

# **Healthcare cost reduction with air conditioning**

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## **SUMMARY**

By improving interior air quality and reducing the opportunity for cross contamination, the air conditioning industry is in a position to reduce the high cost and amount of healthcare required by the spread of respiratory disease. This benefit can be accomplished incrementally at very low cost. The key elements are improved filtration, elimination of mixing ventilation by utilizing personal control, displacement ventilation, and properly designed equipment for humidity control. In addition to reducing the need for healthcare, these measures will result in substantial energy savings and increased productivity [1].

## **INTRODUCTION**

First, by improving the filters in existing systems, the incidence of respiratory ailments may be reduced. Electronic air purifiers use the same principle to improve indoor air quality in homes, schools and offices as is used in the sophisticated systems designed for submarine fleets. Unlike most mechanical filters that only collect larger particles, electronic air purifiers collect particles down to  $0.3\mu$  or less in size. This range includes hazardous invisible particles such as tobacco smoke, atmospheric dust, bacteria, and even some viruses. Electronic filters have low resistance to air flow and are therefore also energy efficient.

Second, by providing personal supply air control to the occupant cross contamination can be reduced substantially, thus reducing infections by transmission from person to person. Freshly filtered personal air is inhaled by the occupant before mixing with contaminants in the space.

Third, by providing personal air control, building systems can be operated at substantially higher temperatures. This will result in great energy savings, and thus indirectly reduce air pollution. The higher temperature reduces the amount of energy required to do the cooling. It also allows the use of higher temperature for "economizer" cooling. The latter will vary materially with location. For example, in Atlanta, GA, economizer operation will save an additional 2000 hours of mechanical cooling over conventional systems [1].

## **DISCUSSION**

In a recent position document entitled "Airborne Infectious Diseases," ASHRAE states "many infectious diseases are transmitted through inhalation of airborne infectious particles termed droplet nuclei" [2]. It goes on to say that "airborne infectious disease transmission can be reduced using dilution ventilation, specific in room flow regimes, room pressure differentials, personalized and source capture ventilation, filtration, and UVGI (Ultraviolet Germicidal Irradiation)." The document further explains that a lot of the transmission takes

place by means of particles smaller than  $10\mu$ . It also points out that the propensity for infection is proportional to the number of particles in the space and the frequency of exposure of individuals. The paper lists 10 engineering control strategies, all of which have been used to some extent in hospitals:

- Dilution ventilation
- Personalized ventilation
- Source capture
- Central system filtration
- Local air filtration
- Upper room UVGI
- In-room UVGI
- Duct UVGI
- In-room flow regimes
- Differential pressurization

The vast majority of commercial HVAC installations at present use dilution by means of ventilation to control interior air quality in conformance with ASHRAE Standard 62.

The use of HEPA filters in operating rooms and hospitals has shown that a better job of controlling contamination can be done in general construction. HEPA filters have not been used because their extremely high pressure drop makes them very expensive to install and maintain. High quality filters have been readily available, and a good many have been sold for use in private homes, but rarely in commercial construction.

For commercial installations several strategies for good filtration have been tried in the past. Air washers worked fine, but the cost of maintenance and installation was far higher than ventilation, for which energy was plentiful and cheap. Electronic filters were tried using plates. When not properly cleaned, they tended to produce ozone, a bad pollutant in itself which can damage people's health.

Fortunately at this time there are electronic filters available whose performance rating comes very close to that of HEPA filters. They have a relatively very low pressure drop and are very inexpensive. Last, and not least, they can be readily installed into existing filter racks.

The effectiveness of electronic filters is 89% to  $0.3\mu$  in 15 minutes, compared to HEPA at 94% to  $0.3\mu$  in 15 minutes. Both filters are active to  $0.01\mu$  (70% for the electronic filter, with HEPA more effective (See Fig. 1). The pressure drop at 500 FPM (2.5 m/s) is approximately 0.2 WG (55 Pa), whereas HEPA filters are 2 WG (550 Pa) when clean. The power consumption of the electronic filters is 2 watts per filter element, an insignificant amount.

### AIR BORNE PARTICLE CHART

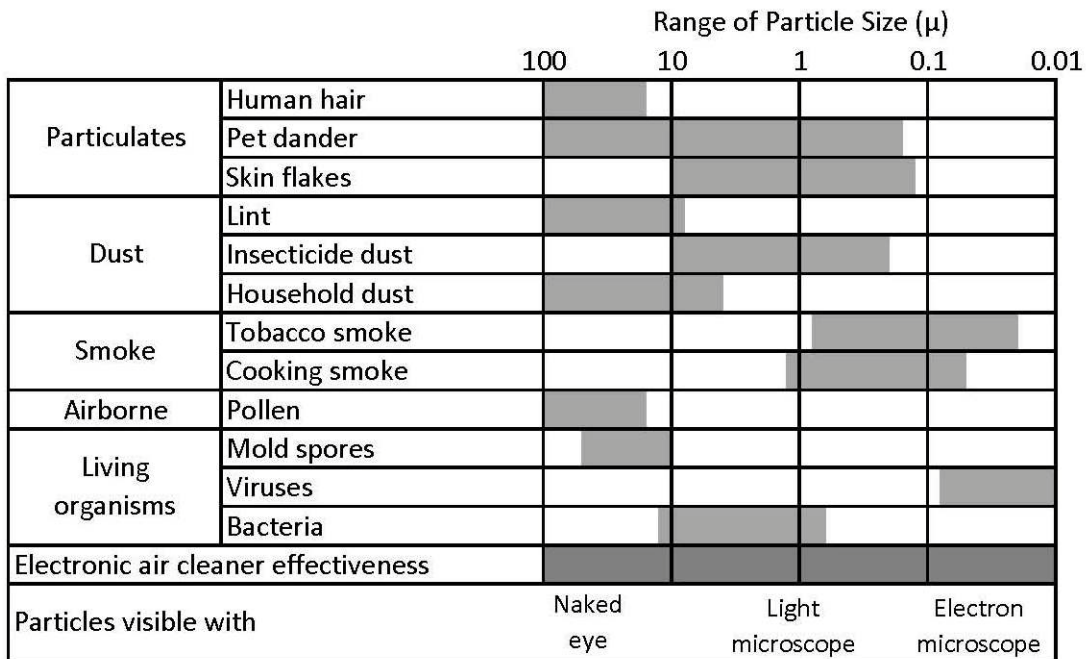


Figure 1. Effective range of electronic air filters

New installations experience significant savings in equipment and operating costs. By using Standard 62 alternate method, the filtration allows substantial reduction of ventilation air. This has been verified in actual installations, for instance, the Lakota School District in West Chester, OH. Lakota reported an equipment saving of \$ 30,000 because of the reduced outside air requirement [3].

On existing installations the savings will be in the operating cost. An example is a high school in southwest Texas which saved \$12,000 in annual energy costs after installation of MERV 8 particulate air filters with integral medium efficiency gas phase sorption media [4].

At present the estimated cost of the electronic filters with integral power supply (not electrostatic filters!) is about 10 cents per SF (\$1 per SM). If the filters are used for both makeup and recirculated air, they may also reduce the spread of respiratory diseases somewhat better than ventilation alone. In many existing buildings with insufficient ventilation the improved IAQ will be great. At 2W per filter, the savings will pay for the filter cost on average in 1-2 years.

All of the above changes in filtration can be readily accomplished in a relatively short time and at low cost because they involve no changes in construction and the same labor as servicing the existing filters.

Unfortunately most existing systems distribute the air by mixing ventilation. The result is a cocktail of contaminants. By design the air is recirculated, spreading contaminants throughout the space several times before they are exhausted or filtered. Wherever possible air distribution should be by means of displacement ventilation or personal control.

It has been concluded based on experiments and calculations that “PV [Personal Ventilation] is able to protect occupants from inhaling airborne contaminants associated with exhaled breath (e.g. virulent agents) as well as contaminants emitted from floor covering.” [5] The amount of protection falls off very quickly as the distance from the personalized air outlet is increased [6]. This condition needs to be part of the instructions to occupants, like the washing of hands and the control of coughing and sneezing. The opportunity for personal controls is available in offices and auditoriums. (There is at least one auditorium in Berlin with personal air installed in the front of your seat.)

Another way to prevent the “contaminant cocktail” and poor IAQ from mixing ventilation is displacement ventilation (DV). Air currents generated by contaminating heat sources, such as people or mechanical equipment, move particles toward the ceiling, where they are removed by return air to the air handling equipment and filtration. DV also allows air stratification, which helps reduce energy consumption. DV has been widely used in Europe and is beginning to be used in schools in the United States. Because of its vertical air movement, it will reduce cross contamination from person to person and the spread of disease [7].

Last, and certainly not least, better humidity control in systems will prevent conditions for the formation of mold and the growth of bacteria. Too many systems are designed for operation under peak load conditions without consideration for the fact that they mostly operate at part load. The growing use of new LED lighting will reduce the heat load in offices and schools, making humidity control more important. Thermostats are available that in connection with a small control panel allow for humidity control to be installed in old systems that do not now have it.

UV installation in the air handling equipment is useful in keeping the coil and drain pan clear. It is ineffective in treating the air which moves through the air handler at too high velocity.

A great deal of research and many other contributions led to this paper. More information can be found in articles cited in the following references.

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