Comparing

ISO 16890

&

ASHRAE 52.2/ MERV

ISO 16890 Vs ASHRAE 52.2-MERV

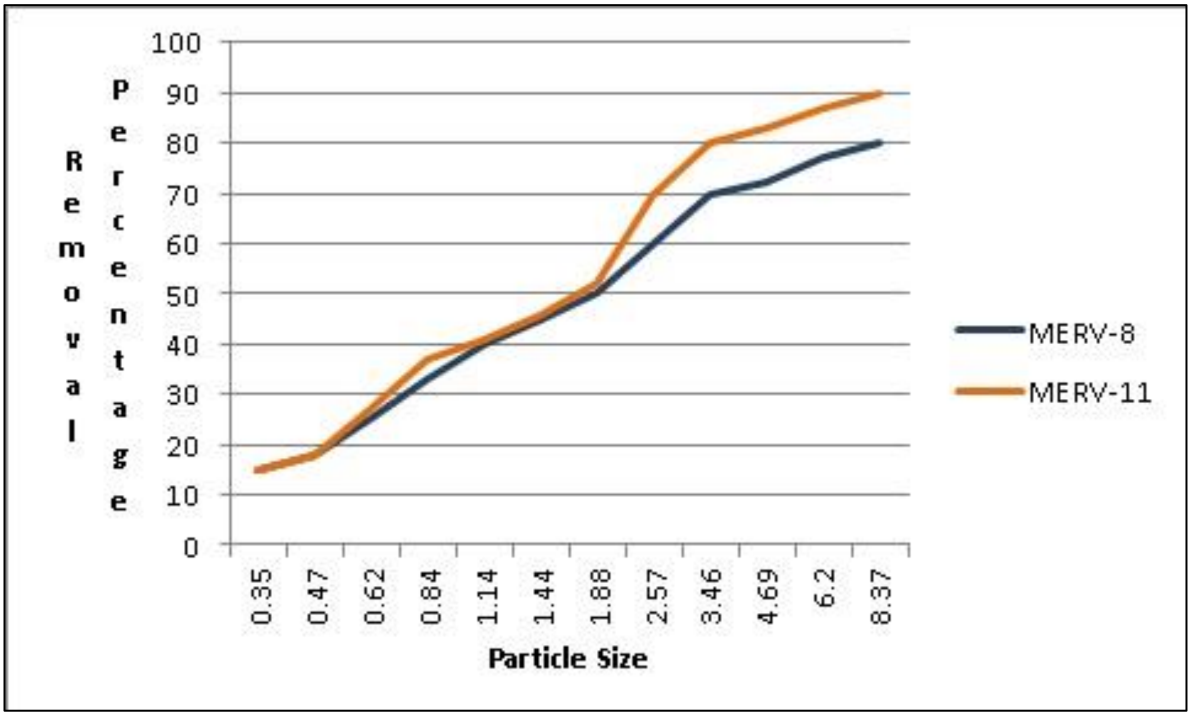
Introduction

While ISO 16890 is now the accepted test method for filters everywhere in the world, the United States and Canada have some detractors that are fighting to keep the old status quo of ASHRAE 52.2 and the MERV standard alive. To understand why this is, or to decide which standard you want to use for specifying or purchasing your HVAC air filters a better understanding of the formation of the two standards, how they measure particulate removal efficiency, and how applicable they are to real-world conditions. A direct conversion of MERV to ISO efficiency is not possible because of how different the test methods are; however at after the closing thoughts a table with our subjective conversions will be included.

The Making of MERV

Prior to the adoption of ASHRAE 52.2 anyone wanting to filter the air purchased filters according to 52.1 Dust Spot Efficiency. With technology progressing it became clear that the dust spot efficiency standard didn't offer a true representation of how well a filter removed or captured particles from the air. It also became economically viable to be able to count particles across smaller more focused ranges instead of doing an overall test of particle removal of a specific test aerosol that was prescribed in 52.1. The time had come for a stricter standard that changed how we looked at air filters and the resulting MERV table of the new standard definitely did that. Instead of looking at the overall removal efficiency of a test aerosol we now looked at specific particle size ranges. The only problem is the removal efficiency number scale that was developed (originally 1-20 then scaled back to 1-16 to remove HEPA and ULPA filters because HEPA and ULPA filters aren't tested under 52.2 procedure) was rather arbitrary and when you went from one number to the next higher number you didn't get an even or equal increase in efficiency. For example the increase in efficiency between MERV-8 and MERV-11 is relatively minor while going from MERV-11 to MERV-13 is significant.

Here's a look at the fractional efficiency curves for filters that would be classified as 8 and 11:



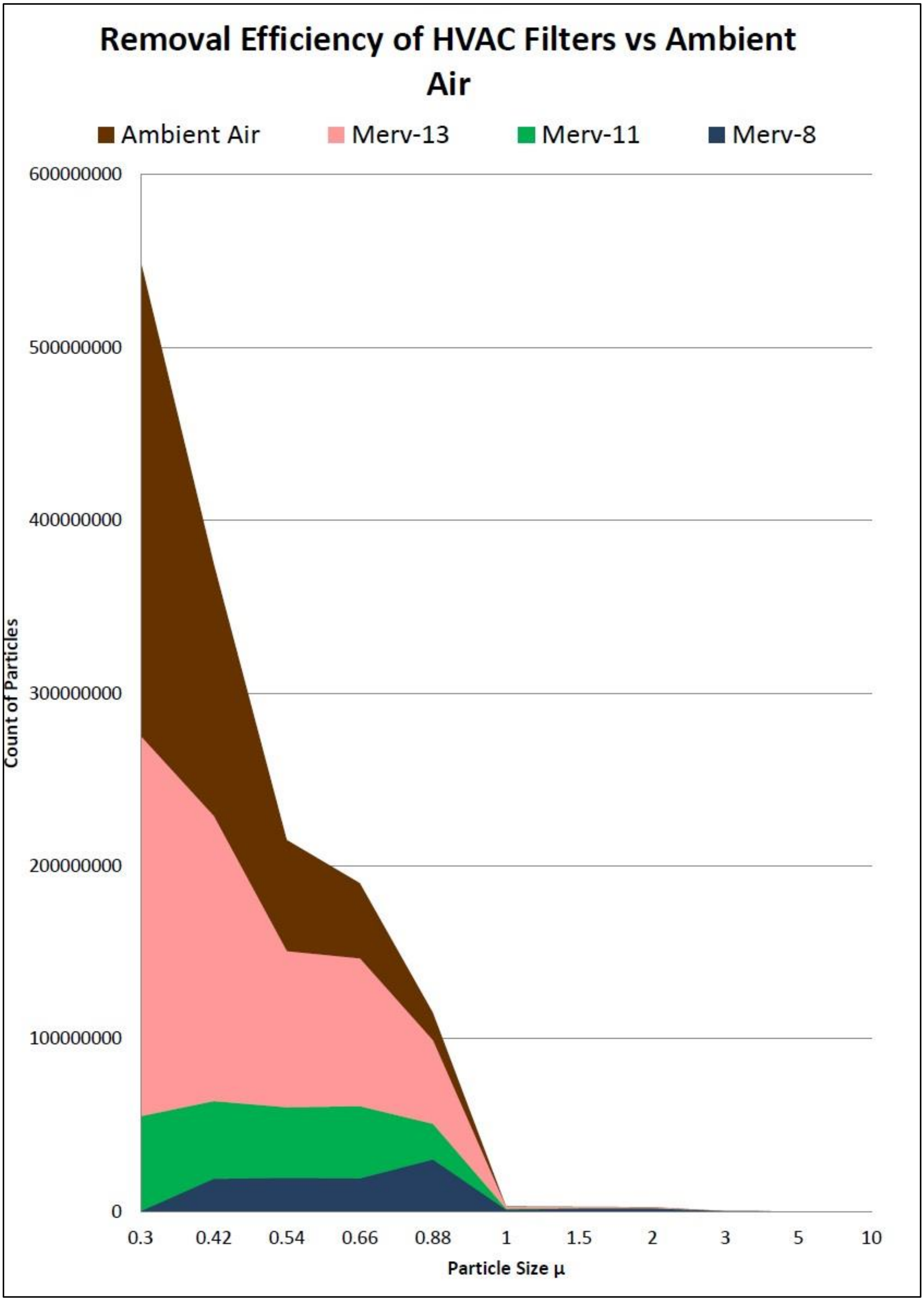
Particle Capture Measurement of MERV

Revolutionary for its time, the table that developed in ASHRAE 52.2 that would determine what MERV a filter would be assigned was a leap forward and truly changed how air filtration was looked at. For the first time we were able to make a filter recommendation based on what particle size we wanted to remove. In this regard MERV will always be a useful standard, especially in industrial process filtration or other areas where removal of a certain particle size (between 0.3µ and 10µ) is of most concern. For example if we know that there are particles that is 0.85µ we need to remove from the air at 75% or more, we could look at a 52.2 report and look at the particle size removal percentage chart and find out which filter would work best. Most likely it would be a MERV-13 or MERV-14. Why it isn't a cut and dry assignment of one MERV here is because of how the filters are given their numerical value. There are 12 ranges that measured and then grouped into 3 major ranges known as E1, E2, and E3 and averaged again. This creates variability within the same ratings – which means one manufacturer's MERV-13 would remove 75% of 0.85 µ particles while a different manufacturer (or even different style of filter from the same manufacturer) may need to go to MERV-14 to get the same 75% removal of 0.85µ particles.

Real World Applicability of MERV

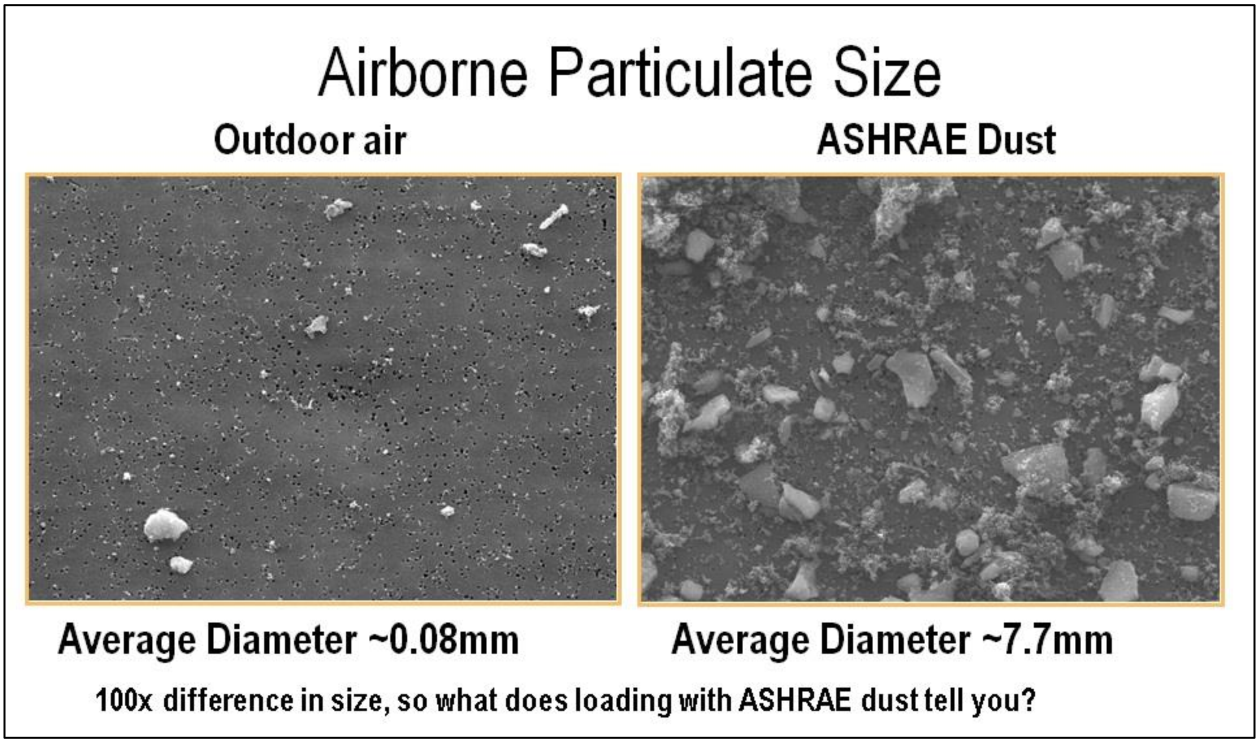
There is no reference to real world or atmospheric air particle size distributions. This has made improper filter efficiencies being used in general HVAC applications rampant. What we've seen is the problem of compromise by engineers and equipment manufacturers that is allowed for in MERV and the recommendations by air filtration specialists that do not understand the relationship of the particle removal of different MERVs of typical atmospheric air. For some reason (most likely because they looked different and the 52.1 efficiency was called 65%) "high-efficiency" filters start at MERV-11.

For general HVAC applications, i.e. office buildings, schools, colleges and universities, and retail spaces, **there is no reason to use MERV-11**. However this efficiency filter is widely used because it is seen as a compromise between the "standard" efficiency MERV-8 and MERV-13 which is typically recommended for increasing Indoor Air Quality or IAQ. And why wouldn't it? Filter manufacturers describe it as high efficiency, some still refer to it as 65% (a big percentage) and it is 3 whole MERV above the "medium efficiency" MERV-8. When you pair the fractional efficiency curve against the distribution of particles in atmospheric air, you find out that MERV-11 only removes about 20% of these particle – hardly high efficiency. This low removal efficiency is worsened if re-circulated air is used because the indoor environment is more particle filled than outdoor air, and because the sub-micron particles are what suspends in the air and picked up by the returns we are simply pushing this dirty particle filled air throughout the building if anything lower than MERV-13 is used. Matching the fractional efficiency curve to atmospheric air we can see that MERV-13 removes a little over 50% of all particles, meaning with every pass the air gets cleaner.


Removal Efficiency of HVAC Filters vs Ambient Air
Ambient Air
Merv-13
Merv-11
Merv-8
600000000
500000000
400000000
300000000
200000000
100000000
0
Count of Particles
0.3
0.42
0.54
0.66
0.88
1
1.5
2
3
5
10
Particle Size µ

There is also the problem of addressing coarse fiber, charged synthetic media. This media is cheaper to make than fine fiber so many manufacturers use it, however it has been proven repeatedly through an almost uncountable number of scholarly independent studies that this media loses its particle capture efficiency over time due to shielding of the media by ultra-fine particles. Appendix J was added as an *optional procedure* to the 52.2 standard in 2007, but most companies do not include it which leads to end users purchasing filters that misrepresent their real-world efficiency. It is common for a filter labeled MERV-13 to drop to MERV-10 or even MERV-8 after a short period of time if it made with coarse fiber synthetics. These filters also have poorer dust holding capacities meaning they don’t last as long as their fine fiber counterparts.

Dust Holding Capacity (DHC) is another area where the ASHRAE 52.2 MERV test method falls short in real world usefulness. This is because the challenge aerosol used to produce DHC values is AHSRAE dust, which is a horrible representation of atmospheric air and loads into a filter much differently than how a filter will load when used in an air handler. The average particle size of ASHRAE dust is over 100 times larger than the average particle size of atmospheric air, rendering the DHC value as a comparative measure of filter performance worthless.



Creating ISO 16890

Prior to its adoption, there were three different test methods being used throughout the world: EN779, ASHRAE 52.2, and believe it or not there were some countries still using the ASHRAE 52.1 standard. Having these different standards ISO formed a committee of filtration experts from around the world to take the best parts of each standard and create a single uniform standard for HVAC air filters. It is important to stress here that this standard's purpose was for rating filters for general HVAC efficiency – this fact is lost on many of the people in the United States wanting to cling on to the now antiquated 52.2 test method. What ensued was as multi-year exhaustive peer-review process that has been unmatched when creating any of the previous air filter test methods.

The unique basis of ISO 16890 was to create a test method that was specifically addressing how air quality was already discussed and gave a reported efficiency that was useful and easily understood by end users that are not air filter experts. The decision was made, and supported through unanimous vote:

1) To challenge filters with a particle size distribution of atmospheric air

2) Report in terms of $_e$PM to use terminology already used in air quality conversations
3) To report a single efficiency like 52.1 and EN779 which is intuitive, unlike the MERV chart
4) Take into consideration the loss of efficiency in coarse fiber synthetic media as a mandatory portion of the standard

The culmination of these criteria is again changing how we look at air filtration for the better and communicating air filter particulate removal efficiencies that is intuitive and benefits building occupants.

Particulate Capture in ISO 16890

Previous air filter test methods used an arbitrarily picked challenge aerosol (52.1), looked at only one particle size (EN779), or looked at particle capture by size in a vacuum without regard to what the filter would be challenged with when used (52.2/MERV). For the first time air filters will be challenged using an aerosol with a globally accepted particle size distribution that will most mimic the atmospheric air that an HVAC air filter will encounter when in use. The removal then is given a single percentage based on the distribution used – $_e PM_1$ which represents high efficiency needs, $_e PM_{2.5}$ for Medium efficiency needs, and $_e PM_{10}$ and ISO_{Coarse} for low efficiency or pre-filtration needs. The reason these thresholds were chosen is because the World Health Organization, the EPA, and other regulators use $PM_{2.5}$ and PM_{10} in their current regulations, with a push now to add PM_1 to their standards because 99% of all particles fall under the PM_1 group and are the particles most detrimental to human health.

It is also mandatory that filters are tested before and after being treated in an IPA vapor chamber. The reason for this is IPA vapor has been proven (again by a staggering number of academics and accepted worldwide) to remove the temporary advantage of coarse-fiber synthetic media which currently allows US based manufacturers to sell their filters as a higher MERV than they actually perform at once installed in a customer's air handling unit. The before and after particulate removal efficiencies are averaged to create the reported efficiency. Included in the test report will be both the initial and post-discharge efficiencies for optimal transparency.

Real World Applicability of ISO 16890

Designing a test procedure that provided results useful to end users and not just filter experts was the intent of ISO 16890 and it has succeeded. Instead of looking at air filters based on particle size removal efficiency, we are looking at air filters through how well they work as close to real world conditions as can be reproduced in a lab. This method created a rating system that clearly articulates how well a filter works – not just when it is clean but also long-term throughout the service life of the filter. It is also now possible to intuitively understand the difference between filter ratings – which is not possible with MERV. This focus on real-world effectiveness does lose some utility because it doesn't produce particle size specific measurements; it instead tests the filter more similarly to how 52.1 did using a mass of particles.

Dust Holding Capacity is no longer useless as it is under the 52.2 MERV standard because the test aerosol has been changed to SAE Fine (ISO Fine) which is far more representative to atmospheric air. This will produce higher DHC values than ASHRAE dust, and some manufacturers currently publish reports using SAE Fine as the challenge aerosol because it gives their filter the appearance of having a higher DHC compared to a test done with ASHRAE dust– now there will be consistency in reporting. Just as in the particle removal efficiency mimicking real world conditions, the Dust Holding Test will also more closely resemble real world conditions, again creating more useful results for end users.

Final Thoughts

ISO 16890 takes the best parts of previous methods and then adds in some additional conditions that were exhaustively peer reviewed which changes how we look at air filters and will help create safer and cleaner indoor environments for us all to work and live in.

The improvements over past test standards are:

- Using a mass particle efficiency similar to 52.1, but the mass of particles is consistent with atmospheric air
- Uses multiple efficiency categories similar to 52.2 to address applications that need High, Medium, and Low/Pre filtration
- Uses a discharging method similar to EN799 that more accurately reports the real world efficiency of the filter
- Uses a challenge Aerosol for DHC that provides more useful information
- Calculates a particle removal/capture efficiency that is intuitive and uses a mass of particles most similar to real world as that can be replicated consistently in a lab as opposed to a random challenge or assigning arbitrary numbers based on arbitrary removal efficiencies

Approximate Conversion*	
MERV	ISO 16890
8	ISO_{coarse} 90%
9	$_{e}PM_{10}$ 60%
11	$_{e}PM_{2.5}$ 50%
13	$_{e}PM_{1}$ 50%
14	$_{e}PM_{1}$ 75%
16	$_{e}PM_{1}$ 95%

*Due to the *significant* differences in these two test methods, a direct conversion is impossible, this table is only a subjective approximation