camfil
CLEAN AIR SOLUTIONS

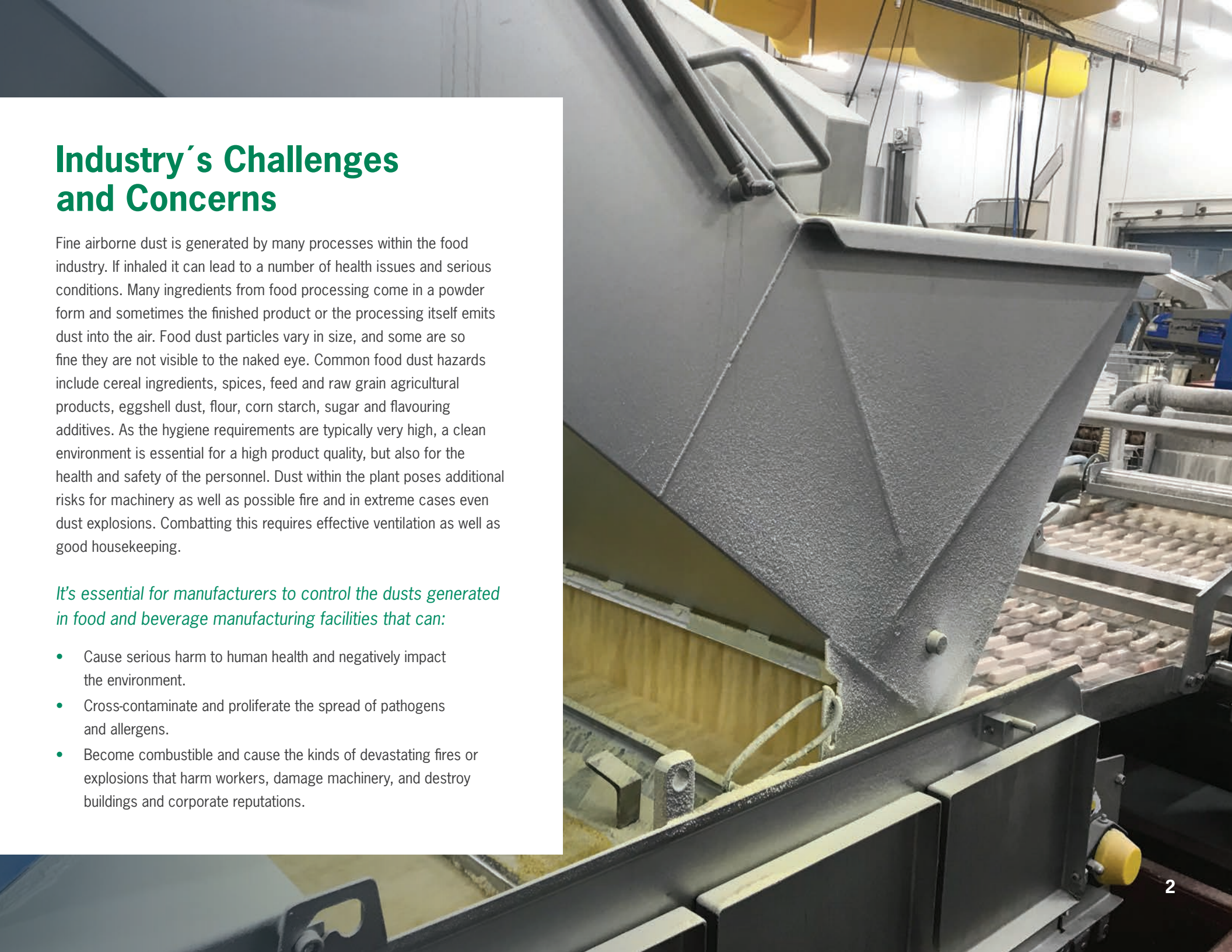
PROTECTING PRODUCTS AND PEOPLE
AGAINST DANGEROUS DUST FROM FOOD PROCESSING APPLICATIONS

Industry´s Challenges and Concerns

Fine airborne dust is generated by many processes within the food industry. If inhaled it can lead to a number of health issues and serious conditions. Many ingredients from food processing come in a powder form and sometimes the finished product or the processing itself emits dust into the air. Food dust particles vary in size, and some are so fine they are not visible to the naked eye. Common food dust hazards include cereal ingredients, spices, feed and raw grain agricultural products, eggshell dust, flour, corn starch, sugar and flavouring additives. As the hygiene requirements are typically very high, a clean environment is essential for a high product quality, but also for the health and safety of the personnel. Dust within the plant poses additional risks for machinery as well as possible fire and in extreme cases even dust explosions. Combatting this requires effective ventilation as well as good housekeeping.

It's essential for manufacturers to control the dusts generated in food and beverage manufacturing facilities that can:

- Cause serious harm to human health and negatively impact the environment.
- Cross-contaminate and proliferate the spread of pathogens and allergens.
- Become combustible and cause the kinds of devastating fires or explosions that harm workers, damage machinery, and destroy buildings and corporate reputations.

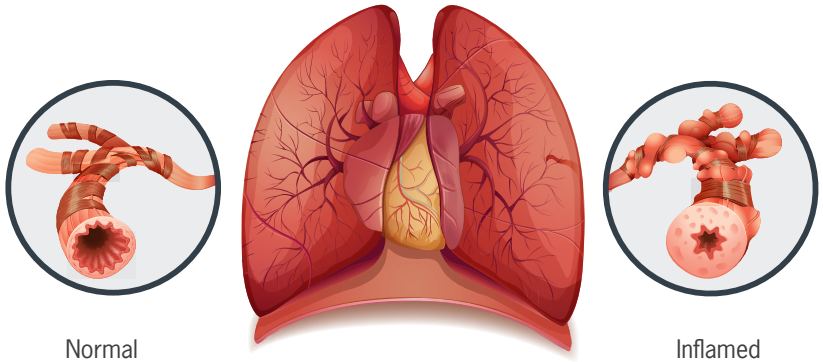


Health Hazards

Regular exposure to certain types of fine dust particles can produce minor allergic reactions on the skin such as dermatitis. Such conditions are uncomfortable for workers and require treatment, the use of protective work wear, which can affect an employee's performance and well-being.

However, the respiratory distress that dust allergens can cause is far more serious. The finest dust particles readily become airborne and are easily inhaled, penetrating deep into the lungs. They can cause life- threatening conditions such as occupational asthma as well as chronic, long-term health issues including lung cancer.

Asthma-Inflamed Bronchial Tube



Normal
Bronchial Tube

Inflamed
Bronchial Tube

Contamination of Products

Cross-contamination is another serious issue and often, a primary concern. Food contamination and foodborne illness cause recalls that cost food manufacturers hundreds of millions of euros. Travelling dust in a food processing plant can result in a pathogen outbreak from the spread of microorganisms or exposing customers to allergens. A plant with very good systems can deliver products that are more pure, higher quality and using less additives.

Preventing cross-contamination requires effectively collecting and removing all contaminants before they become widely dispersed. Collecting, controlling and filtering pathogens and allergens minimises the spread of harmful contaminants and keeps them from returning to the processing environment.

Housekeeping

Deposited dust must be removed from all surfaces in a facility at regular intervals and the more dust getting airborne, the more effort it takes to do this. Some of this is required regardless of the dustiness for hygienic reasons, but a lot of dust clearly complicates this. A well designed system can reduce the need for housekeeping. And dust is not only deposited in the production areas, also the internals of machines as well as the ventilation system itself. Internal dust may not be visible but it can still cause issues. To counter this risk regular inspections are a vital tool.

Fire & Explosion Risks

Food, food ingredients production and handling facilities have experience with a long series of serious accidents involving dust explosions over the years. Major accidents happened on processes like grain storage, fertiliser handling or sugar processing, to name a few.

Combustible dust explosions are a serious risk at many manufacturing and processing plants and an unprotected dust collection system can be a main cause of an accident. An explosion in an unprotected dust collector produces a strong pressure wave that can fragment the housing and send heat, flames and dangerous projectiles into the workplace which can critically injure personnel, damage equipment and buildings. So make sure your dust collector has an effective explosion protection system.

Risk Mitigation and Safety Devices

The goal of any type of explosion protection equipment is to control an explosion, keep employees safe and minimise damage. There are two main types of protective systems you can use:

Active systems such as chemical isolation and fast-acting valves react prior to or during a deflagration event by injecting a suppressant, quenching the explosion. In pipes sometimes very fast valves are used to stop the spread of an explosion.

Passive systems react immediately following an event to prevent the deflagration from traveling to other areas and causing more damage. Most manufacturers use passive systems because they are a lot less costly and don't require as much inspection & servicing. Passive systems control the effect of explosions by releasing the pressure produced when they have reached a certain limit. Examples for passive systems are explosion venting, flameless venting, explosion isolation and safety monitoring filters.

Apart from the application requirements and how to protect the dust collector from the effects of an explosion, there are challenges in selecting and purchasing the right filter elements. According to the ATEX rules its formally the responsibility of the end user to manage any risks from electrostatic effects. This means that at least formally it's a high responsibility task to specify and buy filter elements. It´s not possible to simply trust the supplier but one has to require proper documentation. As this is a complex topic all detailed solutions need to be analysed by experienced personnel.

Dust Explosion & Flammability Testing

Explosibility testing assesses whether a dust is combustible and helps to determine if static dissipative media or conductive filters are needed.

If your dust is combustible, the lab will conduct further analysis on dust cloud explosibility parameters to pinpoint the Kst (the deflagration index of a dust cloud, or rate of pressure rise) and Pmax (the maximum pressure in an unvented, contained explosion).

If your dust is found to be even slightly combustible, you will be required to use explosion venting equipment on your dust collector, along with the appropriate filter media. Fire-retardant media will extinguish itself if no other combustible material is present.

Anti-static (conductive) filter media is recommended when conveyed dusts generate static charges that require dissipation. Anti-static media should be used in applications with explosive dust to reduce potential ignition sources and conform to ATEX-directives.

Common applications for handling food dust with anti-static filters include sugar, starch, spices, coffee, tea, flavouring, milk powder, to name a few.

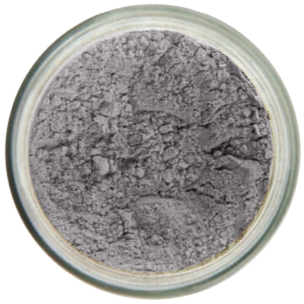
Media with anti-static properties and open-pleat design enable better airflow through the cartridge and better cleaning characteristics, energy-efficient performance and long filter life.

Combustible Dust Classifications

Dust Explosion Class	Kst	Characteristic
St-1	<200	Weak to Moderately Explosible
St-2	201-300	Strongly Explosible
St-3	>300	Very Strongly Explosible

Combustible Dust Properties

- **Kst** – Deflagration index (bar-m/s)
- **Pred** – Reduced pressure after venting (bar)
- **Pstat** – Vent static burst pressure (psi)
- **Pmax** – Max pressure for an unvented dust explosion (bar)
- **(dp/dt)** – Rate of pressure rise (bar/s or psi/s)

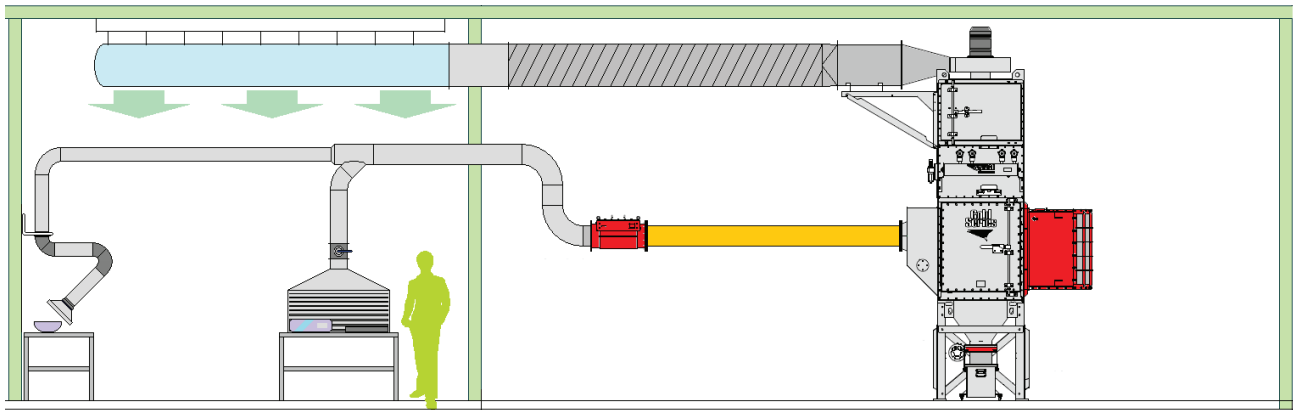


Tailored Solutions

To improve the situation good ventilation is required. Doing this with just general ventilation is very inefficient and costly, as large airflows are required and the effect is limited.

An effective extraction and filtration solution needs to be adapted to the specific process and machinery. Engineering your design helps you to reduce the required air volume while improving the overall system performance. The results provide many benefits such as a more efficient filtration system, improved indoor air quality, optimised operational costs and potentially reduced space requirements.

Investing in a tailored solution can also deliver a speedier return on your capital costs. If a system is adapted to your specific needs, in the long run, you will realise a more energy efficient solution, especially when it can be balanced with general ventilation systems.



How to Capture Airborne Dust

Capturing solutions need to be adapted to the individual workstation and process to be efficient. Capturing solutions can roughly be divided into 3 categories:

- **Enclosure:** The most effective solution is an eclosure that more or less encapsulates the dust generating process (or part of). Typical examples can be an enclosed machine or a mixing vessel. The ventilation is connected directly to the enclosure. Here the challenge is to ensure the air volume and velocity in the enclosure is optimised as such to only capture the waste dust and not extract too much that the actual product is vacuumed from the process.

- **Semi enclosed work positions:** The next category are semi enclosed work positions, suction walls, hoods and walk-in booths. Some typical work processes are filling powdered ingredients into a mixer or a weighing station where different ingredients are measured out. Semi enclosed positions are less efficient compared to a completely enclosed process. To compensate for this, you will require a higher airflow to be effective. Often it's necessary to review the work process and the dust source to determine where the suction device can be positioned. The nature of the contaminant also plays a role here, particle size and temperature are important factors to decide position and distance for an effective solution. As this type of work typically involves an operator that can't be fully protected by the extraction, it may be necessary that the operator is equipped with some PPE.

- **Flexible extraction arms:** The final category includes flexible extraction arms. These are significantly less efficient but they are still better than general ventilation. This is done for processes over a larger area or temporary work, for example maintenance. In this category we also find mobile filter solutions and vacuum cleaners for housekeeping. Mobile solutions can rarely be used for continuous operation, but can be a solution for intermittent work. There are versions of arms adapted to the needs in the food industry.

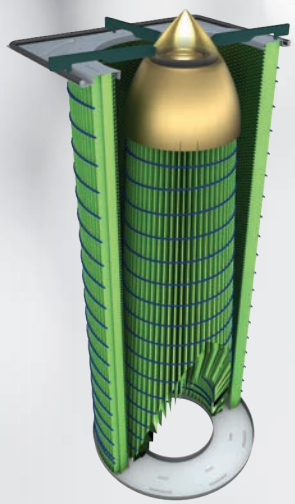
All in all, it´s possible to significantly reduce the required air volume and energy consumption while offering a better environment. A reduced air volume and more efficient capturing also leads to lower investment for dust collectors and longer filter life for the filters in the air handling units. The cost is mainly the time and effort to do the design and installation up front.

Dust Extraction Systems

The dust collector is a very important part of the system. If this can't cope with the incoming dust, the pressure will build up and the extraction will be less efficient. Today it's best practice to control the fan speed using a VSD but this has its limits. The VSD needs to be controlled in the right way, keeping a constant suction pressure or airflow, depending on the requirements for the system. A dust collector must be able to clean itself by using a good internal flow pattern and well-designed hanging cartridges to facilitate the separation of the dust. The flow pattern is important to allow the dust to fall out and not be re-deposited on the filter elements after being cleaned off.

The Filter elements are the heart of any dust collector. They are doing the filtration and have to be able to clean themselves. The design of the filters is the key to a well working and reliable system but also the selection of the filter media, that has a high efficiency and is easy to clean. All medias aren't equal and different medias will be better adapted to different dust types and applications. And one media might work well in one filter element style and not in another.

But it doesn't end there. The geometry of the filter and how the filter media is kept open during loading are key design elements. A media pack that closes when the dust loaded and the pressure is increased can quickly end the filters life. And it can actually be a problem with too much filter media, especially if it's not supported. Camfil has spent many years stepwise perfecting our filter elements and the design of the folded media pack with our HemiPleat technology, looking at the flow during operation as well as during cleaning. This has led to our Gold Series and Gold Series X-Flo designs. The cleaned off dust must be allowed to fall down into the hopper and not end up back on the filters. From this aspect, hanging filter cartridges yields the best performance for most applications.



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Discharge and Safety Solutions

Dust discharge

The collected dust must be moved out of the dust collector using a dust discharge system. This is very important and the manufacturer needs to assess what volume of dust to expect and how the customer wants to work. In most cases the dust needs to be managed in closed bags or containers, but for smaller amounts and indoor operation simpler solutions can be used.

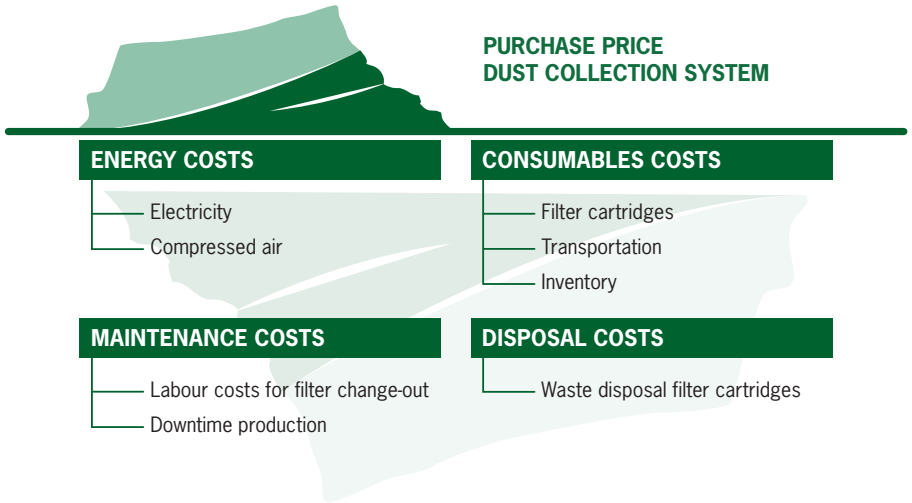
Safety

Safety is a reoccurring concern and dust collectors have an elevated risk for dust explosions. As the dust is accumulated in the dust collector, this is the most likely place for a dust explosion to start. The ignition source is typically not from the dust collector itself but being sucked in to the unit, still it's important to use only certified and tested dust collectors. As the dust collector is a risk point it also needs to be protected against the consequences should an explosion or fire occur. There are many ways of protecting a system and an experienced supplier can and should analyse the needs and individually engineer a safe and functional protection.
Do not forget to protect the ducts leading to and from the dust collector, in case of an internal explosion this will spread through the pipes back into the facility. Also, the return air ducting needs to be protected if they go back into the building. Here Camfil has a unique solution, our iSMF filter that is a secondary filter that allows both recirculation and protects against a propagating dust explosion (to ST2).

Dust Collector
Total Cost of Ownership

When purchasing dust collection systems and filter cartridges, the initial purchase price is just the tip of the iceberg. The bulk of the costs – energy, consumables and operations – are lurking below the surface. A low initial investment can turn out to be a very expensive total cost.

When dealing with the costs of operating cartridge-style dust collectors, 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. The areas where the greatest cost savings can be achieved over the long term are using less electricity, using less compressed air, and using fewer filter cartridges.



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