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Optimizing the Use of Room Air Purifiers in Combination with HVAC Filters for IAQ and Energy Efficiency for both PM 2.5 and UFP particles

Summary: Indoor air quality is increasingly recognized as a serious health hazard in many international environments. The elevated impact of UFPs is also becoming more well understood. This paper investigates the dynamics between room air purifiers and HVAC systems, emphasizing their collective impact on Indoor Air Quality (IAQ) and energy consumption. We engage in an analysis of particulate matter, including a set of studies using PM 2.5 and UFP particles, and examine the subsequent effects under different HVAC operational circumstances. The primary objective is to identify an optimal balance where superior IAQ can be maintained while ensuring minimal energy usage. In addition, the objective is to understand how this balance is impacted by particle size. Our results could lead to actionable insights and pragmatic approaches for achieving optimal air quality and energy sustainability in both residential and commercial settings, enacting strategies in situations where there is particular concern around UFP contamination, ultimately contributing to enhanced health and wellbeing, and energy savings to standard air filters.

Objective: There is a growing awareness that particulates, and especially UFPs, pose substantial health risks, and that removal of these particles from indoor air can be a challenge for low MERV rated filters, especially if energy use is a factor as well. The purpose of this study is to compare the effectiveness and energy use of two strategies for reducing UFP's from indoor air: strategy one is to use higher MERV rated filters, strategy two is to use a lower MERV rated filter but add a free-standing room air purifier (in this case an electrostatic filter with an established UFP filtration rating).

Methods: To perform this study, a 25'X30'X10'test room was built with a VFD HVAC system and built in energy monitoring system. A spray gun, powered by a compressor, disperses dust evenly with the help of ceiling and ground fans. Once the particle counter shows stable concentrations of 15 million particles per cubic feet, testing begins. Data collection stops after 1 hour to ensure consistency through all experiments. Two sets of experiments were run. The first set of tests used standard PM 2.5 dust with a standard distribution of particles and a PM 2.5 particle counter that reports concentrations in 6 size ranges. The second set of tests used UFP dust and an UFP particle counter. In both cases, tests were run to establish the impact on particle reduction of MERV 8,11 and 13 filters with and without a free-standing room air purifier.

Results: The first set of tests demonstrated that pairing a basic MERV 8 filter with an in-room purifier can match the air quality offered by using just a MERV 13 filter for PM 2.5 particles.

The results of the second set of tests showed that the decay rates of UFP's were nearly identical when using only MERV 8,11, or 13 filters. The addition of an auxiliary air purifier significantly reduced the concentration of ultrafine particles, demonstrating that UFP collection is primarily achieved by the auxiliary air-purifier. In addition, energy use was calculated and results show that the use of auxiliary air purifier used less energy than a higher MERV rated filter in addition to being more effective at UFP removal.

Conclusion: In our research, we found clear benefits of combining in-room air purifiers with standard HVAC systems. By using this combined method with lower grade MERV filters, we can reduce energy costs and still maintain high indoor air quality. This approach is both practical and efficient. It suggests a balanced way to achieve cleaner indoor environments, especially in settings like offices or homes. Our results highlight an effective strategy for those seeking to optimize air quality without incurring significant operational challenges. This research can guide future decisions in indoor air management, pointing towards a promising direction. In addition, this research indicates that for environments concerned with UFP's, the use of higher rated HVAC

filters may in fact offer little protection while increasing energy use, and that use of an in-room air purifier with a known UFP removal rating may be a preferred solution.

Primary authors: Mr VIOSCA, Alan (Agentis Air LLC); ROTHENBERG, Larry (Agentis Air LLC); Mr LONG, Normand (Agentis Air LLC); Mr REZAEI, Ramin (Agentis Air LLC)

Presenter: ROTHENBERG, Larry (Agentis Air LLC)