WHITE PAPER

Chemical Dust Collector Total Cost of Ownership

When purchasing dust collection systems and filter cartridges for collecting chemical dusts, the initial purchase price is just the tip of the iceberg. The true costs – energy, consumables and operations – are lurking below the surface. The good news is that there are ways to reduce these costs over the long term.

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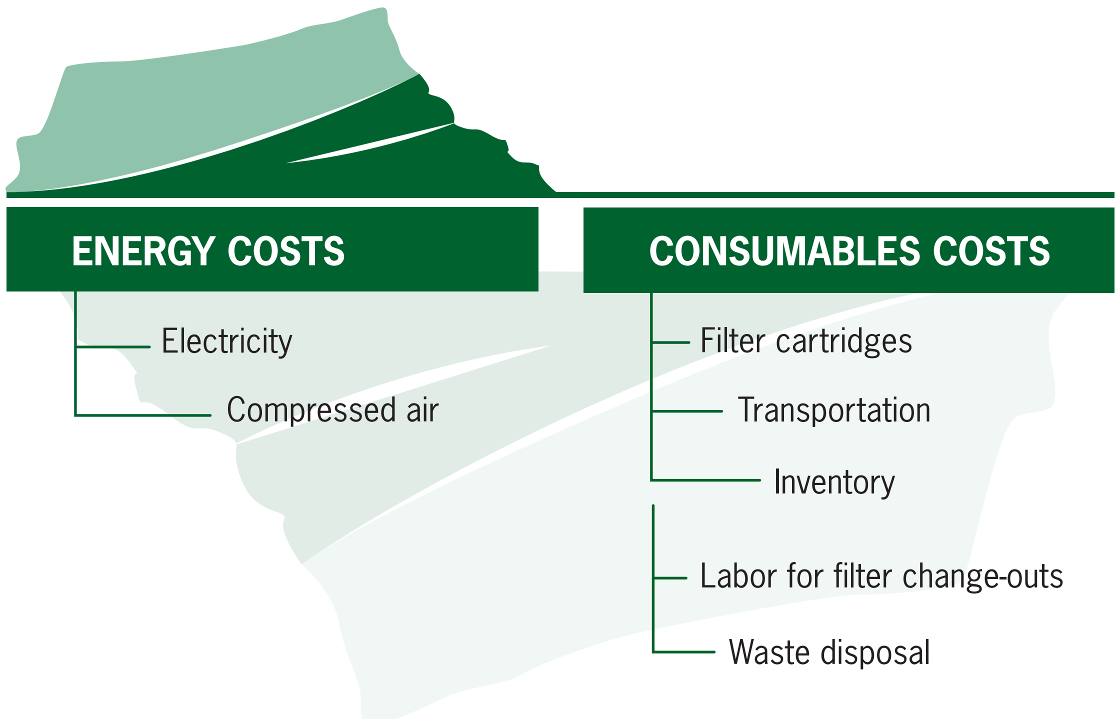
camfil
AIR POLLUTION CONTROL

When dealing with the costs of operating cartridge-style dust collectors in chemical manufacturing or processing facilities, it's important to consider the total cost of ownership (TCO) rather than just the initial purchase price of the collectors and consumables. As shown below, there are four major cost contributors: energy required to run the collector, purchase price of filter cartridges and other consumables, maintenance time to service the equipment, and filter disposal costs. This white paper focuses on the areas where the greatest cost savings can be achieved over the long term – using less electricity, using less compressed air, and using fewer filter cartridges.



Energy Costs

Dust collectors consume electrical energy the whole time they are running, but the largest portion of the electrical load goes to the fan motor that moves the air through the system. A lot of energy is used to heat or cool the air that replaces the air that dust collection systems constantly suck out of the plant or facility they are cleaning.

Reducing Fan Motor Energy Usage

As mentioned above, the fan motor is the dust collection system component that consumes the most electricity. This consumption is directly proportional to the volume of air the motor is moving through the system, which is measured in cubic feet per minutes (CFM). Dust collectors are variable systems. Their resistance to airflow (pressure drop) changes over time, according to the dust loaded on the filter cartridges (see Figure 1).

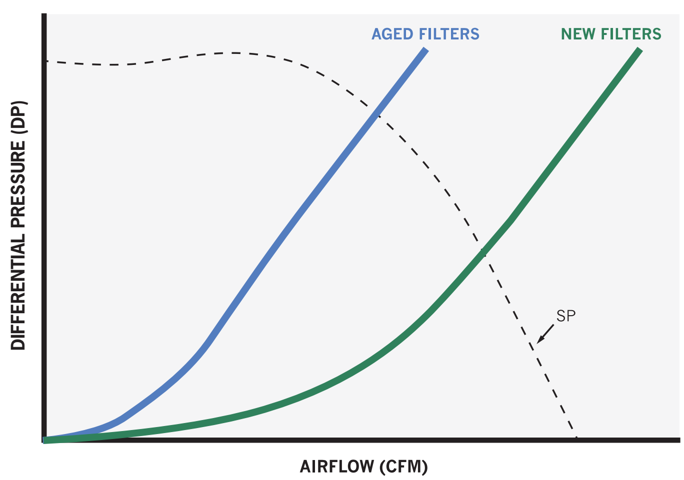


Figure 1: Differential Pressure, Airflow and Static Pressure for New and Aged Filter Cartridges

Without any intervention, in the early stages of the filters' life when the static pressure across them is low, the fan will move more air than needed. This consumes unnecessary energy and also causes air to hit the filters at a high velocity, which reduces filter life.

In the late stages of the filters' life when they are loaded with dust particles, the airflow becomes restricted and the fan has to work harder to keep the airflow high enough to capture the dust particles. This increases the static pressure, also referred to as pressure drop, which is measured by inches of water. At this point, the airflow needs to be adjusted to avoid excessive energy usage. This can be accomplished manually or by installing a variable frequency drive (VFD).

Manual airflow adjustment

Dust collectors typically use a damper at the outlet of the fan motor to mechanically vary the system's static pressure. One option to alter the airflow is to manually adjust these dampers. When the filters are new, the damper can be closed more to achieve the desired airflow. As the filters become dirty, the damper can be opened more to increase airflow.

Figure 2 illustrates the typical relationship between a constant-speed fan and energy usage when using an outlet damper to mechanically control the system's static pressure.

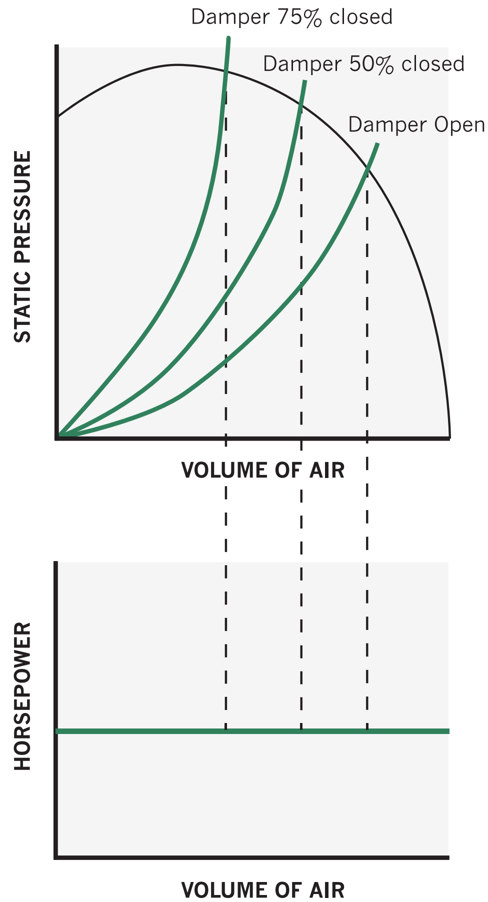


Figure 2 – Energy Relationship of a Constant-Speed Fan and Energy Usage

Energy control device

A better option is to use a VFD to electrically control the fan speed. A VFD is an electrical device that automatically manipulates the power frequency and power consumption supplied to the fan motor. Routine human interaction is no longer required. The VFD will automatically sense changes in airflow and pressure drop, and will adjust the fan speed to return the system to optimal airflow. Operators achieve significant electrical savings over the long term because the amount of energy needed to operate the fan motor varies with speed.

When the filters are new, the drive decreases fan speed to obtain the desired airflow. When the filters become loaded with dust, the drive speeds up the fan to keep the airflow consistent. The electrical control is much more efficient than human intervention in keeping a desired airflow and minimizing the electrical energy consumed.

Adjusting the frequency of the incoming power is an effective way to change the fan motor speed since their relationship is directly proportional. For example, a VFD can change a motor that runs at 3,600 rpm at 60 Hz to run at 1,800 rpm at 30 Hz. The fan draws only the amount of power required for the specific fan speed. For example, a fan that runs 25% slower would use 42% of the power required for full speed. The same fan running 50% slower would use 12% of the full-speed power.

The bottom line is that VFDs enable users to save an average of 30% on their energy costs to operate the dust collector. Also, maintenance and operation costs are reduced because fan speed adjustments don't require human intervention.

Figure 3 illustrates the multiple relationships that define the amount of energy being used at different speeds. These graphs were acquired from the 26th edition of the Industrial Ventilation manual of recommended practice for Design, figures 7-9b. Variable frequency drives have been proven to save a lot of energy over the life of the filters. The additional capital cost savings made possible by installing a VFD on a dust collection system will vary with different applications. However, the return on investment is typically under a year.

Consider this example:
Let's assume you have a dust collector with a 50 HP motor running at 460 volts with 58 full load amps of current. Operating 24/7, the fan motor would use 46.2 kW power at full load. If the electricity rate is $.10 per kWh, it would cost $40,481 per year to operate the fan motor. By installing a VFD (estimated cost $11,000), the same motor would cost $28,337 per year to operate, saving $12,144 per year. The VFD would pay for itself in less than 11 months.

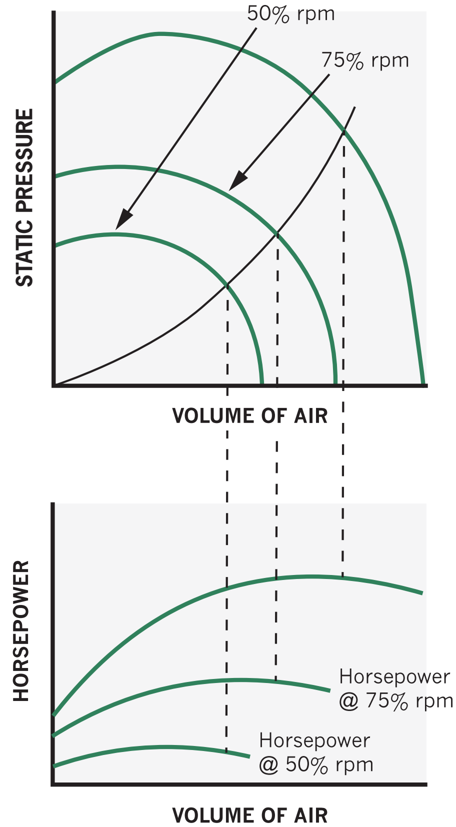


Figure 3 – Energy Relationship of a Variable Speed Fan

Reducing compressed air costs

Pulse cleaning is a critical technology to help your dust collectors maintain a steady airflow (CFM) and run at peak efficiency. When the pressure drop reaches a certain level, pulse cleaning systems send quick bursts of compressed air back through the filters. If the filters are designed properly, accumulated dust is blasted off and into the hopper, helping maintain a lower average pressure drop and increasing filter life.

However, producing compressed air is expensive, so pulse cleaning has always been one of the highest operating costs associated with dust collection. For that reason, it is also one of the operating costs with the most potential savings.

Today's most advanced chemical dust collectors can reduce compressed air consumption by as much as 50% versus competitive dust collectors. They use less compressed air because they are able to pulse clean far less often.

When properly designed, the cleaning system will remove the built-up material from the filter cartridges, reduce the pressure drop across them, reduce the fan energy consumption, and in turn, reduce associated energy costs. Properly designed dust collection systems that take this into consideration will provide more airflow while maintaining a low pressure drop. Among other design features, they use high-efficiency filter cartridges that can handle higher airflows while maintaining a high level of filtration efficiency. Because of the pleating technology, each filter cartridge contains more usable media than standard filter cartridges, so they can move more air and process more dust. The cartridges are also fabricated with inner cones of additional pleated filter media. This means that each cartridge has more downward-facing media that can evenly distribute the pulsed air along the outer pack of the filter and through the inner

A GSX16 is frequently used to safely capture chemical dusts. An integrated safety monitoring filter is installed so that air can be safely recirculated back into the building without creating a combustible dust risk.

cone. With each pulse, more dust is ejected from the filters straight into the hopper. The result is a more thorough cleaning with each pulse, so the airflow remains unrestricted and the pressure drop remains low for a longer period of time. The cleaning system doesn't have to pulse as often, providing a large savings on compressed air.

For example, Camfil Gold Series X-Flo collectors consume half the compressed air of traditional collectors, which saves them money on energy from air compressors and dryers. It also saves on any downtime associated with those systems. Over the life of the collector this leads to thousands of dollars in savings.

Saving energy by recirculating heat and air conditioning

To do their job effectively, dust collection systems move a lot of air from the plant or other manufacturing facility they are cleaning. Dust collectors generally take the inside chemical dust-laden air, send it through the filters to remove the dust, and then expel it outside via ducting. When the inside air is heated or air conditioned, the facility's HVAC system has to work hard to continually replace the air that was removed. Facilities can reduced their energy usage by safely recirculating the cleaned air back into the workspace. However, this can't be done safely without a filter on the return ducting that prevents the chemical dust from re-entering the workspace if there is a leak in the primary filter system.

A properly tested and documented integrated safety monitoring filter (iSMF) provides that function without using additional floor space. The iSMF also functions as a flame arrestor for combustible dust, making it safe for facilities handling combustible chemical dust to recirculate their air.

This Camfil GSX96 industrial dust collector is fitted with an integrated safety monitoring filter, trough hoppers, auger system and rotary airlock for a combustible dust application.

Consumables Costs

As shown in Figure 4, properly designed premium filter cartridges generally last 50% longer than standard filters because they pulse-clean more effectively. This is because premium filters are able to maintain a consistent airflow and low pressure drop longer than standard filters. The vertical lines in the graph represent the times that filter cartridges are changed out.

Premium filters also produce other cost savings, which add up significantly over their lifecycle. Since quality, high-efficiency filters allow more air to flow through the system, they use less compressed air. This is because they don't need to be cleaned as often and are changed out less frequently, which also reduces maintenance, transportation, downtime and disposal costs. Disposal costs can be significant, particularly if a hazardous material is being collected and the filters require incineration.

Filter cartridge replacement

When replacing filters, their initial purchace price is only part of the cost. Purchase price is usually evaluated per cartridge, but some collectors operate using fewer cartridges. For example, a Camfil Gold Series X-Flo GSX24 dust collector uses 24 filter cartridges to move 36,000 CFM of air, while other dust collector brands might require 32 cartridges to move the same volume of air.

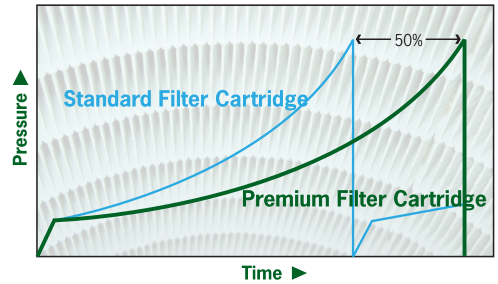
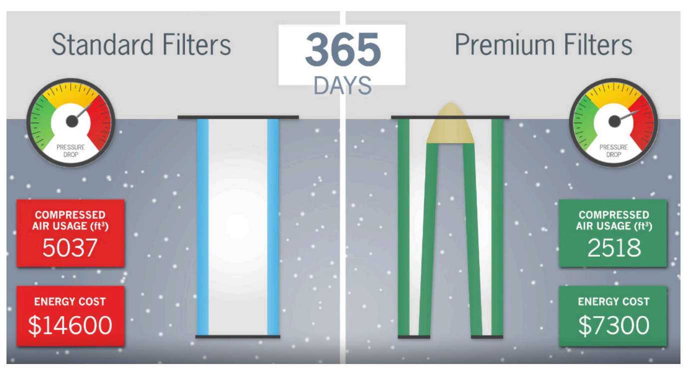


Figure 4 – Filter Life Comparison

Properly designed cartridges can also filter more air at lower pressure while using less energy and compressed air. In addition, they can maintain that airflow and efficiency for a longer period of time. As a hypothetical example, consider a side-by-side comparison of two identical dust collection systems – one outfitted with standard filter cartridges and the other with premium cartridges. Here is what would likely play out during the course of a year:

- At around 4 months, the collector with standard cartridges would be using twice as much compressed air as the collector with premium filter cartridges.
- At 6 months, the standard cartridges would need to be changed out because they would be too clogged with dust for the pulse cleaning system to maintain low differential pressure. If not changed at this point, they will put undue stress on the fan motor and use unneccessary energy. However, the premium filters would still be working effectively because they have more usable media and the media is pleated in a way that releases more dust with each pulse.
- At 12 months, the premium filters would also need to be changed out because they would be fully loaded and unable to maintain a low pressure drop and prevent excess energy from being consumed.
- After one year, the dust collector with standard filter cartridges would have used 5,037 cubic feet of compressed air and $14,600 of energy. The dust collector with premium filter cartridges would have used 2,518 cubic feet of compressed air and $7,300 of energy. The cost of 6 additional filter cartridges and the additional $7,300 energy savings far exceed the cost of a year's worth of premium filter cartridges.



Filter media

Premium cartridges are constructed with the filter media that is most appropriate for the specific application and type of chemical dust. For example, certain applications may require media treated with coatings that promote dust release, flame retardance or conductivity. Using the wrong media can cause unsafe operating conditions, a combustible dust hazard, high pressure drop and excessive energy use. Using the correct media creates a safer, cleaner work environment with less dust collector maintenance. Dust collectors are only as strong as their filter cartridges, which makes filter media selection vital.

Gold Cone X-Flo filter cartridges are quickly and safely changed out.

Pleating technology

Premium cartridges are designed to maximize the amount of usable filter media in each cartridge. This isn't accomplished by squeezing in more square meters of media using more tightly packed pleats. It is acconplished by using pleating technology that maximizes efficiency. For example, Camfil HemiPleat technology uses synthetic beads to hold the pleats open, which exposes more media to the air stream, creating more media that is available to catch airborne dust particles.

Independent tests of this technology versus standard pleating show that HemiPleat technology greatly enhances pulse cleaning. Filter cartridges that use this technology capture more airborne chemical dust particles and release more of those particles when pulsed, resulting in a more efficient system requiring less maintenance. HemiPleat technology provides the lowest initial pressure drop and the lowest pressure drop that lasts through the lifetime of the filter. Figure 5 shows that filters with this technology have a lower pressure drop for any given airflow.

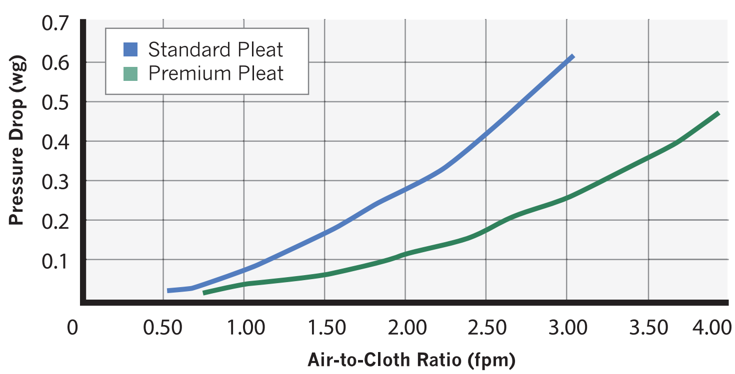


Figure 5 – Pressure Drop vs. Air-to-Cloth Ratio

Reducing labor and downtime

It takes maintenance personnel time to change out the filter cartridges, so labor costs can be reduced by using a collector that uses fewer filters and uses filters that last longer and perform better between change-outs. As discussed, premium filters can last twice as long and can handle more CFM per filter while maintaining a lower average pressure drop.

In addition, some dust collector vendors like Camfil monitor their dust collectors remotely, receiving alerts when high differential pressure set points are hit. Camfil can then alert the customer and troubleshoot issues that they likely would not have noticed yet. These monitoring systems are good preventive maintenance tools that reduce overall downtime costs.

Here are some situations that would be quickly discovered by the Camfil GoldLink monitoring system:

- Someone forgot to turn on the cleaning system or the compressed air, and the filters haven't been cleaning.
- The dust bins are full and loading over the filters, causing high differential pressure.
- Filters have become too loaded with chemical dusts to work effectively and require a change-out.

Remote monitoring systems like this provide peace of mind. Facility managers can focus on more important things, knowing they will be alerted if there is a dust collector issue that needs to be addressed.

Waste disposal

Depending on the type of material being filtered, there are costs associated with properly disposing of filters that are laden with chemical dust. Also, the CO_2 emissions from the operation of premium dust collection systems are significantly less and should be considered and stated as a cost impact on the environment.

This industrial dust collector is built to optimize safety and minimize operating costs and waste disposal costs.

This worksheet can be used to help calculate total cost of ownership for a chemical dust collection system. However, there are many factors that can't be captured in a worksheet. It is best to contact a dust collection specialist to discuss your specific situation.

Total Cost of Ownership Worksheet

How many days will this system operate in a year?	365	**days/year**
How many hours will this system operate in a day?	24	**hours/day**
What is the volume of air required to operate the system?	10400	**cfm**
How much does a kilowatt hour cost?	0.10	**dollars per kWh**
What is the cost of no production for one hour?	500	**dollars per hour**
What does a HemiPleat filter cost?	120	**dollars**
What does a Brand A filter cost?	90	**dollars**
How many filters are there in the dust collector?	16	**filter cartridge(s)**
What is the expected shipping cost per filter?	10	**dollar per filter**
What is your labor and overhead rate for one hour?	80	**dollars per hour**
How much does it cost to dispose of a filter?	10	**dollars**
How much does a variable frequency drive cost?	2600	**dollars**
What is the current interest rate?	4.5	**%**
How many minutes does it take to change a HemiPleat filter?	5	**minutes**
How many minutes does it take to change a Brand A filter?	10	**minutes**
Will there be a variable frequency drive operating this system?	yes	**yes or no**

For information on how to calculate actual total cost of ownership using the above worksheet, call your local Camfil APC representative.