

Evaluating the Life Cycle Cost of Ozone Filtration

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Mo.2.C.1 Controls: Formaldehyde, VOCs and ozone

Monday, June 6, 2011, 3:25 PM

Indoor Air 2011



What is the Cost of Ozone Filtration?

- Standard Development
 - Ventilation standards such as ASHRAE 62.1-2010 and ASHRAE 189.1-2009 now require ozone filtration under certain conditions.
 - The ozone concentration which triggers the need for ozone concentration has been a point of discussion for both and is obviously the point of concern.
- Financial Burden Considerations
 - If the ozone filtration is too stringent, it may place a financial burden on facility owners and managers that is considered excessive. Therefore, limiting the number of counties and percent of the population that must use ozone filtration limits the financial impacts of that standard. However, consideration of health impacts and the return on investment of ozone filtration should also be considered.

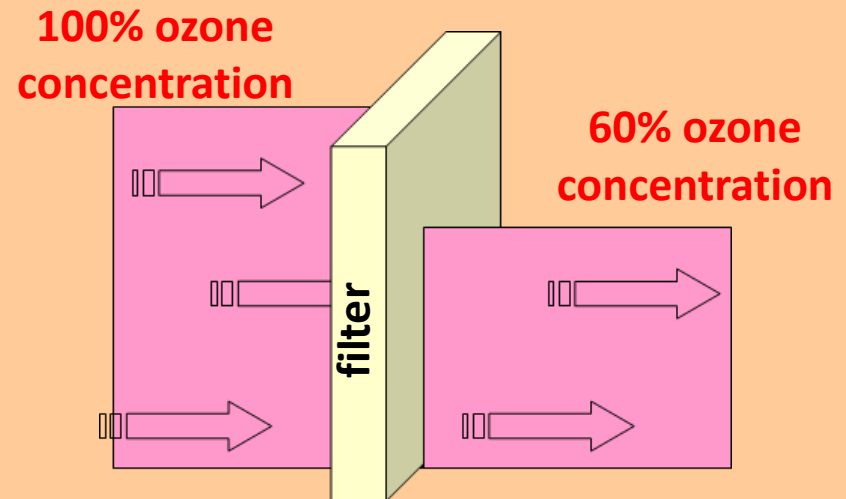
ASHRAE Standard Requirements

- ASHRAE 62.1-2010
 - design value* exceeds **0.107 ppm**
 - min efficiency of **40%**
- ASHRAE 189.1-2009
 - same as 62.1 but using US EPA non-attainment criteria: **0.075 ppm**

*US EPA Ozone Design Value

most recent 3-year average of the fourth-highest daily maximum 8-hour average

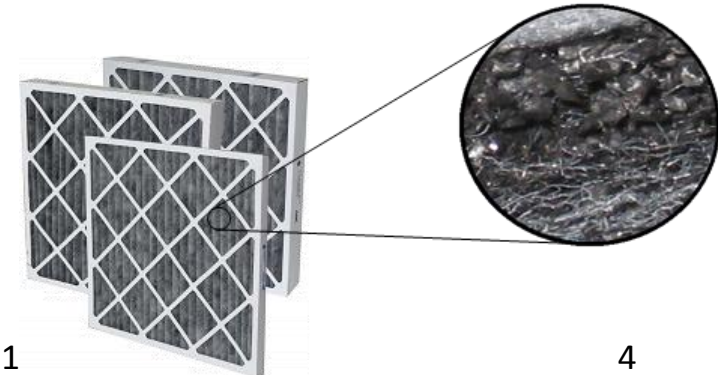
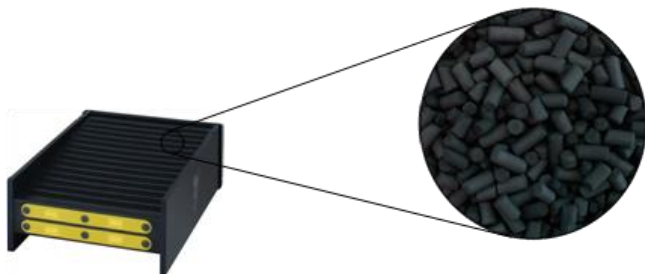
Minimum Ozone Efficiency



Ozone Filter Capacity & Efficiency

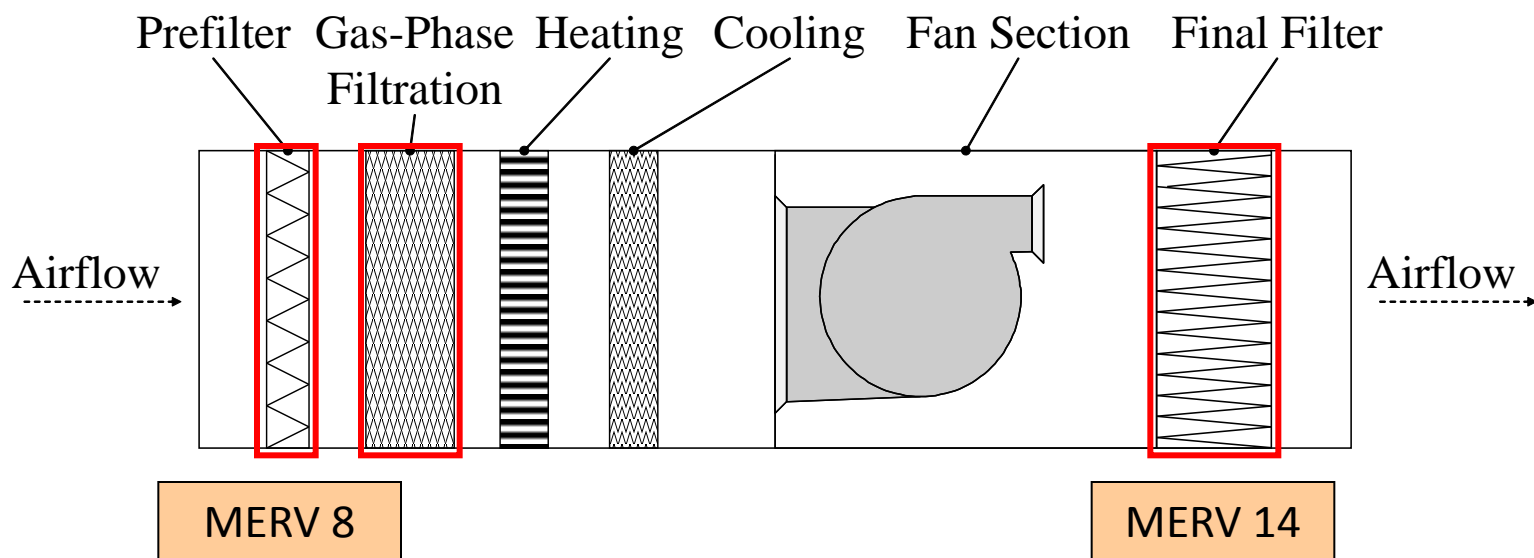
- Activated carbon filters are commonly known as ozone removal filters
 - Relatively high capacity and operational removal efficiency for ozone.

Capacity	Efficiency	Description	Reference
0.2-0.34 g/g avg	50%	granular carbon bed & carbon loaded pleats	Gundel, 2002
3 year life	>50%	granular carbon tray system	Shair, 1981
extended periods of time	>50%	various systems	Beko, 2007













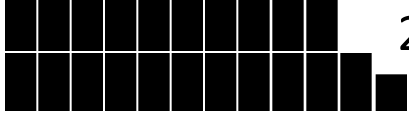

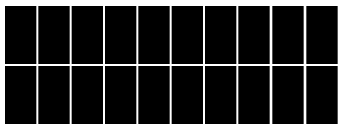

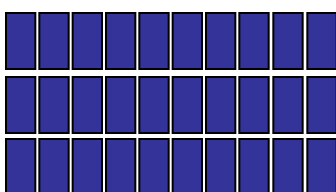

Methods

- Additional Cost calculated based on filter cost, replacement, & ΔP
- BASE System = hospital system, 2000 cfm (3398 cmh)

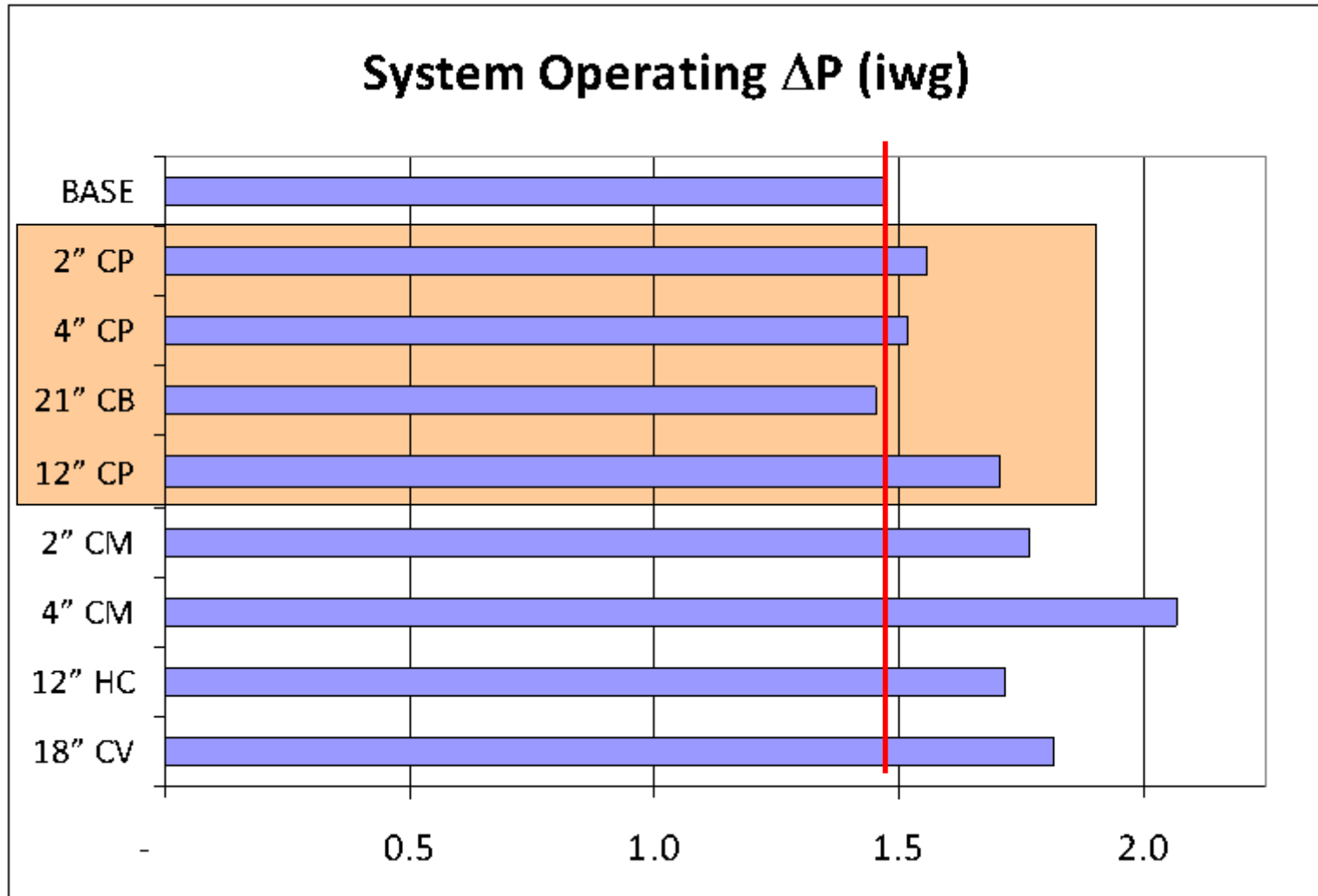


Methods (2)

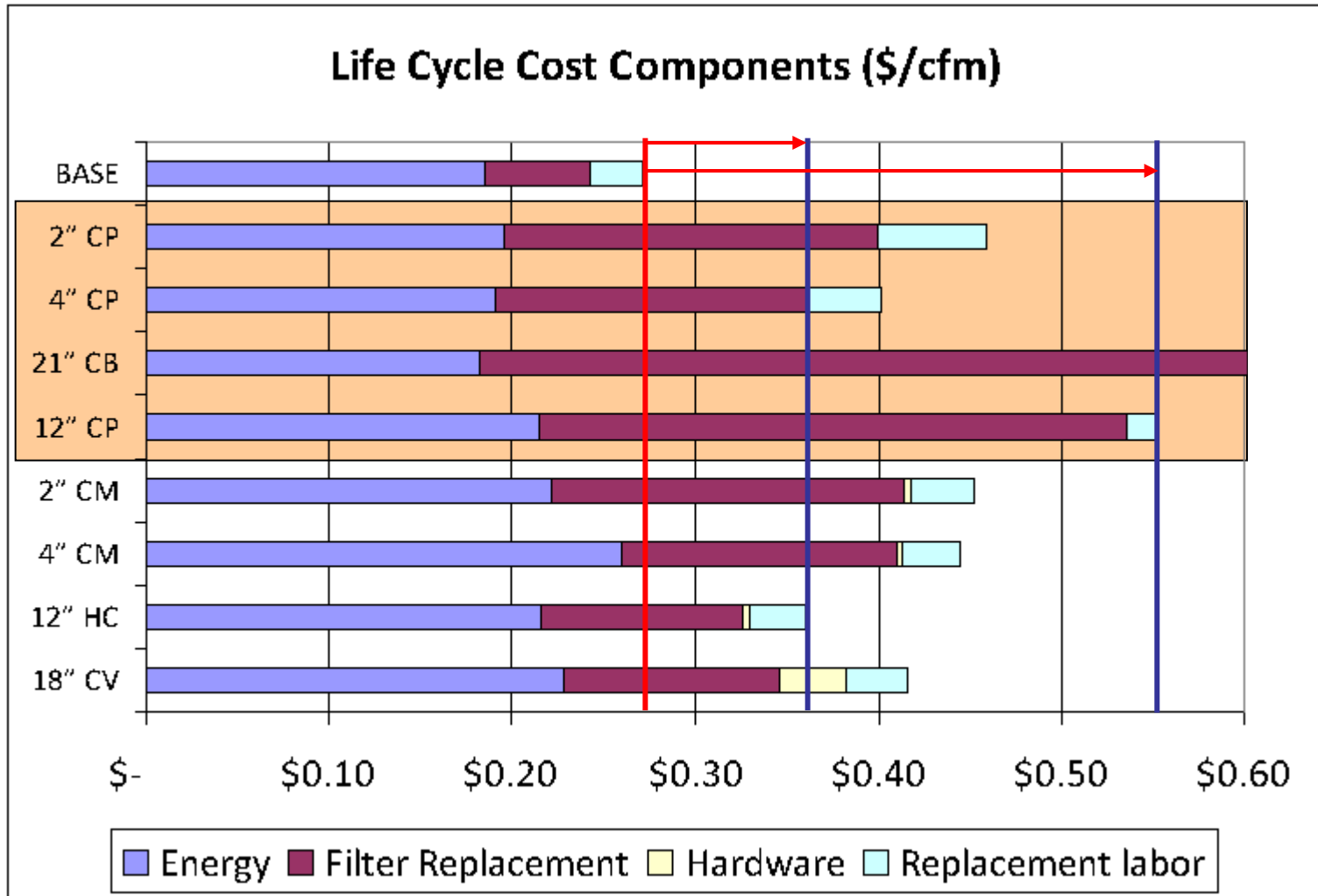
- Filters Considered – in order of mass of carbon

<u>Description</u>	<u>Carbon (lb)</u>	<u>ΔP (iwg)</u>	<u>Cost</u>
Carbon Pleat (2")	 1.8	 0.8	\$
Carbon Pleat (4")	 2.6	 0.8	\$
Carbon Bag Filter (21")	 3.5	 1.0	\$\$\$\$\$\$\$\$\$\$\$\$
Carbon Pleat (12")	 7.8	 1.0	\$\$\$\$\$\$\$
Carbon Matrix (2")	 8.5	 0.3	\$\$\$\$
Carbon Matrix (4")	 21.6	 0.6	\$\$\$\$\$\$\$
Honeycomb V-Bank (12")	 24.0	 0.3	\$\$\$\$\$
Cassette V-Bank (18")	 60.0	 0.4	\$\$\$\$\$\$\$\$\$\$\$\$

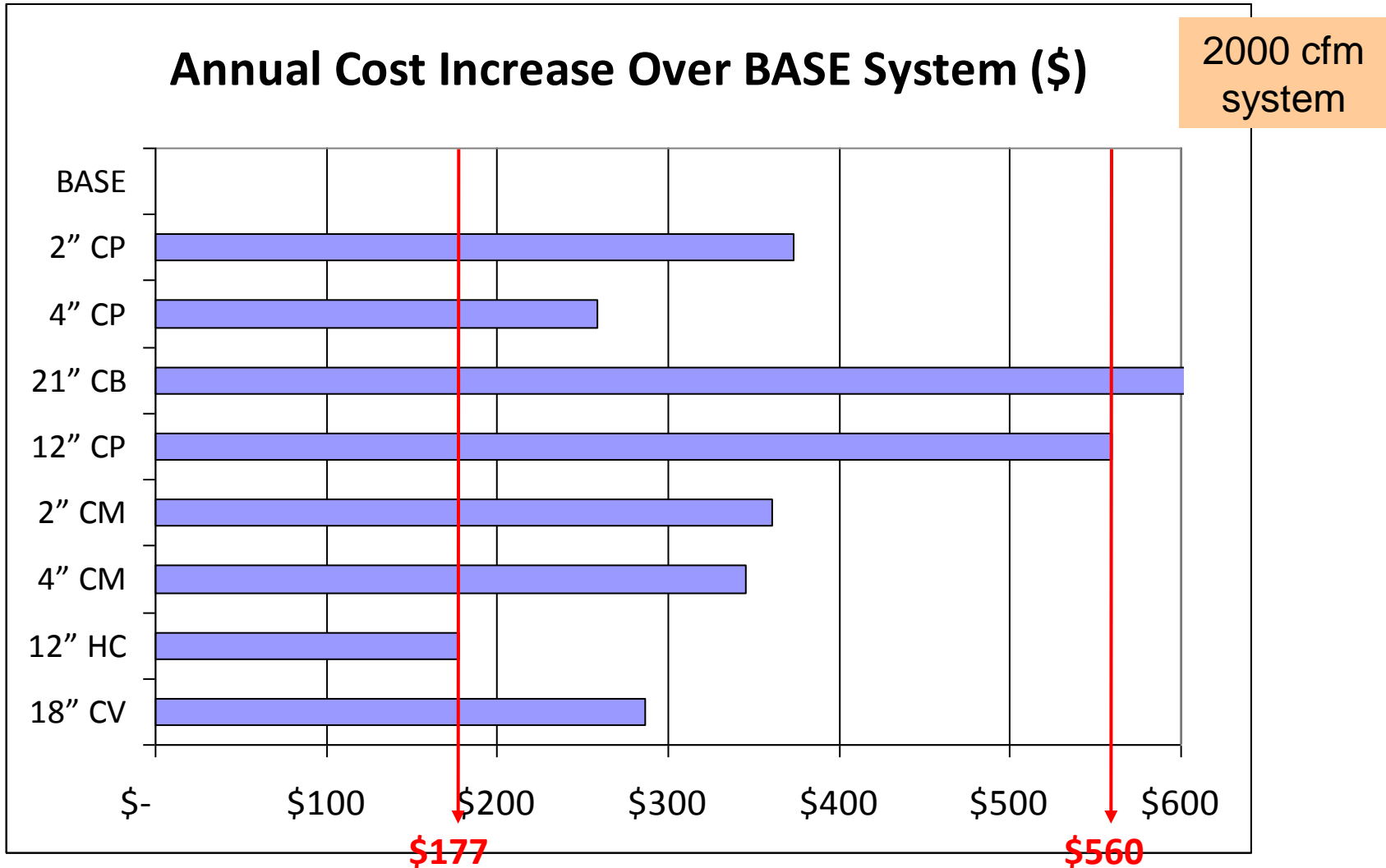
Results



Results (2)



Results (3)



Discussion

- There are multiple ozone filters. The proper choice will depend on the application specifics. For the filters reviewed here, the additional cost ranged from 0.08 to 0.28 \$/cfm (not including the outlier of 0.97 \$/cfm)
- For a 2000 cfm air handler, the additional cost ranges from 177 to 560 \$/year.
- The filter prices used in this analysis are estimated to be market sale prices.
- The life of the ozone filters (carbon filters) is affected by actual contaminant concentrations
- There is uncertainty in the efficiency of many gas phase filters. The references used in this paper showed many carbon filters were able to achieve efficiencies above 50% for extended periods of time. However, confirmation of ozone efficiencies should be obtained when installing filters to meet code requirements

Conclusions

- The ideal ozone control solution will have the lowest (or even zero) pressure drop penalty, site acceptable ozone removal efficiency, infinite life, and extreme ease of retrofit.
- No such filter exists currently and facilities must use the listed filters in this paper or similar ones to meet ozone filtration requirements.
- In relationship to the overall operational cost of the air handler and the health impacts of ozone, the additional costs presented here appear to be reasonable to meet filtration requirements in ozone nonattainment regions or other areas where it is required by code.

References

- ASHRAE. (2009). ANSI/ASHRAE/USGBC/IES Standard 189.1-2009 Standard for the Design of High-Performance Green Buildings. Atlanta, GA: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. and U.S. Green Building Council.
- ASHRAE. (2010). ANSI/ASHRAE Standard 62.1-2010 Ventilation for Acceptable Indoor Air Quality. Atlanta, GA: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
- Beko, G., Clausen, G., Weschler, C.J. (2007). Sensory Pollution from Bag Filters, Carbon Filters and Combinations. *Indoor Air* 2008, 18, 27-36.
- Gundel, L.A., Sullivan, D.P., Katsapov, G.Y, & Fisk, W.J. Lawrence Berkeley National Laboratory, Indoor Environment Division. (2002). A Pilot Study of Energy Efficient Air Cleaning for Ozone (LBNL-51836). US Department of Energy. Retrieved from http://www.osti.gov/bridge//product.biblio.jsp?query_id=1&page=0&osti_id=808935
- Shair, F.A. (1981). Relating Indoor Pollutant Concentrations of Ozone and Sulfur Dioxide to Those Outside: Economic Reduction of Indoor Ozone through Selective Filtration of the Make-up Air. *ASHRAE Transactions*, 87(1), 116-139.