# Dust Collection Design:
# Incorporating Safety, Performance, and Energy Savings

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Baghouses and filters are typically the last pieces of equipment that are considered when planning a new facility or plant expansion. Filtration equipment is typically not directly involved in the production process and, therefore, does not contribute to the revenue stream, or does it? Revenue is dependent on safe, pleasant working conditions, minimal down time, and a low cost of operation. A properly planned and designed dust collection system can certainly contribute to all of these variables to enhance your bottom line.

There are many different baghouse styles available on the market today as well as a wide variety of media products possible for each baghouse. In addition to process related decisions, protection of the dust collection system, and the baghouse itself, from the hazard of dust explosions and fires must be given consideration in the overall system design. All of these variations make it difficult to decide which is best choice for your specific application. Not everyone is a dust collection expert, so when designing or purchasing a system, it pays to work with someone who is.

In light of the recent regulatory changes it can be extremely difficult to keep up with what is considered the safest way to handle various dust collection challenges. Recently, the Occupational Safety and Health Administration (OSHA) issued a Combustible Dust National Emphasis Program, directive number: CPL 03-00-006, effective October 18, 2007 which was reissued as number CPL 03-00-008 effective March 11, 2008. This document contains policies and procedures for the inspection of workplaces that create or handle combustible dusts which include, but are not limited to, metal dust, wood dust, coal and other carbon dusts, plastic dusts, and organic dusts such as sugar, flour, paper, and soap. The directive recommends that NFPA explosion protection standards be consulted for the design requirements associated with the explosion protection of process equipment, including dust collectors. Since 2006, all of the pertinent explosion protection standards have been revised and new editions have been released. The current editions of NFPA 654: Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids, NFPA 61: Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities, NFPA 68: Standard on Explosion Protection by Deflagration Venting, and NFPA 69: Standard on Explosion Prevention Systems include significant new responsibilities for the owners of enclosures requiring explosion protection.

Both NFPA 68 and NFPA 69 contain sections detailing required documentation, installation, and inspection for each protected enclosure. Specifically, NFPA 68 section

11.2 and NFPA 69 section 15.2.1.1 detail the design information required to be kept up to date and on file by the owner for each protected enclosure. According to the referenced sections, this file must contain the following information (see referenced sections for a full listing of required data for specific protection methods):

- Manufacture's data sheets and instruction manuals
- Design calculations
- General specifications
- End user inspection/maintenance forms
- User documentation of conformity with applicable standards
- Sequence of operation for each protection system
- Combustible material properties test report
- Process hazard review
- Process plan view including protected process, placement location of all explosion prevention devices, and personnel work locations
- Process elevation view
- Vent relief (pressure and fireball) path, where applicable
- Mechanical installation details
- Electrical supervision (if provided) installation details
- Process interlocks (if provided) identifying each equipment interlock and function
- Event deflagration isolation requirements
- Employee training requirements

One item included in this list requires that a "Combustible material properties test report" be included with the required documentation. The information resulting from the material testing which is used in determining the proper method and level of explosion prevention are $K_{st}$ and $P_{max}$. $K_{st}$, as defined by NFPA 68, is the deflagration index of a dust cloud and is measured in bar-m/sec (pressure rise over time). $P_{max}$ is defined as the maximum pressure developed in a contained deflagration and is measured in bar. Section 6.1 and the explanatory material found in A6.1.2 make it clear that $K_{st}$ and $P_{max}$ data for a specific application should no longer be determined by the use of general information found in charts, rather, the particular dust that will be introduced to the vented enclosure must be tested because, according to NFPA 68, these values can vary greatly from other samples of the same dust.

As you can see from this brief summary, complying with these new regulations can be very complicated, especially for someone that does not work with them every day.

In addition to the standards referenced above, NFPA 13: Standard for the Installation of Sprinkler Systems and NFPA 77: Recommended Practice on Static Electricity also have a significant impact on baghouse and dust collection system design.

It can be very expensive to make a mistake when trying to comply with safety standards as modifications that may need to be made after an OSHA or insurance inspection will be much more costly than getting it right the first time. It makes sense to work with someone that understands these new requirements and can provide the technical expertise to provide good, sound, and safe total solutions. The proper equipment and design may cost a bit more initially but the cost of fire, explosion, the resulting down time, and escalating insurance costs make it a sound investment.

In addition to requiring a safe dust collection system for your process, you will also want it to run as economically as possible. Two factors that heavily effect the total cost of operation are the compressed air usage for the cleaning mechanism and the pressure drop across the baghouse. Traditional "pulse jet" baghouses are the most commonly used cleaning technology throughout most industries and have been an efficient workhorse for decades. They typically use high pressure compressed air (90-100 PSI), have multiple diaphragm type pulse valves, and are cleaned based on a set duration between pulses. This does the job, but at what cost?

Many industries are now turning to more modern cleaning methods. One of the most efficient options is pulse jet cleaning except with medium pressure air (6-12 PSI) instead of the traditional high pressure. Studies have shown that medium pressure/high volume and high pressure/low volume are technically comparable in cleaning efficiency, however, there are several advantages to using medium pressure air[1].

The first advantage is found in the amount of horsepower required to generate the cleaning air volume necessary to clean the filter bags. Common sense tells us that it will take less energy to compress air to 10 PSI than it does to compress it to 100 PSI. The question is "how much less". Studies have shown that a traditional **high pressure** pulse jet baghouse, sized to handle 20,000 CFM at an 8:1 air to cloth ratio will require a 15 horsepower air compressor with a drier and filter to prevent an accumulation of condensation inside the filter's air header. The same size **medium pressure** pulse jet filter will require a 5 horsepower positive displacement blower and no drier. The air on the medium pressure unit is not compressed and heated enough to cause condensation. In addition to the 60% energy savings, the power required to heat high pressure compressed air cleaning headers in cold climates to prevent freezing is not necessary. Adding "On Demand Cleaning", which only allows the timer to pulse the bags when the differential pressure indicates they require cleaning, can further enhance the savings of using medium pressure technology.

In addition to the medium pressure pulse jet units with the multiple diaphragm valve, there are round units available that may only have one or two large valves that do the same work as 20 or 30 smaller ones. This design may greatly reduce maintenance cost and still provide the advantage of less horsepower consumption.

The medium pressure power savings could also pay off in a way you may not be aware of. There are areas in the country where incentives are available from state governments and power companies to use the most energy efficient equipment available. There have been cases where these incentives have paid for the cost of the new equipment. Always check to see if programs like this are available in your area. The reward may be more than you expect.

The second factor in baghouse energy savings is the pressure drop required to move the air through the baghouse. The two most common features that contribute to this are the inlet design and the filter media. There are many different inlet designs, such as tangential, involute, radial, high entry, etc, and each have specific advantages for various applications. Each inlet design will require different energy levels to move the process air though them. The differences may only be 0.5-1.5 inches of water column, but that pressure difference on a 200 horsepower fan can have a significant impact on its amperage draw. Remember that this pressure drop applies to every hour of every day that that fan is running. Make sure that your vendor or designer is giving you the most efficient inlet for the application and not just the cheapest alternative.

Filter media is the other most significant air restriction in the baghouse. As mentioned previously in this article, there are many types of media available. Each media has a specific purpose for a specific application and a specific dust. The various media also have different flow rate characteristics and air cleaning efficiencies. The most effective way to determine the correct media for the application and dust is through testing. Acquiring a particle size analysis or even having the dust ran through a small scale simulation is the most positive way to determine what the best media choice would be. The same media efficiency required for carbon black will probably not be needed for wood shavings.

Require that the baghouse be sized so that the air to media ratio is not so high as to cause high differential pressure. Bag life does vary by application but as a rule of thumb, if a baghouse is sized correctly, the bags should last a minimum of 1-2 years. Most properly sized application will run at less than 3" WC for the majority of the bag life.

In summary, spending a little more time in the planning stage of a project and a little more money on the capital equipment can return huge dividends during the life cycle of the equipment. The most cost effective way to solve a dust collection opportunity is to work with someone who is very knowledgeable with both the regulations and the technology that is available and right for your particular application. Preliminary testing is a very inexpensive method to get it right the first time. You can find out what will work, what will not, what is the most cost effective, and what will meet your required emissions standards. Testing in the field can be very expensive and time consuming. You owe it to yourself to plan ahead and take every precaution to get it right the first time.

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[1]Silo Dust Collector Comparison, Jack D. Hilbert PE, Pneumatic Conveying Consultants 2008