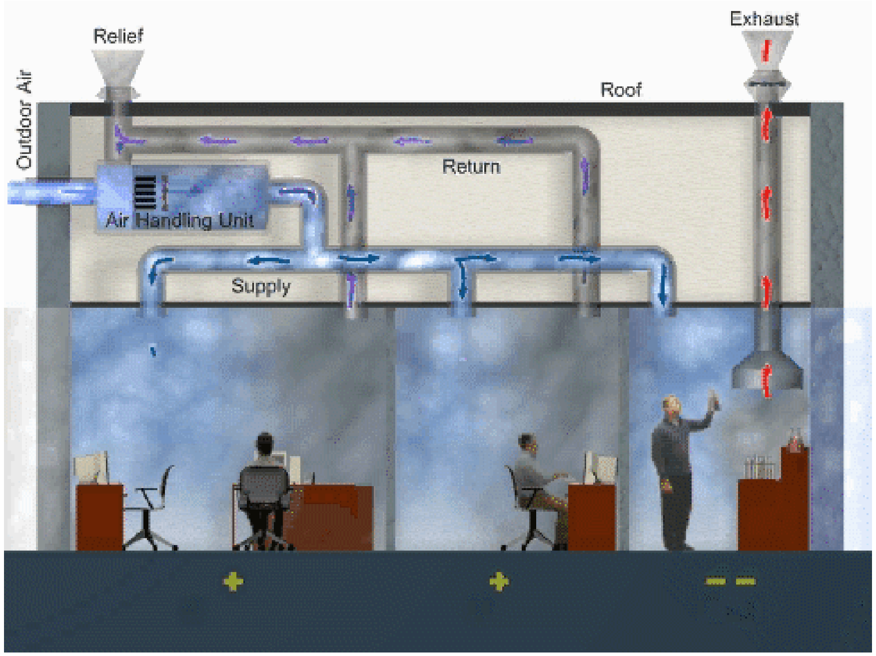
Discussion Topics

- HVAC Filters – why and impacts to energy use
- Filtering basics
- How filter selection can save energy
- Strategies and pitfalls
- Catch all discussion
- What’s next

The Purpose of Filters

- Historic focus of HVAC filters was to protect equipment; coils, fan, ducts, etc.





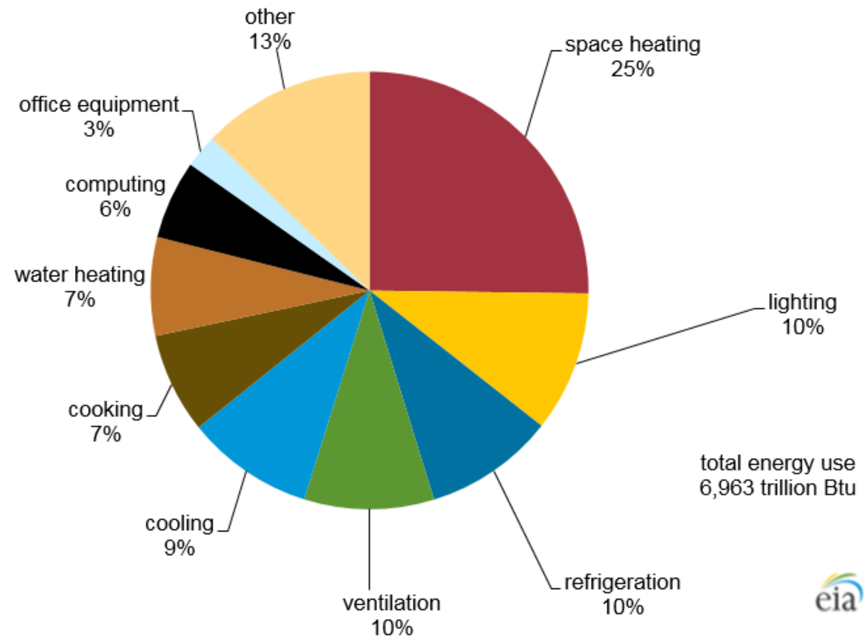
Source: EPA

- Modern focus has expanded to include Indoor Air Quality

HVAC and Filters Contribution to Building Energy Use

- HVAC accounts for over 40% of energy use in commercial buildings
- Filters drive the energy use and cost of operating the fan
- The fan and coils can have a domino effect on other HVAC components

Figure 5. Space heating demanded the most overall energy use in commercial buildings in 2012, followed by other uses



Source: U.S. Energy Information Administration, 2012 Commercial Buildings Energy Consumption Survey.

Savings Claims

- Wide range of claims

Competitors use commercial equipment that can't duplicate our technology, resulting in average pressure drops that are 20 – 50% higher.

Did You Know...

There are 95% efficiency synthetic media filters that have the same pressure drop as 65% efficiency glass media filters, providing the ability to increase filtration efficiency by 30% without increasing energy costs at all.

.....can slash operating costs by as much as 2/3 by reducing system static pressure, eliminating pre-filters, reducing fan energy, extending maintenance intervals from months to years and potentially cutting outside air requirements in half.

- How to make sense of the claims is not straight forward
- It is important to understand the basics,
  - Temper expectations
  - Understand the interrelationship between filters and the rest of the HVAC system

Filtering Basics

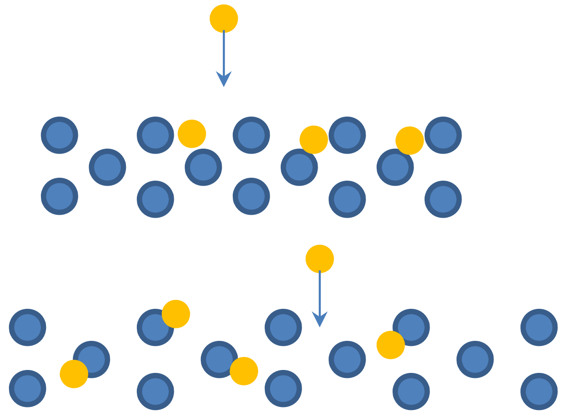
- Filtering approach
  - Mechanical (Geometric)
    - Particles are “trapped”

    ΔP ↑ change in ΔP ↑

    MERV increases over time
  - Electrostatic

    ΔP ↑ change in ΔP ↑

    MERV can decrease
- Types of filters
  - Fiberglass
  - Polyester/pleated filters
  - Reusable



Efficiency vs. Efficiency

- Minimum efficiency reporting value (MERV)
  - Not an energy efficiency measure
  - A measurement scale designed by ASHRAE to rate the effectiveness of air filters in removing particles from an airstream
  - MERV-A is a rating after the filter has gone through "conditioning" (simulated aging/use)
- High-efficiency particulate arresting (HEPA)
  - Also not an energy efficiency measure
  - An air filter that removes (from the air that passes through the filter) 99.97% of particles that have a size of at least 0.3 µm
- Energy Efficiency – related to ΔP of filter bank

MERV

MERV	Min. particle size	Typical controlled contaminant	Typical Application [2]
1–4	> 10.0 μm	Pollen, dust mites, cockroach debris, sanding dust, spray paint dust, textile fibers, carpet fibers	Residential window AC units
5–8	10.0–3.0 μm	Mold, spores, dust mite debris, cat and dog dander, hair spray, fabric protector, dusting aids, pudding mix	Better residential, general commercial, industrial workspaces
9–12	3.0–1.0 μm	Legionella, Humidifier dust, Lead dust, Milled flour, Auto emission particulates, Nebulizer droplets	Superior residential, better commercial, hospital laboratories
13–16	1.0–0.3 μm	Bacteria, droplet nuclei (sneeze), cooking oil, most smoke and insecticide dust, most face powder, most paint pigments	hospital & general surgery
17–20	< 0.3 μm	Virus, carbon dust, sea salt, smoke	Electronics & pharmaceutical manufacturing cleanroom

Simplified MERV chart See ASHRAE 52.1 and 52.2 for full criteria

HEPA

- HEPA removes 99.97% of particles that have a size of at least 0.3 µm
- Ultra Low Penetration Air (filter) (ULPA) filter can remove from the air at least 99.999% of dust, pollen, mold, bacteria and any airborne particles with a size of 0.1 µm or larger.

HEPA class	Retention (total)	Retention (local)
E10	> 85%	---
E11	> 95%	---
E12	> 99.5%	---
H13	> 99.95%	> 99.75%
H14	> 99.995%	> 99.975%
U15	> 99.9995%	> 99.9975%
U16	> 99.99995%	> 99.99975%
U17	> 99.999995%	> 99.9999%

Key to savings from filters

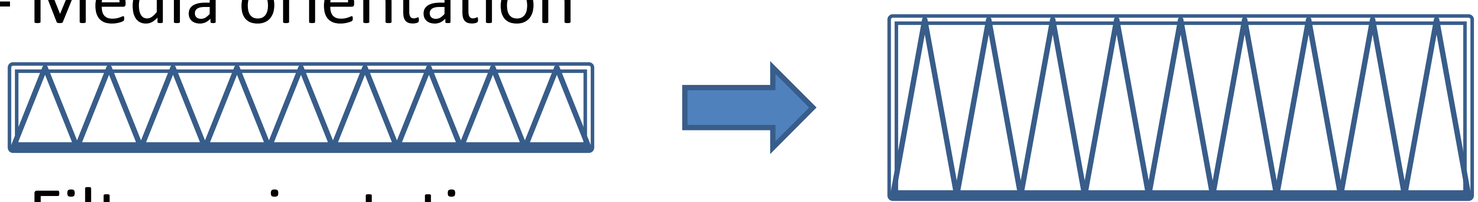
- Energy Savings
  - Cost of energy over the life of the filter can be 4X the cost of the filter
  - Pressure drop across filter is the driver for savings
    - Reduced Demand
    - Consumption savings
- Labor savings
- Material savings

	Filter A	Filter B
Efficiency	MERV 14	MERV 14
Filter Style	12″ Deep Rigid	12″ Deep Rigid
Media Area	120 sq. ft.	120 sq. ft
Initial Cost	$70	$70
Initial sP	0.45″ Water Gauge (WG)	0.65″ WG
Final sP	1.50″ WG	1.50″ WG
DHC	300g	300g
Filter Life	12 months	12 months
Energy Cost	$276/year	$305/year

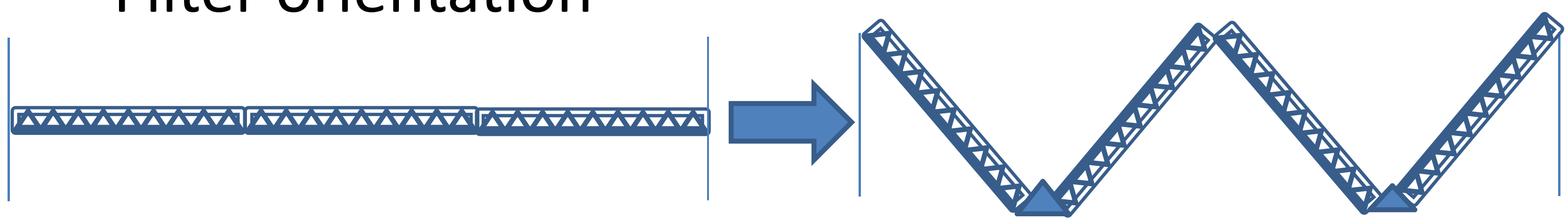
Calculation: Energy Consumption = Q*dP*t/n/1000
Assumes 24/7/365 operation, energy cost of $.08/kWh, fan, motor, drive efficiency (n) of 58 percent

Basic Strategies

- Filter media
  - Reducing pressure drop while maintaining ability to capture particles
  - Material that resists moisture absorption
- Increasing surface area of filters
  - Media orientation



  - Filter orientation



Retrofitting Challenges

- Estimating expected savings
  - Not a simple exercise due to related systems
  - Consider interdependencies
    - Lower ΔP may increase air flow unless fan is controlled
    - Air side will *generally* not have a significant impact on the water side efficiencies (could impact Δ T)
- Existing system design
  - Filter bank design
  - Control capabilities of the fan (e.g., CAV vs VAV)

Opportunistic efforts

- When performing or planning other HVAC upgrades – consider filter system improvements
  - Fan replacements/upgrades
  - Package unit replacements
  - CAV to VAV conversion

How savings can be lost or not realized

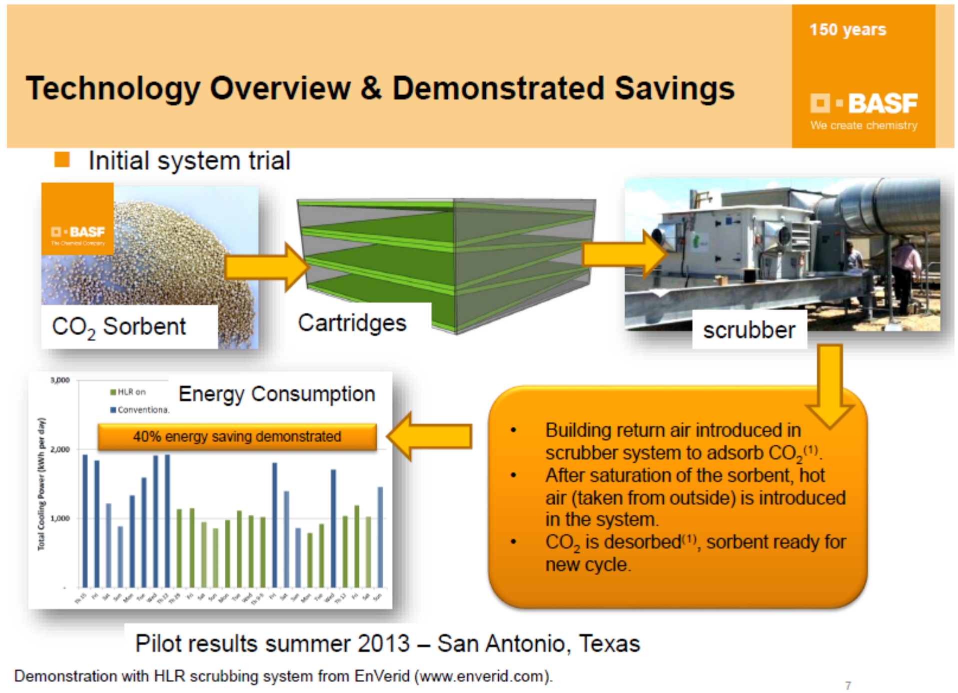
- Inaccurate savings estimates (oversold)
- Longer service intervals present other risks
- Excess filter loading can result in filter failure
- In applications that control contaminants (e.g., laboratory HEPA filters) – additional filters could increase disposal costs
- System pressure changes could impact operations
- Not updating control strategies as part of an upgrade

Random thoughts

- ASHRAE 90.1 requirements around BHP – filtering upgrades can help achieve these requirements (related to LEED)
- MERV and MERV-A ratings – better when are close or the same
- Cheap filters may cost more in energy use – focus on total lifecycle cost
- For HEPA or High MERV applications (also generally applicable)
  - Don’t forget to reduce sources of contaminants as a first line of defense
  - Reduce required airflow if at all possible

What's next – new or additional systems

- Ultraviolet light systems – no increased fan energy use but do use energy themselves
- Air scrubbers – remove CO2 and other contaminants to reduce outside air requirements
- New or alternate filtering strategies



Questions?