Specialty bag filter media for better performance in tough applications

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This article describes how to select a specialty bag filter media to solve poor dust-cake release, dusting, premature media wear, static, or similar problems in your baghouse.

Like Rodney Dangerfield, bag filters used in pulse-jet, reverse-air, and shaker baghouses don't get much respect. That's because today baghouses are considered old technology and just not very glamorous compared with cartridge collectors.

Yet there are an estimated 88,000 baghouses at work in plants around the world, according to a report by the industry market research firm The McIlvaine Co. Many, if not most, of these baghouses use standard (or *commodity*) filter media, usually installed by the original equipment manufacturer and later replaced by bag filter manufacturers, who both base the media choice on low price. But just what is a "standard" media?

A standard media is a general-purpose filter media, suitable for many applications. It's often produced in a high-speed, no-frills operation to meet market demand for low cost over quality or performance. But what was standard in 1970 is not the standard today: For instance, 40 years ago, the standard 16-ounce polyester felt in bag filters was made from DuPont Type 54 Dacron staple fiber supported by a strong scrim (a reinforcing layer of woven fabric). Today, the standard 16-ounce polyester felt is made from generic polyester fibers or recycled polyethylene terephthalate (PET) beverage bottles, and it has no scrim support. Think Mercedes Benz in 1970 versus Yugo today.

Before we talk about the standard bag filter media available today, let's cover some media basics. Standard media is available in felt and woven types. *Felt media* is a dense nonwoven fabric produced by mechanical action, pressure, and heat, while *woven media* consists of continuous warp and filling yarns woven in a plain, twill, or sateen pattern. Felt media can be treated, such as by singing or glazing, to improve dust-cake release or other properties. A media is commonly identified by its basis weight (in ounces per square yard), base fiber (such as polyester), and type (felt or woven) — such as "16-ounce polyester felt."

For bag filters, felt media is typically used in pulse-jet baghouses, while woven media is used in reverse-air and shaker baghouses. The following list includes the vast majority of standard filter media used today in pulse-jet, reverse-air, and shaker baghouses. They're applied regularly — and sometimes indiscriminately — but do work reasonably well in many applications.

In pulse-jet baghouses, the most commonly used standard media are:

- 11- and 16-ounce polyester felt (plain, singed, or glazed)
- 12- and 16-ounce polypropylene felt (plain, singed, or glazed)
- 16-ounce homopolymer acrylic felt (plain or singed)
- 14- or 16-ounce aramid felt (plain or singed)
- 16- or 18-ounce polyphenylene sulfide (PPS) felt (plain or singed)
- 14- or 16-ounce polyimide felt (plain or singed; trade name P84[1])
- 8-ounce spunbond polyester (for pleated bag filter elements)

- Several varieties of woven fiberglass (with or without a membrane)

The latter, woven fiberglass media, is also the standard in reverse-air baghouses. In shaker baghouses, one of the most common media is 9-ounce polyester woven sateen.

Problems with these standard media arise when they don't work for a given application because they don't match the dust or process or don't provide the required filtering efficiency, airflow rate, service life, or safety. These problems typically fall into one of the several categories listed in Table I.

Now visualize a chart with two plot lines: a downward-trending line representing the continually diminishing quality of standard media and an upward-trending line representing ever-tightening environmental emission requirements and ever-changing dust characteristics as dusts become finer, more uniform, and more difficult to clean from filter media. The two lines form a long X, and the gap between the lines at the X's right represents the problem for most baghouse users: *How can I better filter more difficult powders with lower-quality filter media under ever-tighter regulatory requirements?*

The good news is that specialty filter media are readily available to solve the many problems described in Table I. While specialty media do cost more initially than standard media, their better performance and longer service life make them more cost-effective in tough applications.

Table I

Common problems with standard bag filter media

Problem	Result
Poor dust-cake release (blinding or plugging)	High differential pressure, inadequate airflow
Dusting (bleeding)	Lost product, high dust emissions, environmental violations
Premature wear or abrasion	Early filter failures, lost product, high dust emissions
Static buildup	Poor dust-cake release, high differential pressure, explosion potential
Sparks or fires	Filter pinholing, baghouse fires
Fibrous dusts	Poor dust-cake release, dust bridging between filters, filling baghouse with fibrous dust with no dust-cake release

Before we discuss how to select specialty media to solve your baghouse filtration problems, a few caveats are in order:

- Using specialty filter media isn't a substitute for providing proper baghouse maintenance.
- Using specialty media can't overcome problems caused by a poorly engineered dust collection system, a poorly designed baghouse, or a baghouse that's been modified and pushed beyond its original design limits.
- Filter media, whether standard or specialty, has its own performance limits based on its base (or *substrate*) fibers' inherent properties.
- There's no one-size-fits-all specialty media for baghouse applications.

Finding the right specialty media solution

If your bag filters are subject to one or more of the problems listed in Table I, what are your specialty media options? Here's the breakdown.

Poor dust-cake release. Poor dust-cake release (also called *blinding* or *plugging*) may well be the most common problem for baghouse users. The causes are usually too much moisture in the airstream or dust, natural fats and oils in the dust (such as from food products), hydrocarbons (which are oily), static on dust particles, or a dust's natural tendency to agglomerate. These properties can make the dust sticky, cause it to agglomerate, and ultimately result in a dust cake (or *filter cake*) that's strongly attached to the media fibers.

You can also choose a felt media whose base glazed felt has been treated with an oil- and water-repellant chemical bath to further reduce the sticky dust's ability to adhere to it.

When you can't eliminate the moisture or oils or the dust's agglomeration tendency, choose a specialty felt media that's glazed on the dust-cake side. Glazing plasticizes the fine fibers on the felt surface and reduces the sticky dust's ability to adhere to it. (You can accomplish the same effect with woven media for a shaker baghouse by changing the media from a spun-yarn fabric to a smooth multifilament fabric.)

You can also choose a felt media whose base glazed felt has been treated with an oil- and water-repellant chemical bath to further reduce the sticky dust's ability to adhere to it, such as the example shown in Figure 1. In this case, the quality of the base felt is important: Adding any special treatment to a poor-quality base felt will simply shift the media's performance issue from one problem to another. Consult a reputable bag filter manufacturer to ensure that your filters are constructed of a properly made felt media for your application, with the filtering efficiency, strength, and durability to meet your process conditions and handle all of your dust's characteristics.

Another approach is to use a felt media with a smooth polytetrafluoroethylene (PTFE) membrane on the dust-cake side. This very smooth, slippery membrane enhances the release of moist, sticky dusts. Again, the base felt's quality is important, so get the bag filter manufacturer's help in matching the media's fiber and base felt to your dust and process conditions. *Caution:* A PTFE membrane doesn't work well in the presence of fats, oils, or hydrocarbons.

Dusting. Dusting (also called *bleeding*) is the opposite of the poor dust-cake release problem. In this case, the dust may be too fine, have little or no tendency to form a dust cake, or have a smooth round particle shape (such as a pigment dust). Or the media's basis weight may be too light, the media may be poorly made, or its fibers may be too coarse. In fact, problems with dusting and the resulting emissions are becoming more common as bulk solids manufacturers strive to provide finer, more uniform powders, and these problems will continue to increase as more nanopowders are developed. Solutions will become more urgent as the EPA standard for $PM_{2.5}$ emissions (that is, emissions of particulate matter smaller than 2.5 microns) replaces that for PM_{10} emissions and baghouse users have to ensure that the finest particles in the airstream are removed by their filter media. [***Editor's note:*** For more information go to http://tinyurl.com/emiss2-5; also see which currently available media have been verified to meet $PM_{2.5}$ emissions standards in "Baghouse filtration product verified" under "Highlights" at http://tinyurl.com/verifiedfilters.]

Figure 1

Glazed felt media treated with oil- and water-repellant chemical bath to improve dust-cake release

Courtesy of BWF America, Florence, Ky.

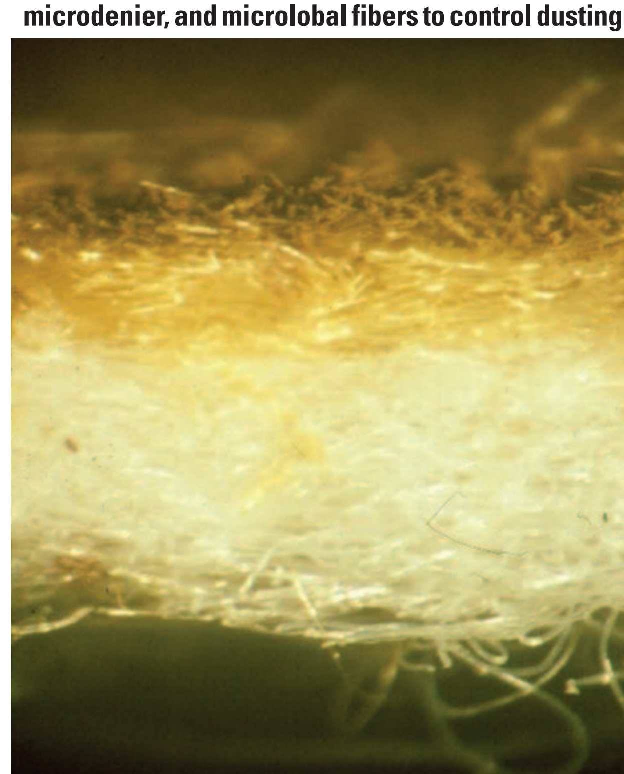
Because more surface area equals greater filtering efficiency, solving dusting problems can mean choosing the correct fiber diameter for the media, using a fiber blend, or using media with a membrane.

Fiber diameter. The fiber diameter is typically from 15 to 20 microns in a needled felt (the most common type of felt, manufactured by moving barbed needles through batts or webs of loose fibers to interlock them). *Micro-denier* (ultrafine) fiber diameters half this size are now available, significantly increasing the felt's number of fibers and available surface area. With proper needling densification (increasing the densification with more needling passes during manufacturing) and a strong scrim support, this felt can solve most dusting problems.

Fiber blend. Another way to control dusting is to use a specialty media felt with a top layer made of a blend of multilobal fibers (which have a cross-section of multiple lobes) to provide greater surface area. Still another option is to use a media made of a blend of standard, fine, microdenier, and microlobal fiber felts to meet specific dust control or emission requirements. One example is shown in Figure 2. By analyzing your dust's properties and running a representative dust sample through a particle size distribution test, your bag filter manufacturer should be able to recommend the optimal media design and fiber blend for your process.

Figure 2

Cross-section of felt blend of standard, fine, microdenier, and microlobal fibers to control dusting



Courtesy of Albarrie, Barrie, Ontario, Canada.

Membrane. Using media with a PTFE membrane also can solve a dusting problem. The *fibrils* (small, randomly connected fibers) making up the membrane create more surface area and form very fine pores, yielding high filtering efficiency. As long as the membrane stays intact, a membrane on any of various substrates is an effective media for very fine dust and tight emissions control.

Premature wear or abrasion. Premature filter failures resulting from wear are normally caused by mechanical problems, such as uneven airflow inside the baghouse, rusty filter cages, or improperly sized filters. When mechanical problems aren't a factor, a high-velocity dust or a highly abrasive dust may be the culprit, wearing through the media and the thread on the filter seams.

In either case, the most common solution is to treat the media — whether a synthetic fiber felt or a woven fabric — with a heavy silicone solution. The key is to deposit enough silicone so that, after the media is dried (or cured), each fiber is fully coated. For effective abrasion resistance, the minimally acceptable amount of silicone (measured after drying) is 2 percent of the media's basis weight. When the silicone coating is adequate, it tends to deflect dust particles' direct abrasive contact on the media surface. As particles penetrate the media, the silicone also acts as a lubricant to protect the fibers inside the media from abrasive wear.

A PTFE membrane doesn't perform as well as a silicone treatment in abrasive dust applications. Despite the membrane's inherent slipperiness, it's relatively thin and doesn't have the strength to resist a highly abrasive dust.

Static buildup. Users are often unaware that in a dry airstream with the right dust concentration, adequate oxygen content, and an ignition source, many dusts are potentially explosive. Static is an explosion hazard particularly in plants handling highly explosive dusts or dusts that tend to build a high static charge during drying or conveying. Your plant's safety manager can determine whether your airstream's dust concentration is potentially explosive, and whether static discharge (or arcing) is a potential ignition source in the baghouse or surrounding area.

While grounding the entire baghouse has been a common explosion-prevention technique in the past, if the filters themselves aren't conductive, static can build up on the media surface and result in arcing between adjacent filters or between a filter and the baghouse wall. Instead, you need to choose specialty filters that will help safely conduct the static charge away from the baghouse and prevent an explosion. The filter should be made of a durable conductive (that is, *static-dissipating*) media. Simply using standard media with stainless steel or copper grounding braids in the filter's vertical seams *won't* create a fully conductive media surface.

Although three static-dissipating media treatments or materials are available — chemical treatments, epitropic (carbonized) fiber blends, and stainless steel fiber blends — only the latter will provide adequate durability and effective static dissipation in an industrial application with dust-covered media. Today's stainless steel fiber blends have stainless steel fibers at fixed intervals in the media's scrim. The needling process during manufacturing brings individual fibers to the media surface, creating enough conductivity on the surface to make the entire filter surface conductive (by the current standard of no greater resistivity than 10^6 ohms when charged with 500 volts). A well-made stainless steel fiber blend will register below 10^3 ohms — a barely measurable resistance. Unlike earlier versions, today's stainless steel fiber blend media doesn't have problems with uneven steel fiber distribution and is less likely to have loose fibers that can contaminate your material.

The stainless steel fiber blend media is available in polyester and polypropylene, and stainless steel needling technology could be applied to other fiber types. The media is also available with PTFE membranes and in a very few woven fabrics. Your media and bag filter manufacturers should provide conductivity or resistivity certification for the stainless steel fiber blend in the filters you select.

Caution: Any bag filter made from static-dissipating media must be connected to the grounded baghouse's tubesheet to provide full conductivity from the filter bottom to the ground. For snap-band filters, you can achieve this by using cuff materials made from a stainless steel blend or, for a cuff made of nonconductive material, by using a cuff that has stainless steel grounding braid sewn onto it at regular intervals. Using a filter with grounding wire in the vertical seams will increase the security of the connection between the fully conductive filter and the grounded tubesheet.

Sparks or fires. Hot or burning particles, pyrophoric particles (which can ignite spontaneously), and sparks can wreak havoc in a baghouse. Hot or burning particles can create pinholes in the media. In the worst case, a hot or burning particle or spark can create a full-scale baghouse fire that destroys the filters and damages the baghouse's metal components.

A common way to prevent these problems is to install a mechanical or chemical spark- and fire-prevention system inside the baghouse. Choosing a particular specialty media or media treatment is another approach. These options include:

- *Using a flame-retardant chemical finish on the filter media.* Be aware this finish isn't highly effective and doesn't prevent pinholing.

• *Switching from a thermoplastic media fiber, such as polyester or propylene, to a higher-temperature fiber that doesn't support combustion, such as aramid or fiberglass.*

• *Using a media with a layer of nonflammable fiber or coating on the dust-cake side.* Polyimide, melamine (trade name Basofil[2]), and basalt volcanic fibers are suitable for this purpose as long as they're compatible with your other process conditions.

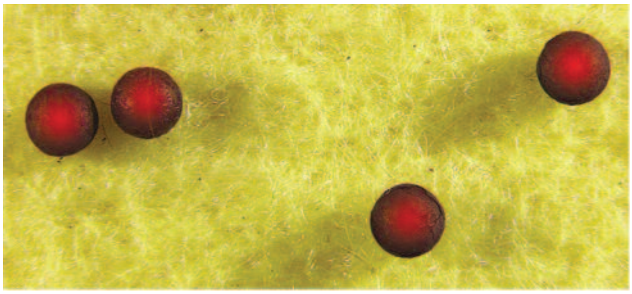
• *Using a media with a nonflammable surface treatment — such as graphite, PTFE, or another similar material — on the dust-cake side.* Make sure that the media or bag filter manufacturer has tested the finish to support its performance claims and ensure that the coating is compatible with or can tolerate your process conditions. An example of media with a nonflammable surface treatment is shown in Figure 3.

Be aware that none of these specialty filter options will completely eliminate media degradation if the hot or burning particle is large enough and the airstream's draft is strong enough to "push" the particle through the media. Even a felt media that doesn't support combustion, such as aramid, will *pyrolyze* (chemically decompose by heating) and fail at the spot where the hot or burning particle lands. Using a mechanical or chemical spark- and fire-prevention system is more effective if you can't eliminate sparks or hot and burning particles at their source.

Fibrous dusts. While a fibrous dust causes more of a nuisance than a condition that could shut down a process, over an extended time it can cause major headaches. The fibrous dust cake formed on the filters can eventually bridge between filters and between the filter and the baghouse wall, packing these areas so densely that the only way to clean out the baghouse is to go inside it and remove the fibrous dust cake by hand. Typical fibrous dusts include dust from coarsely sawn wood, fiberglass, diaper components, and polypropylene-polyethylene streamers.

Figure 3

Media with nonflammable surface treatment resisting heat from red-hot steel balls in scrap-metal melting operation



Courtesy of BWF America, Florence, Ky.

Specialty filter media that can mitigate fibrous dust problems include:

• *Felt media with a heavy glaze on its dust-cake side (suitable only for media with thermoplastic fibers).* While this is the least effective solution, it does close the media surface to some degree, providing less opportunity for fibrous dust particles to attach to the media.

Make sure that the media or bag filter manufacturer has tested the finish to support its performance claims and ensure that the coating is compatible with or can tolerate your process conditions.

• *Felt media with a PTFE membrane that has pores so small that a fibrous particle has no place to attach.* This is a more effective solution, and as long as the membrane stays intact, it provides excellent discharge of the fibrous dust cake.

• *Felt media with a polyurethane or PTFE coating that has small pores.* To the human eye, this media surface appears impervious, but it actually consists of layers of open-cell foam that allow airflow through the surface. This media works very well with fibrous dust and large particles, but not with finer dusts, which can penetrate the pores and remain in the media during filter cleaning.

• *Felt media with a separate layer of fused polyester granules applied to its dust-cake side.* The melted granules form a secondary surface far enough from the base felt to prevent the fibrous particles from attaching to the base, allowing the dust cake to release effectively during cleaning.

More specialty media and their applications

Additional specialty filter media and media treatments are available to handle a range of filtration problems. [***Editor's note:*** Find a detailed filter media selection chart at the author's Web site (www.filtermediaservices.com) and at www.powderbulk.com under "Tools & Resources."]

These two examples are for shaker and reverse-air baghouses:

• Shaker felts: Lightweight needled felts for replacing conventional woven fabrics.

• Stable knit fabric: A proprietary media[3] for replacing conventional woven fabrics.

These are for pulse-jet baghouses:

• PTFE-bath-treated felts: Media (particularly those felts using PPS fiber) for economically enhancing filtering efficiency.

• Asymmetrical felts: Media with the woven scrim on its dust-cake side to provide dust-cake release like that of a smooth woven fabric.

• Chemically treated felts: Media for improving resistance to hydrolysis (decomposition by reaction with water) and chemical attack.

• Fiberglass felts: Media for high-temperature applications up to 500°F (260°C).

• Ceramic wovens and felts: Media for ultrahigh-temperature (550°F [288°C]) and above) applications.

• Basalt volcanic fiber felts: Media for spark protection and ultrahigh-temperature (550°F [288°C] and above) applications.

You can see that not many specialty media fabrics are woven media. There are two reasons for this. A pulse-jet baghouse, which requires felt media, is the unit of choice in most new baghouse applications. In addition, the production process for woven fabrics and the fabrics' inherent design properties make them harder to modify or enhance with specialty treatments than felt media.

Specialty treatments for the 8-ounce spunbond polyester used in pleated bag filters are also limited. In addition to the plain (untreated) version, this media is available only with a water- and oil-repellant finish or static-dissipating (aluminized) finish. If the problem with your pleated bag filters can't be handled by either of these finishes, there's no specialty media solution for it unless your baghouse wasn't specifically designed for pleated bag filters. In this case, you can switch back to conventional bag filters on wire cages, which will give you many more specialty media options.

Help choosing a specialty filter media

To successfully match a specialty bag filter media to your difficult dust and process conditions, you'll need to carefully consider all your application's variables and investigate your dust's characteristics. Look to media, bag filter, and baghouse manufacturers for help analyzing your bag filter problem and determining which specialty media can best solve it. These experts are extremely knowledgeable about the latest specialty media options and have helped users find the right media for hundreds of difficult dusts and process conditions. Let their expertise work for you.

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References

1. Evonik Industries, Lenzing, Austria.
2. Basofil Fibers, Enka, N.C.
3. Seamless Tube media, Midwesco Filter Resources, Winchester, Va.

For further reading

Find more information on filter media in articles listed under "Dust collection and dust control" in *Powder and Bulk Engineering*'s comprehensive article index (in the December 2009 issue and at *PBE*'s Web site, www.powderbulk.com) and in books available on the Web site at the *PBE* Bookstore. You can also purchase copies of past *PBE* articles at www.powderbulk.com.

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