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Changes for the Better

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Filtration in Ventilation Equipment

MESCA – Energy Recovery and Ventilation

HOW IT WORKS
MITSUBISHI ELECTRIC Heating and Cooling

In a previous HiW article, we discussed the importance of IAQ by introducing fresh outside air into buildings. In this article, we will explore how filters work and why proper filtration is just as critical as bringing fresh air.

The filter media is made up of fibers that are randomly intertwined with each other. When particles enter the intake section of a ventilation equipment, the particles are impacted and intercepted onto these fibers. Now, since particles vary in size, filtration depends on the spacing between the fibers and even air flow velocity. Some particles stick to the fibers, while smaller particles simply pass right through. Here are the 4 filtration mechanics we must know to understand how small particles get filtered:

1. **Inertial impaction** – as the name suggests, a typically large particle attaches itself to the filter fiber due to its inertia, causing it to separate from the airflow and collide with the media.
2. **Interception** – this typically happens to medium sized particles. They're too small to possess inertia but follows the path of the air flow and eventually adheres to the media.
3. **Diffusion** – typically happens to smaller sized particles where they travel in random air flow paths known as Brownian Motion of small particles. This random movement increases chances particle colliding with filter media.
4. **Electrostatic attraction** – typically found in filters with synthetic media. As particle travels along same air flow path, electrostatic force will pull the particle towards the media if it even gets close, eventually collides with the fiber.

Now that we understand the filtration mechanics, it is crucial to understand filtration efficiencies. According to ASHRAE 52.2 standard, filtration efficiencies are measured on a scale from 1-16, called MERV (Minimum Efficiency Reporting Value). It measures how effectively the filters trap small particles on the filter media and preventing them entering the building's occupied spaces. The below table shows how effective each MERV rated filter performs using 3 ranges of particle sizes:

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Table 12-1 Minimum Efficiency Reporting Value (MERV) Parameters

Standard 52.2 Minimum Efficiency Reporting Value (MERV)	Composite Average Particle Size Efficiency, % in Size Range, µm			
	Range 1 0.30 to 1.0	Range 2 1.0 to 3.0	Range 3 3.0 to 10.0	Average Arrestance, %
1	N/A	N/A	$E_3 < 20$	$A_{avg} < 65$
2	N/A	N/A	$E_3 < 20$	$65 \leq A_{avg}$
3	N/A	N/A	$E_3 < 20$	$70 \leq A_{avg}$
4	N/A	N/A	$E_3 < 20$	$75 \leq A_{avg}$
5	N/A	N/A	$20 \leq E_3$	N/A
6	N/A	N/A	$35 \leq E_3$	N/A
7	N/A	N/A	$50 \leq E_3$	N/A
8	N/A	$20 \leq E_2$	$70 \leq E_3$	N/A
9	N/A	$35 \leq E_2$	$75 \leq E_3$	N/A
10	N/A	$50 \leq E_2$	$80 \leq E_3$	N/A
11	$20 \leq E_1$	$65 \leq E_2$	$85 \leq E_3$	N/A
12	$35 \leq E_1$	$80 \leq E_2$	$90 \leq E_3$	N/A
13	$50 \leq E_1$	$85 \leq E_2$	$90 \leq E_3$	N/A
14	$75 \leq E_1$	$90 \leq E_2$	$95 \leq E_3$	N/A
15	$85 \leq E_1$	$90 \leq E_2$	$95 \leq E_3$	N/A
16	$95 \leq E_1$	$95 \leq E_2$	$95 \leq E_3$	N/A

As per ASHRAE 62.1 & 62.2, current requirements for non-residential buildings, a minimum of MERV 8 efficiency is required and MERV 6 for residential buildings. However, higher efficiencies are being used in many cases such as MERV 13 and 14 filters to provide a much healthier breathing environment. MERV 8 is typically used as a pre-filter and MERV 13-16 for final filters. Final filters are frequently used in general commercial type buildings, long term care facilities, hospital environments, and general surgery rooms. MERV 17-20 rated filters are commonly used in clean rooms, pharmaceutical facilities, or applications that contain carcinogenic materials.

It is also important to point out that proper filter maintenance is crucial to the DOAS equipment. Over the span of a filter's life, the efficiency drops and may cause detrimental effects to the equipment such as shorter motor lifespan due to increase pressure drop in the system.