Using MERV Ratings to Determine the Effectiveness of Industrial Dust Collectors

How Appropriate?

by Matt Kalis, Donaldson Company, Inc.

Standards to appropriately and accurately measure the effectiveness of industrial dust collector systems have never existed. Since many dust collector and filter manufacturers make claims about their products' performance, many end users find themselves lost in a world of boasts and promises. In an effort to implement a basis for comparison, many companies, industries, and jurisdictions have resorted to the application of MERV ratings, established by ASHRAE 52.2 for the general industrial ventilation cleaning industry. But is this an appropriate measurement of effectiveness for industrial dust collectors?

Applying the MERV rating system to measure the effectiveness of industrial dust collectors is problematic for the following reasons:

- MERV tests at stipulated media flow rates are much different than the typical operating flow rates of industrial dust collectors;
- MERV ratings indicate minimum filter efficiency (typically at start up) rather than typical filter emissions over the filter life;
- MERV measures the effectiveness of the filter media, rather than the entire dust collection system and its self-cleaning system; and
- MERV identifies pressure drop but doesn't address overall energy consumption.

WHAT IS MERV?

MERV stands for *Minimum Efficiency Reporting Value*. It is a rating system incorporated into the test specification of ASHRAE 52.2. It assigns a single number to a filter in an effort to identify its minimum performance in removing particulate from an airstream. Higher numbers **are intended** to indicate higher filtration efficiency, but many industrial dust collection industry experts would argue that they don't.

ASHRAE 52.2 was initially written to establish a method to measure the performance of general ventilation air cleaning devices. While general ventilation air cleaning systems and industrial dust collector systems both remove particulate from an airstream, they have little else in common. The differences are addressed below.

OPERATING FLOW RATES FOR GENERAL VENTILATION VS. INDUSTRIAL DUST

The 52.2 standard was established to test the efficiency of **static** air filters used in general ventilation systems, such as room and building air filtration systems. By contrast, industrial dust collection air filters function in a very **dynamic** environment, with dust continuously building on and being cleaned from the media as needed. Most industrial dust collectors include a self-cleaning system that allows the filters to continue performing much longer than if they were not cleaned repeatedly. Sometimes the filters are cleaned when there is no airflow, but often the cleaning occurs during normal operation. The ever-changing dust cake (and its associated pressure drop) means that the efficiency of the filter is also ever-changing. Each time a filter is cleaned, the efficiency of the filters changes. The static conditions used in ASHRAE 52.2 cannot be appropriately applied to the dynamic conditions within a dust collector.

Industrial manufacturing processes produce dust – in amounts not expected in general ventilation cleaning systems. The airstreams within the processes at saw mills, grain handling facilities, metal fabrication shops, and thermal spray booths typically produce 0.5 to 20 grain per cubic foot of particulate. Manufacturers cannot afford to stop production to change the filters on a frequent basis so they rely on dust collectors with self-cleaning systems. The self-cleaning systems allow a filter to remain in use for a longer period of time.

In contrast, an ASHRAE 52.2 test inserts relatively little dust into the airstream. It uses about 0.005 grain per cubic foot of air. This is 100 to 4000 times less dust concentration than in a typical industrial dust collector airstream.

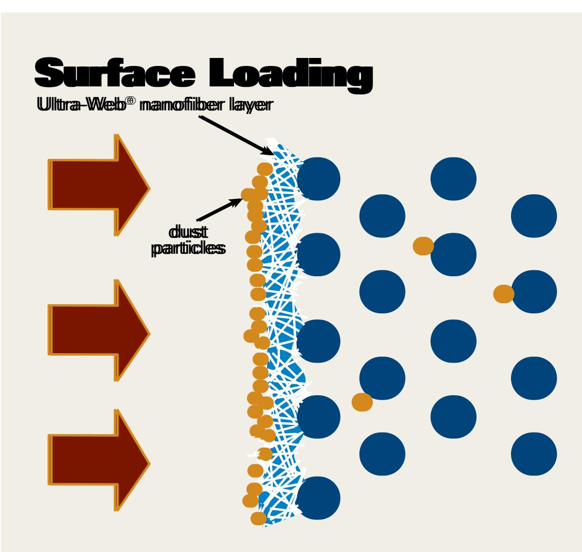
Another critical factor to consider is that media face velocity differs greatly between general ventilation and industrial dust collection. A typical dust collector will have a media face velocity in the range of 0.5 to 12 feet per minute. By contrast, ASHRAE 52.2 tests airflow velocities in the 118 to 748 feet per minute range. That means the magnitudes are 10 to 1500 times higher in a MERV test than in a dust collector. Since media velocity can affect efficiency, the applicability of the MERV test for an industrial dust collection application should be questioned.

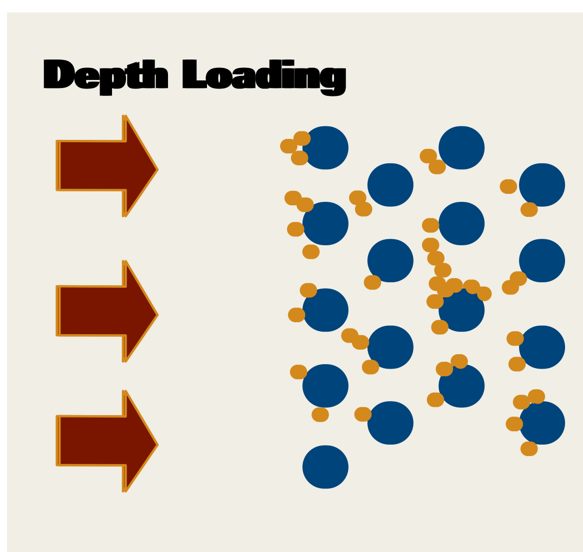
INITIAL VS. LIFE EFFICIENCY

The goal of ASHRAE 52.2 is to measure the efficiency of a general ventilation cleaning system. The goal of a dust collector is to control emissions over time. Upon first glance, it would appear that a filter's efficiency would be directly related to the emissions that the filter allows to escape the system. However, a filter's efficiency cannot be directly correlated with emissions in an industrial dust collector. If one tried to calculate emissions over time based off of MERV efficiency levels, the emissions would be greatly overstated. The miscalculation occurs because a filter in a dust collector becomes seasoned with dust and generates dust cakes over and over.

The operating principle of an industrial dust collector uses the accumulation of the dust cake to provide additional filtration. Since the dust cake provides a resistance to airflow, the resistance across the filter media of a dust collector is typically in the range of 2 to 5 inches of water. During that time, the dust cake is constantly being replaced as the filters are cleaned and then the dust rebuilds. The ASHRAE 52.2 test operates in a totally different range of resistance. The test will stop at a maximum resistance of 1.4 inches of water (or sooner depending on the level of efficiency being obtained). The testing for MERV is tied simply to the filter media's ability to capture dust, while a dust collector's operating cycle uses the accumulation and release of the dust cake as a significant contributor to performance efficiency.

These differences in the function of a dust collector versus the application of an ASHRAE 52.2 test will





make the approach to engineering media significantly different. For a static filtration system, it would be advantageous to have depth-loading media that allows the particulate to load throughout the depth of the media without actually penetrating through the filter element. The media that allows dust to load in the filter without building up a dust cake will handle more particulate and will last longer in a static environment.

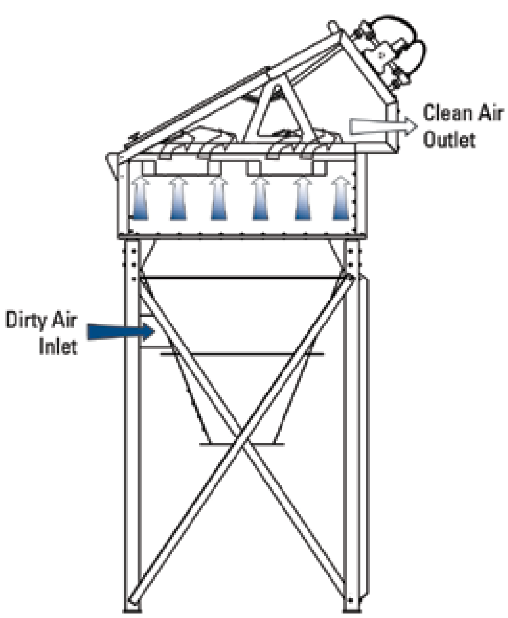
However, this is not ideal when trying to clean the media in a dynamic environment. The more dust retained on the surface of the media (surface-loading) the easier it is to clean it off. It is very advantageous to have a surface-loading media in a dust collector to ensure longer filter life.

A filter manufacturer could easily design a depth-loading media to ensure a higher MERV rating for its filters, and consumers might likely assume the higher MERV rating means a better filter. However, these depth-loading media often sacrifice the ability to release particles during the cleaning. An industrial dust collector consumer who buys a filter based strictly off the MERV rating might not be aware that he is sacrificing a significant area of performance - the ability to be cleaned. The best filter for industrial dust collectors would offer better efficiency AND better cleaning performance.

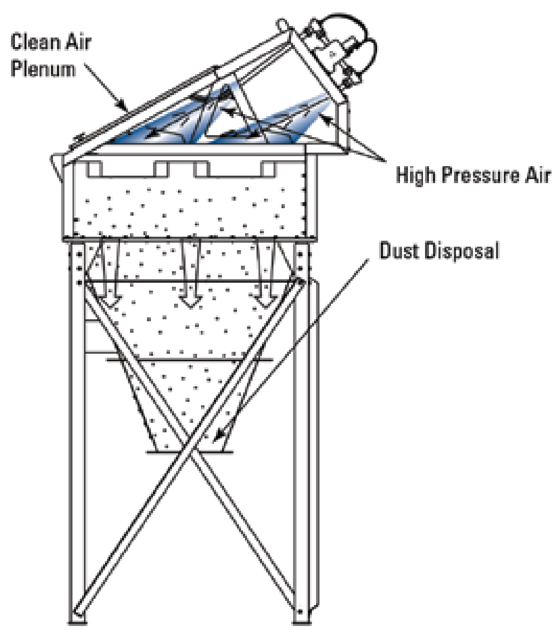
Given the number and complexity of factors that go into industrial dust collector performance, one could argue that it is ineffective to base dust collection purchasing decisions on a MERV rating that is based solely on initial efficiency. The conditions that separate a MERV 13 performance rating from a MERV 14 performance rating represent only a brief portion of the dust collector filter's life. The MERV rating that is established during the **initial few minutes** of the filter's life cannot predict the effectiveness of the **remaining 6 to 24 months** of the filter's life. Again, the efficiency characterization of 52.2 is not reliable. Actual industrial dust collector performance is more accurately based on the engineering in the cleaning system, surface loading media technology, and airflow management.

MEDIA VS. SYSTEM PERFORMANCE

The MERV rating system is also inadequate in identifying the effectiveness of an industrial dust collection system because it gauges the media, rather than the entire filtration system. Ideally, a standard would allow the end user to compare what the emissions would be during regular operation. It would gauge the effectiveness of the entire filtration system. Airflow management within a dust collector is critical to its overall performance. The design of it should manage the airflow so that most of the dust never reaches the filters in order to enable the media to last longer. The airflow should also be managed so that the collected dust settles without getting re-entrained in the airflow or be permanently suspended. There are



Normal Operation



Filter Cleaning Operation

many approaches to cleaning mechanisms, but the design of the cleaning system and the media should go hand in hand. The dust collector user is concerned only with the total performance, so the measurement of one or the other is incomplete.

PRESSURE DROP VS. TOTAL ENERGY CONSUMPTION

Another issue is that ASHRAE 52.2's notation of pressure drop does not acknowledge the broader performance characteristic of increasing concern to so many end users – energy consumption and its cost. Higher restriction in a filter takes more energy to maintain the proper airflow. The cleaning energy is also very important. A dust collector can have a great cleaning system and a low pressure drop but may require a massive amount of cleaning energy. Few would consider that scenario acceptable. Yet MERV ratings do not provide guidance to end users on this critical performance characteristic.

So What's Next?

Given all of the reasons why the MERV rating system is inappropriate for industrial dust collectors, where does that leave us? If there were a new standard, it should consider many of the main performance characteristics that an end user is concerned about – primarily those discussed in this paper. Other considerations end users have for choosing an industrial dust collector may also need to be considered. Size, cabinet integrity, noise, and the ability of the filter system to recover from an upset condition are other characteristics that end users typically want to know about.

Leaders in the industrial dust collection industry, ASHRAE, and ISO are currently working together to address this issue. ASHRAE's technical committee 5.4 has recently completed a research project (RP1284) to determine the best way to develop a test specification for dust collectors, and there is a special projects committee working to write a test specification based on this research. ISO's Technical Committee 142 is also busy writing a similar test specification to be used on an international level. Both may be several years away from being fully written and developed, but at least they are addressing the needs of the industrial dust collection market that MERV was never intended to address. Those interested should get involved. Consider being a part of the public reviews before the standards are published so that your feedback can help ensure the end users' needs will finally be met.

In the meantime, when confronted with a dust collection filter system selection choice, ask the manufacturer questions regarding the applicability of MERV to the situation at hand. More importantly, spend the time asking about characteristics that will better predict the effectiveness of the dust collection system such as: operating flows, expected filter life, media design, airflow management, cleaning system design and energy usage. Your bottom line will reflect your more discerning choice.

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