The importance of a correct air-to-filter-media ratio for a dust collector

The air-to-filter-media ratio is one of the most important factors to consider when selecting a dust collector. This article will address why this ratio is important and how it relates to dust collector selection.

The air-to-filter-media ratio, also known as air-to-cloth ratio, has long been one of the major parameters for selecting a proper dust collector. This “ratio” is actually a measure of the airflow velocity through the filter media. The reason for the name change from “cloth” to “filter media” is due to the wide variety of materials that can now be used for separating the conveyed dust from the airstream. Thus, the term “cloth” no longer represents the full range of filter materials available.

The air-to-filter-media ratio for a dust collector is determined by dividing the airflow in cubic feet per minute (cfm) by the filter area in square feet. This results in feet-per-minute (fpm) airflow velocity through the filter media. For example, a dust collector with 3,000 square feet of cartridge filters with a flow of 4,500 cfm would have an air-to-filter-media ratio of 1.5-to-1. This also means the airflow has a velocity of 1.5 fpm through the cartridge filter media.

Selecting a dust collector with insufficient filter area will likely result in failure and become a constant maintenance headache due to reduced airflow through the dust collection system. This results in a continuous cycle of poor performance and high maintenance costs. However, selecting a dust collector with excessive filter area, although more costly, will rarely be detrimental to the overall system performance.

An excessive air-to-filter-media ratio causes the collected dust to accumulate within and on the filter media despite even the best automatic filter cleaning systems. This situation results in premature failure of the filter media due to the high energy required to pull the desired airflow through the filters, meaning a high differential pressure in inches water gauge. Since centrifugal fans back up the performance curve to produce higher differential pressure, this results in reduced system performance due to the reduced airflow. Unfortunately, once this reduced system performance occurs, the performance will only get worse.

Ironically, selection of a dust collector with insufficient filter area is often based upon supplier promises and a low initial purchase cost. Once the system is installed, however, the result of this decision is poor performance and higher maintenance costs, which wipe out any cost advantage associated with the initial purchase.

Selecting a dust collector with an insufficient air-to-filter-media ratio will result in a system that doesn’t properly collect the emitted dusts. Such a system is a waste of money, a combustible dust hazard, and typically a maintenance nightmare. Some of the main factors you should analyze when selecting the correct air-to-filter-media ratio are:
1. The characteristics of the dusts being collected.
2. The type of filter being used.
3. The type of filter cleaning method used.

Dust characteristics
The type of dust being collected and its characteristics directly affect the filter required for your dust collector. If your dust will release off the filter easily, doesn’t agglomerate easily (or isn’t tacky, adhesive, or cohesive), and the particle size is more than 2 microns, then the filter needed will generally be less expensive than for other applications. Some examples of dusts with these characteristic are saw dust, grains, and many minerals.

If you have a dust that includes particles less than 2 microns (especially when submicron particles are present), that are cohesive and adhesive, and that have a light bulk density, your dust collector will need significantly more filter area than the easy-to-filter materials. Plus, additional considerations regarding rising or interstitial velocity, filter material, and material loading must be considered. Examples of these dusts include resins, carbon black, warm rice bran, phenolics, wood flour, metal oxides, and various chemical dusts.

Additional material characteristics that should be considered when selecting a filter size and type are temperature, moisture, oils, particle geometry, chemical reactivity, and more.

Filter types
In the early history of dust collection, only bag-type filters were available. Through innovation over the years, other media, such as cartridge and micro-denier filters, have been developed, and each new type of filter media has advantages and disadvantages that must be considered.
When using typical polyester bag filters there’s a considerable archive of historical data on the acceptable air-to-filter-media ratios for many commodity dusts generated in the grain, wood processing, mineral, and chemical industries. The Internet provides access to this information, but you must be careful in using this data as your dust may have characteristics that aren’t considered in the generic examples provided. For example, if your dust has a significant percentage of material that is below 2 microns, then standard polyester bag filters may not be the best selection, and cartridges or micro-denier filters may be more effective.

When cartridge filters first became available as an alternative to bag filters, the suppliers attempted to use these filters at the same air-to-filter-media ratios as bag filters. This decision proved disastrous and nearly ended the use of these filters in the market. Eventually, the general market began to realize that significantly lower air-to-filter-media ratios were required for cartridge filters to work long-term. Unfortunately, due to market pressures and perhaps ignorance, there are still some suppliers who will make exorbitant promises of high air-to-filter-media ratios that result in poor dust collection system performance.

When combustible dusts are involved, this situation results in increased hazards and risks that must be avoided. In my experience, the successful use of cartridge filters results in air-to-filter-media ratios of 3 to 4 times less (meaning 3 to 4 times more filter area) for cartridges compared to bags for a majority of applications. Ironically, this results in a cartridge dust collector that is physically similar in size and cost to a baghouse dust collector. Cartridge filters will typically have significant limitations when higher temperatures, moisture, oils, and other conditions are present.

Micro-denier bag filter media is the latest advancement in bag filters. With ever-increasing regulatory PM standards (2.5 micron dusts and less), this type of filter media is becoming more important. Due to its composition, this type of media will filter at levels similar to cartridge filters and well below the 2.5 micron level. In addition, this filter media, usually at relatively low cost increases, can be substituted for more standard bag filters without an increase in the differential pressure (or energy) required. This media can also be coated (with PTFE, for example) for difficult applications or high temperatures. However, there’s also some evidence that significantly cohesive and adhesive dusts, such as sawdust with resin and warm rice bran, will prematurely blind these filters. More evidence is needed to make a valid judgment.

Filter cleaning methods
Three methods are most commonly used to continuously clean the filters for long filter life and to help maintain the proper air-to-filter-media ratio:

High-pressure compressed air used on a time or differential-pressure basis. This has been available since the 1950s and is a proven method used in most industries. When a reliable, dry compressed-air supply is available, this method is a highly viable solution to providing continuous filter cleaning.

Reverse-air cleaning using a fan or positive-displacement blower. This proven method, created for the grain industry in the 1960s, uses either a relatively high-pressure fan package or positive-displacement blower package to blow reverse-flow (to dust collection flow to the fan) air through the filters on a continuous basis. A rotating “arm” assembly in the clean-air plenum is used to position the reverse-flow over the filters.

Automatic or manual mechanical shaker. Manual or automatic shakers have likely been available since dust collectors existed. This method mechanically shakes the bag filter by either moving a lever back and forth or by using a motor-driven cam. However, shakers are limited in their use. To be effective, the airflow through the system must be stopped (either by shutting off the fan or using valving for isolation) to allow the shaking of the filters to be effective. This filter-cleaning method is mainly limited to small units used for individual dust sources, although shaker cleaning dust collectors have found wide use in the foundry industry.

For further reading
Find more information on this topic in articles listed under “Dust collection and dust control” in Powder and Bulk Engineering’s comprehensive article index in the December 2017 issue or the Article Archive on PBE’s website, www.powderbulk.com. (All articles listed in the archive are available for free download to registered users.)

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