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Ensuring Effective Dust Collection in Challenging Environments

by Tom Godbey, Donaldson Torit
Senior Application Specialist

When it comes to selecting a dust collector for a particular environment, the characteristics of the specific dust to be collected needs to be considered. What is the size of the dust? Is it extremely small? Is it a mix of sizes? Is it abrasive? Is it hygroscopic, or moisture absorbing? Does it agglomerate easily, or not at all? Is it explosive/combustible? Is it corrosive/toxic/unstable?

All these are necessary considerations, related to the dust being collected, but the dust is not the only factor to consider. It is essential that the properties and conditions of the gas stream entering and passing through the collector are also factored into the choice of a dust collector.

Gas stream characteristics have a significant - and sometimes greater - impact on equipment selection than dust characteristics. The combination of the dust and gas stream characteristics can make for some challenging equipment selections. Let's look at just a couple of the more common gas stream characteristics and their impacts on selecting an appropriate collector: temperature, moisture, and chemistry.

TEMPERATURE

Temperature - especially high temperature - affects not only the selection of filter media, but the construction materials of the collector, and the filter style – bags or cartridges. Temperature can also influence the method of filter reconditioning/cleaning and the total required filter area. (The required filter area is driven by the required air volume and the reasonable filtration velocity, commonly referred to as the Air-to-Media Ratio.) Higher temperature conditions usually require more conservative filtration velocities.

There are many different filter media available with known characteristics. **Figure 1** is an example of a Filter Media Characteristic Chart showing the temperature limitations and other attributes of various commonly-available filter media. It would seem relatively simple to select filter media by the process of elimination, and, it can be simple IF you know the other characteristics of the gas stream.

However, not all media are suitable for all types of collectors or conditions. Fiberglass, as an example, is not generally considered suitable for envelope-shaped pulse jet collector bags - just as spunbond polyester is not generally considered suitable for shaker style collectors. So the operating temperature and available media for temperature can influence the type of collector being considered.

As mentioned earlier, temperature can also influence materials of construction for the collector. This includes the type of metals, gaskets, or paint as well as special requirements for insulation for both moisture and acid condensation control, or personnel safety.

And, finally, it is important to remember filtration velocity is impacted by changes in the density of the gas stream. Increases in temperature and the total volume of filtered air increase with temperature, so temperature influences collector size.

MOISTURE

High moisture levels can have both negative and positive effects on the performance of dust collectors. When moisture levels are higher, precautions must be taken to prevent condensation on not only the filter media but also on the interior sidewalls of the collector body and hopper to avoid an obvious effect of moisture interacting with the dust - mud. It is often difficult, if not impossible, to remove mud from a filter media by normal pulsing or shaking. It is even more difficult to try and get any air movement through the mud, thus the value in maintaining an interior temperature in the collector above the moisture and acid dew points.

Maintaining the collector wall temperatures above the moisture dew point can be equally important, especially on the interior walls of the hopper. The interior walls of the hopper are typically the coldest temperature inside a collector, and it is not unusual to see moisture condensation on the interior hopper walls while the temperature on the media is well above the dew point.

Consider the impact of dust from the filters being pulse cleaned, falling onto the wet hopper walls. The result is dust not sliding smoothly down the hopper walls as intended, but sticky dust eventually bridging across the discharge opening, effectively shutting down the operation just as if mud were formed on the bags themselves.

Preventative action to keep these issues from developing can take the form of insulation of the housing or additional heating elements on the exterior of the hoppers. Some environments even require heating of the compressed air used in pulse cleaning to prevent the collector from passing through a dew point because of the chilling effect from expanding compressed air released during each pulse.

While condensation is an extreme moisture condition, problems can arise from just elevated moisture levels without condensation actually occurring. Hygroscopic dust such as sugars, salts, and lime actively absorb moisture from a gas stream and can become very difficult to dislodge from filter media.

As a general rule, dust collectors perform best when the relative humidity of an air stream containing hygroscopic dust is kept at or below 40% RH. The use of hydrophobic or fluorocarbon-treated media can enhance dust release characteristics of the media filtering these dusts, resulting in more stable pressure loss across the filter media and longer intervals between filter replacements.

The challenges associated with high moisture levels are relatively well known and predictable. However, low moisture levels with high temperatures and dusts such as metallic salts can become even more challenging. At high temperatures and low moisture

FIGURE 1. Filter Media - Performance Characteristics

Based on increasing temperature conditions

Fiber Type			Polypropylene	Polyester	Homopolymer Acrylic	Aramid	Polyphenylene Sulphide	Polyimide	PTFE	Spunbond Polyester
Tradename					Dralon **	Nomex®†	Ryton®	P84®		
Tempterature F° (C°)	Continuous Operating Temperatures (Dry) *		194 (90)	275 (135)	266 (130)	374 (190)	356 (180)	356 (180)	464 (240)	140 (60)
	Media	Continuous Dry	212 (100)	302 (150)	284 (140)	392 (200)	374 (190)	500 (260)	482 (250)	140 (60)
		Continuous Moist	212 (100)	212 (100)	257 (125)	356 (180)	374 (190)	356 (180)	482 (250)	140 (60)
		Peak	230 (110)	356 (180)	302 (150)	482 (250)	446 (230)	572 (300)	536 (280)	176 (80)
		Melting Point or Decomposition	320 (160)	482 (250)	482 (250)	752 (400)	545 (285)	842 (450)*	554 (290)	464 (240)
Supports Combustion			YES	YES	YES	NO	NO	NO	NO	YES
Abrasion Resistance			Very Good	Excellent	Good	Excellent	Good	Very Good	Moderate	Moderate
Resistance to Hydrolysis			Excellent	Poor	Good	Good	Excellent	Very Good	Excellent	Poor
Resistance to Acids			Excellent	Good	Good	Very Good	Excellent	Very Good	Excellent	Very Good
Resistance to Alkalies			Excellent	Good	Very Good	Very Good	Very Good	Very Good	Excellent	Good
Resistance to Oxidizing Agents			Moderate	Very Good	Very Good	Very Good	Poor	Very Good	Excellent	Very Good
Resistance to Organic Solvents			Good	Very Good	Very Good	Excellent	Excellent	Very Good	Excellent	Very Good
Relative Cost vs. Polyester			x2.0 – 2.5	x1	x2.5 – 3.0	x5	x7	x10	x25	x0.85

* Begins to carbonize above this temperature
** Dralon is the only true 100% Homopolymer Acrylics
† Nomex is a registered trademark of E.I. Dupont de Nemours & Co., Inc.

levels, metallic salts (as well as other dusts with similar characteristics) behave as if each dust particle has the same electrical charge. The particles repel each other and agglomeration of small particles into larger particles can become negligible. Since dust particles must agglomerate for collected dust on the media to be dislodged and migrate to the hopper, if dust never agglomerates, the particle size stays the same and the air currents just transport disturbed dust back to the media to be re-deposited. This means dust would never migrate into the hopper. With some dusts, this effect is severe enough that it can actually be advantageous to introduce moisture into the air stream, often in the form of steam, to promote agglomeration. Unfortunately, many times dusts with these characteristics are not recognized until after the collector is already in operation. Yes! With moisture, the challenge can be either too much or too little!

CHEMISTRY

Chemistry is that broad term encompassing a multitude of contaminants, the most common being acid gases but also including condensable compounds, hydrocarbons, Volatile Organic Compounds (VOC), and others. Acid-forming compounds such as Sulfur Oxide (SOx) and Chlorine (CL), which are common byproducts of combustion, are included in this grouping. These compounds, when combined with moisture, (also a byproduct of combustion) have the potential to form acids when the temperatures in the system drop below their acid dew points. Each of these presents challenges in materials of construction, surface coatings, insulation, and filter media selection. Gas streams with mixtures of several of these contaminants represent even more challenge and require a thorough review of the process and performance priorities. Many requirements will cause conflicts so the final collector selection will require tradeoffs, such as higher initial capital cost for a special coating but a longer collector life or a longer interval between filter replacements but at the expense of a higher cost filter media.

CONCLUSIONS

Each of these gas stream characteristics offers common challenges in the selection and operation of dust collection equipment, but gas streams with combinations of these factors offers great challenges. The answer for one process may not be the best answer for what would appear to be a similar gas stream. As an example, Polyphenylene sulphide (Ryton) media may be an excellent selection for a hot SOx-laden gas stream from a coal fired boiler. However, it may not be a good selection for hot SOx-laden gas from a coal fired kiln when a kiln induces significant amounts of excess air and as a result, produces higher oxygen content than the coal fired boiler. In this hot moist flue gas environment, Ryton media can be subject to a loss of physical strength due to oxidation as oxygen levels exceed 8%. Boiler flue gases are rarely above that level, but the excess air from the kiln can drive oxygen levels well above that level. Thus, a polyimide (P84) media may be a better selection even though it has a lower resistance to the acids.

The point is: make proper equipment selections for challenging gas streams, the full characteristics of the gas stream must be known. So when an inquisitive dust collector salesman/engineer starts grilling you about your process, trust his intention. His primary goal is to prevent surprises during commissioning and operation that might occur because something was left unknown in the planning phase. No one likes those types of surprises, and everyone is better served by facing the challenges up front.

Donaldson FILTRATION SOLUTIONS

Donaldson Company, Inc.
Torit
P.O. Box 1299
Minneapolis, MN
55440-1299 U.S.A.

Tel 800-365-1331 (USA)
Tel 800-343-3639 (within Mexico)

donaldsontorit@donaldson.com
donaldsontorit.com