

Performance Analysis of MERV14 Air Filters in MERV 8 Air Handling Unit System

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Abstract:

To facilitate the removal of the airborne virus by using good ventilation either through natural or mechanical and fresh air flow under the HVAC systems. In this research, we have installed MERV-14 filters to determine its performance in a MERV-8 air handling unit. In this system MERV-14 filters works as a secondary air filtration system. MERV-14 filters remove airborne, large air particles size up to 0.3 microns. Higher the MERV rating means removing the fine particles of air-by-air filters. The installation of MERV-14 filters has been done as per the ASHRAE guidelines with following all safety guidelines and standards. The results also suggest that MERV-14 filters provide fresh air with higher CFM to the buildings and offices. AQI (air quality index) is an important tool to identify the quality of air. AQI values were identified for the different location for a MERV-8 air handling system. A MERV-14 system was attached with the MERV-8 air handling system and then the value of AQI was identified and compared. For MERV-14 attached, MERV-8 air handling system the observed value of PM10 is $42 \mu\text{g}/\text{m}^3$ which is under the acceptable limit consider good air quality inside the building. We have also calculated the PM2.5 reading which was $31 \mu\text{g}/\text{m}^3$ which is very for good for occupants working in a building.

Keywords —MERV 14, MERV 8, Air Handling Unit, Air Filter,

I. INTRODUCTION

MERV, the acronym for Minimum-Efficiency Reporting Value, The MERV rating procedure assesses the particle removal efficiency of a filter over three particle size ranges 0.3-1-micron, 1-3-micron, 3-10 micron. The higher MERV rating filters remove more particles in the smaller size ranges. The minimum MERV rating to remove 50% of the 1-3-micron size range is MERV-10. MERV-16 filter captures more than 95% of all three particle sizes, including bacteria, airborne, microorganisms and tobacco smoke. Therefore, this study used MERV14 filters as the

high-efficiency filters and compared the system performance to filters of lower MERV ratings. In a study we have compare the different MERV rating filters and check their capacity of air cleanliness. It may be interesting in future work to apply the field measurement techniques to evaluate the change in filter efficiencies as filters load as a follow-up to the change in energy use as filters load reported here removal of smaller particles generally results in higher airflow resistance. We are using the filter size of MERV is 600*650*50 in mm. To facilitate the removal of the airborne virus by using good ventilation either through natural or mechanical) and fresh

air flow under the HVAC systems. Earlier MERV 8 filtration system was being used in the HVAC system. Now we are going to upgrade from MERV 8 to MERV 14 filtration system. MERV 8 filters will be used as pre-filters and MERV 14 filters will be used as second stage filtration.

II. LITERATURE REVIEW

Masih Alavy et al [1] This is experimental data of different filters and their characteristics that influence the effectiveness of high efficiency of filters in 21 residences in Toronto, Canada. In-suit effectiveness was assessed with decay tests at the beginning. At the end of the filter's life with four different filters (MERV 8-14 from ASHRAE standard 52.2) are installed in an operational HVAC system with either system on or off. There was a big difference between the median PM_{2.5} effectiveness of the non-electret filter with compared to electrets filter. The change was 16% vs. 63% at the same nominal efficiency (MERV 8). But median PM_{2.5} 's effectiveness of electret filter improved b/w 5% to 9% as MERV increased from 8 to 14 which was a small change. There were some other changes in the effectiveness of filters as there were more changes in the effectiveness of filters if the same filters were installed in different homes in comparison of different filters in the same house or building. This variation in the performance of filters arose because the ventilation rate (home-specific particle loss rates) varies greatly in different buildings. As the loss rate increases due to non-filter factors, the effectiveness of the filter decreases.

John Zhang et al. [2] Experiments have shown that the droplets which come from the mouth in the sneezing and coughing contain viruses and bacteria. These droplets cover a wide particle size range. A small droplet floats in the air and dry to form fine particles. These particles stay in the air for hours. The sars-CoV-2 virus which is responsible for COVID-19 is transmitted

through these droplets, aerosols and contact. Some research showed that this virus can be distributed in the air and on the surface of any object. Other research discovered that airborne transmission mainly via nascent aerosols from human atomization is highly responsible for the transmission of this virus. Another study showed that a viable virus was detected in the air up to three hours post aerosolization. The W.H.O. state that the use of airborne precautions whenever applicable in addition to standard, droplet and contact precaution. ASHRAE's Epidemic Task Force recently issued COVID-19 position reports which state that transmission of this virus by air should be controlled by controlling the airborne exposure. Many studies have been done in the past for removing bioaerosols with the help of filters and other devices. This study pointed to the viral filtration of residential HVAC filters with different efficiency ratings e.g. MERV 14, MERV13, MERV12 and MERV5.

Nirmala et al. [3] The incidence of Porcine reproductive and respiratory syndrome virus (PRRSv) infections in Midwestern breeding herds swine farms have been reduced by filtering the air. The nature and type of viruses trapped in different types of filters are not yet clear because there is no reliable method to elute and identify these viruses. In this study, we report that eluting viral particles from air filter with the help of grinding filter specimens with liquid nitrogen and coupled with TRIzol reagent to extract RNA can detect both PRRSv influenza A virus with min. efficiency rating e.i. MERV14, MERV 15 and MERV 16. In this study, PRRSv vires were detected in 27% and IAV (influenza A virus) virus was detected 66% by filters that have been installation b/w 08\12\13 and 07\12\17. PRRSv was also founded on used filters from the farm which states that herd aerosol spread for these viruses. This study opened up new windows to further investigate the airborne transmission of viruses and risk in swine farms and to control them.

Yizhi Zhang et al. [4] Filters in heating, ventilation, and air-conditioning (HVAC) systems are the most prevalent air cleaning method in residential environments in North America. These concentration results suggested that in general, indoor concentration had a similar seasonal trend as the ambient concentration, and indoor activities (e.g., cooking) elevated indoor particle levels for 40-50% of the time. again, the impacts of electret filter was examined using a filter with a MERV rating of 8 taken as the reference point at each home. The mean effectiveness of the filters (MERV 8E = -4.19%, MERV 11E = -0.51%, and MERV 14E = 14.5%) were lower than values found in the literature, most likely due to lower HVAC system runtime in our sample of homes (median = 9.6%). Overall, this filter effectiveness analysis reveals that the real-life filter performance was strongly influenced by system and house characteristics (e.g., system runtime, in-situ efficiency, air change rate, and particle source strength), and thus can be different from modelling and laboratory test results.

Alireza Mahravi et al. [5] The analysis of dust collected on the filters installed in the heating, ventilation, and air-conditioning (HVAC) systems, filter forensics, is a useful Method to identify concentration, size distribution, and composition of indoor air particles. After all extractions 0.1–5.5 g and 0.02–11.4 g ranging of dust particles removed from the artificially and naturally loaded filters, respectively. These ranges were equivalent to 11.3–52.2% and 1.8–72.9% recovery efficiency, the ratio of dust recovered to the dust loaded in the filters. This method was found to be an effective way to add the recovery to enable filter forensics for the detection of multiple analytes. The recovered sample was slightly over-representative of particles greater than 10 µm. Therefore, caution should be taken when applying filter forensics for studying contaminants associated with smaller particles.

Clothilde Brochot et al. [6] With an equal mass, nanoparticles (NP) have higher toxicity than particles with the same chemical composition but with a larger surface area. However, the toxicological knowledge concerning NP is still insufficient to establish limited values of exposure. To evaluate the filter performance for NP, five types of filters were investigated to measure their performance for particles smaller than 300 nm including NP. The Experimental data permit the evaluation of the MPPS for these mechanical filters. Nevertheless, the 150–500 nm range provides a better estimation of the MPPS in the conditions which were tested. Also, filtration velocity influences efficiency for nanoparticles at 50 nm but no effect was observed for MPPS.

Egel et al. [7] The presence of biofilms at the cooling coils of monetary air conditioning (AC) devices can notably lessen the warm temperature switch performance of the coils and may purpose the aerosolization of microbes into occupied areas of construction. We investigated how weather and AC operation affect the ecology of microbial groups on AC coils. Forty massive-scale business ACs had been taken into consideration with illustrations from warm-humid and hot-dry climates. Both bacterial and fungal ecologies, which include richness and taxa, at the cooling coil surfaces had been notably impacted with the aid of using doors weather, thru variations in temperature that result in improved moisture (condensate) on coils, and with the aid of using the minimal performance reporting value (MERV eight vs MERV 14) of constructing air filters. supported centred qPCR and series analysis, low-performance upstream filters (MERV eight) had been associated with a more abundance of pathogenic microorganisms and medically applicable fungi. due to the fact the implementation of air conditioning maintains to develop worldwide, higher knowledge of the elements impacting microbial increase and ecology on cooling coils ought to permit extra rational techniques for biofilm management and

the result in decreased strength intake and more healthy buildings.

Emily R. Jones et al. [8] Fine particulate (PM_{2.5}) is an airborne pollutant associated with terrible acute and persistent human fitness outcomes. Although the majority of PM_{2.5} studies has centred on out of doors exposures, human beings spend the majority of their time indoors, in which PM_{2.5} of outside starting place can penetrate. in the course of these paintings, we measured indoor PM_{2.5} constantly for three hundred and sixty-five days in 37 city business workplaces with mechanical or mixed-mode airflow in China, India, the UK, and as a consequence us. We located that indoor PM_{2.5} concentrations had been normally better while and in which out of doors PM_{2.5} became elevated. In India and China, suggest workday indoor PM_{2.5} tiers passed the arena Health Organization's 24-hour publicity tenet of 25 g/m³ approximately 17% and 27% of the time, respectively. Our statistical fashions located proof that the operation of mechanical air flow structures ought to mitigate the intrusion of outside PM_{2.5}: in the course of preferred paintings hours, a 10 g/m³ boom in out of doors PM_{2.5} became associated with a 19.9% boom in the anticipated attention of indoor PM_{2.5} ($p < 0.0001$), in comparison to a manner larger 23.4% boom in the course of non-paintings hours ($p < 0.0001$). Finally, our fashions located that the use of filters with rankings of MERV 13–14 or MERV 15+ became associated with a 30.9% (95% CI: –55.0%, +6.2%) or 39.4% (95% CI: –62.0%, –three.4%) discount of indoor PM_{2.5}, respectively, in comparison to filters with decrease MERV 7–12 rankings. Our outcomes reveal the capacity efficacy of mechanical air flow with green filtration as a public fitness method to defend people from PM_{2.5} publicity, in particular in which doors tiers of PM_{2.5} are elevated.

Mitra A et al. [9] the most intention of this clinical studies is to training session the effectiveness of commercially to be had air filters and to in shape differing styles of

commercially to be had air filters in sure categories. With the latest record-breaking wildfires and as a consequence the Covid-19 pandemic, studies at the outcomes and capabilities of nanoparticles have emerged as more and more important. Inhalation of nanoparticles in smoke might also additionally result in excessive fitness outcomes on humans, affecting particularly the systema respiratorium. As nanoparticles can go through molecular membranes, absorption takes place swiftly and impacts many diverse components and capabilities of the bodily body. While air filters are a green approach to decreasing small-sized debris inflowing air, present-day filtration requirements best follow large-scaled microparticles, and filtration efficiencies for nanoparticles are regularly unknown. a sincere knowledge of the effectiveness of air filters and mask is vital to forestall inhalation of nanoparticles. using a shape and differing varieties of woodsmoke, the penetration quotes of nanoparticles thru air filters had been determined. Tests had been finished with 4 one-of-a-kind air filters the use of woodsmoke from hickory and applewood pallets. because of outliers affecting suggest and variance values, a JavaScript code became written to put off outliers from the data sets. Trials with hickory smoke furnished extra constant outcomes than with applewood smoke. Average filtration effectiveness the use of hickory smoke became tremendously near for all air filters at around 50%. Results from applewood smoke had been tremendously inconsistent. because of a sincere variety of know-how and excessive preferred deviations, effectiveness could not be installed precisely.

Z. Lua et al. [10] in the course of this study, for higher knowledge the realistic elimination impact of air coping with unit (AHU) gadget on airborne microorganisms (which include microorganism and fungus) and debris and microbial increase, the samples of microorganisms and debris in 10 air coping with unit (AHU) structures which include fan coils

and indoor air had been gathered and analysed in air and element surfaces of such structures in IT/ITES offices and multy story building. it is located that the elimination performance is nice for microorganisms 73.9% and as a consequence the bottom for debris (0.5–2 micron) 24.4%. The floor attention of package micro-organism is 29 CFU/cm² and fungi 137 CFU/cm². Five of 10 structures have better fungi concentrations on air consumption than that on the diffuser. The outcomes additionally display that the critical air delivery gadget with no unusual place components has trouble achieving/keep proper overall performance as soon as microorganisms and debris exist, particularly for particle length $D \leq 3 \mu\text{m}$. the scale distribution has massive effect elimination performance. The microbial increase on surfaces of duct and device became observed and may be transferred into indoor air. this could lower the indoor air pleasant and purpose negative fitness.

III. METHODOLOGY

For air filtration System

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- a) DLF Buildings are equipped with AHUs on each floor to meet air conditioning requirements for the tenant area. These AHUs are designed of required CFM along with fresh air provisions in the AHU room. The AHU supplies air through the supply duct to the tenant area & the return air comes back to the AHU room. This is how air circulation is completed.
- b) Fresh air provision has been provided for maximum outdoor supply rate as per design requirements. As per ASHRAE 62.1 standard. Fresh air is coming through the air shaft & there is manual provision to increase the outdoor air supply in the system.
- c) Maintenance of AHUs is being carried out as per the site-specific PPM schedule.
- d) The temperature and relative humidity are being maintained at 24 to 30°C and 40 to 70% respectively.
- e) Fresh air intake is maintained at 100% to maintain positive pressure.

- f) Cleaning of filters - As per ISHARE recommendation, use 5% Cresol solution (containing 50% Cresol and 50% Liquid soap solution), mixing 1 liter of this solution in 9 liters of water.
- g) Condensates drain pan are disinfected with 1% sodium hypochlorite dosing. (This will apply only if the HVAC equipment is working on a re-circulatory mode.)
- h) Disposal of AHU filters should be done as per existing DLF Waste Management SOP No-07.

The following additional requirements are drawn from the COVID-19 Guidelines issued by ISHRAE (Indian Society of Heat, Refrigeration, Air Conditioning Engineers

- a) Provide adequate Ventilation (Fresh Air and Exhaust).
- b) Inspect and clean the indoor unit Coils, as per the Operation & Maintenance guidelines given by the OEM/PPM.
- c) Heat Recovery Wheel (HRW) if installed: It is advisable to keep this wheel in off mode to reduce cross-contamination. Upon restarting, the wheel must first be sanitized.
- d) Toilet and Kitchen Exhaust Fans must be kept in operating mode.
- e) It is advisable to provide a MERV 13 or higher filter fitted on the Air Handling Unit. If a filter of higher filtering capability is fitted into an existing system
- f) A minimum fresh air volume of 8.5 cum/ hour per person and 1.1 cum/ hour per sq. m (5 cfm per person and 0.06 cfm per sq. ft.) is recommended. The recommendation is to maximize the supply of outside air within the limits of the system.

IV. RESULT & DISCUSSION

The efficiency of air filtration is depending upon the Value of MERV, the higher MERV rating means it separates more fine air particles. We have evaluated the MERV-14 air filtration system to clean the air more than 90% by removing the airborne particles and other air contaminants. MERV-14 is a second stage filtration system which increased the life of their filters. Filters with higher MERV rating traps small particles more effectively

than filters with lower MERV ratings. MERV 14 air filters system provide between 90% and 95% efficiency for filtering particles between 3 and 10 microns in size (such as mold spore, cement dust and dusting aids). IT also provides efficiency of 85% and 90% for filtering air particles ranging from the size of 1 micron and 3 microns (such as lead dust, legionella, coal dust, humidifier dust, and nebulizer droplets)

CFM of existing pre filter without MERV-14- CFM = Area (Face area of existing filters in ft) * Air velocity (ft/min) * 10 (multiplying factor). CFM = 30.61 * 45.02 * 10 CFM = 13781 CFM of MERV-14 filters along with pre-filter (MERV-8). CFM = Area (Face area of existing filters in ft) * Air velocity (ft/min) * 10 (multiplying factor). CFM = 30.86 * 45.48 * 10 CFM = 14035.

Indoor Air Quality of pre filter without MERV-14
PM 10 = 42 PM 2.5 = 31

V. CONCLUSION

The present research describes the performance of MERV-14 air filtration system. In this paper, we do the experimental analysis of MERV-14 filter installation along with MERV-8 filters in Air Handling units. The system develops a corresponding difference in the air quality circulating inside the buildings/floors and prevent COVID-19 infection and other diseases as Allergy, Asthma. V. REFER

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