WHITE PAPER

The Importance of Effective Dust Control and Containment in the Workplace

In many instances, pharmaceutical and chemical manufacturing involves the handling and processing of powder or granular ingredients, many of which have risks attached when in dust form. A comprehensive risk assessment of each and every application is essential before evaluating the appropriate dust control solution.

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The questions that need answering when analysing the potential risks associated with dusts generated in the workplace include the following:

1. **Are the dusts potentially hazardous to human health and the environment?**
2. **Do they have the potential to cause explosions or fires?**
3. **Do they have the potential to interfere with moving parts of machinery and electrical componentry?**
4. **Is there the potential for cross-contamination of products?**

The effective control of dusts, particularly when the finer particles become airborne, is an essential part of the manufacturing process. In this article we will identify the key components of an effective dust control system, the legal requirements that must be met and the ancillary equipment available for optimum protection and system energy efficiency. It can be a complex and considerable capital purchase so there is a real need to get it right, first time.

Before even considering the dust control system, the first step is to fully understand the ingredients that are being used in production. The MSDS (Material Safety Data Sheet) is a good start, providing basic details relating to toxicity, handling requirements etc. but more specific information is required:

• **Dust particle size analysis** – the greater the percentage of sub-micron particles then typically, the greater the explosive potential and potential harm to human health, the environment and machinery. This information will help in choosing the dust control equipment required for effective dust capture, transport and filtration. There are companies that provide dust particle analysis and some dust control companies have their own laboratory and analysis facilities.

• **Dust explosive characteristics** – there are certain values that need to be determined so the correct explosion protection and explosion venting measures can be specified as part of the dust control system. The first of these is the Kst value which measures the rate at which a dust explodes. The second is the Pmax which is the maximum pressure produced when the dust explodes in a sealed vessel. The third is the minimum ignition energy (MIE) which is self-explanatory. For many standard materials, these figures are already known and a dust control company will help to verify them. However if they aren't known or there is some doubt, there are companies who can undertake the explosion testing to obtain these values.

Dust collector designed specifically for pharmaceutical and hazardous dust containment applications

• **Exposure limits** – the more potent the dust the lower the exposure limits set for personnel coming into contact with the materials. It is the employers' responsibility to know and understand the exposure limits for each product they are using, and take the necessary steps to ensure the limits are not exceeded. The information regarding exposure limits is country specific. Using the UK as an example, the information is available via the HSE website: http://www.hse.gov.uk/coshh/basics/exposurelimits.htm

The next stage is to determine where in the process the dust is being generated. It is important to extract the dust from source to ensure that it does not escape into the workplace. A reputable dust control company will have the necessary qualified and experienced personnel to design the correct dust control system, specific to the application. The main constituent parts of a typical system are as follows:

Example of an installation of a typical dust extraction/ collection system

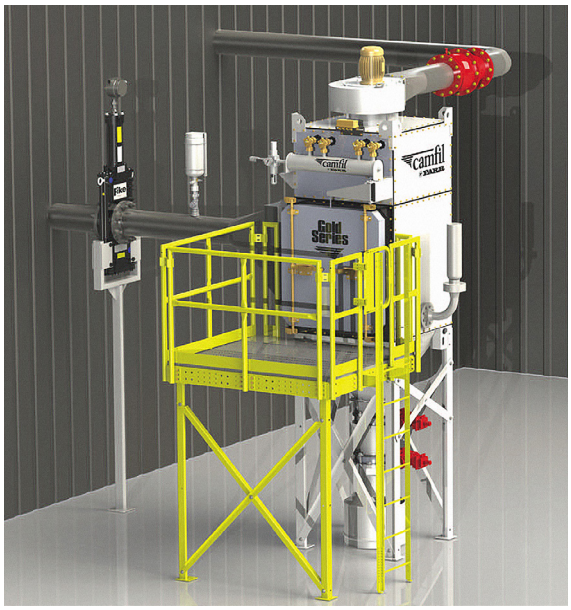
• **Capture Hoods** – there are a wide range of capture hood designs to choose from. A dust control company should be able to specify the most appropriate design for each and every extract point. Well-designed capture hoods with the required airflow face velocity will ensure any airborne dust is extracted. This will help to negate the four main risks outlined at the start of this

• **Ducting** – the circular ducting transports the dust to the dust collector unit where it is filtered. Selecting the correct diameter of ducting at every branch of the ducting system requires an experienced and qualified engineer. They will calculate the airflow velocity requirements to effectively transport the dust through the ducting layout, ensuring the system is well balanced. If the dust is moved too quickly then it may affect the filters in the dust collector. If the dust is moved too slowly then it may collect in the ducting system causing a significant hygiene, fire and explosion risk.

• **Dust Collector Unit** – the dust collector unit is essentially a self-cleaning filter housing with a fan that moves the contaminated air out of the workplace, filters the dust and fume particles and discharges them into a bin or similar receptacle. The choice of filter material is critical and dependent on the dust characteristics, size, shape, charge and also the application conditions including temperature, humidity, pH etc. The area of filter material required is also important so that the dust collector is sized appropriately to handle the airflow and dust concentration as effectively and efficiently as possible. For particularly potent dusts or those with a higher percentage of sub-micron dust particles, it may be necessary to incorporate a secondary set of filters, HEPA or absolute filters, to ensure the very finest of dust particles are captured. Any gases present in an application will also be extracted so these must also be taken into account when assessing the potential risks.

• **Fanset** - The choice of fan and associated motor is also critical to the overall effectiveness of the dust control system. The fanset has to achieve the required airflow and pressure to match to design criteria established by the dust control engineer. The fan and motor will be sized according to the calculations made during the designing of the ducting system.

Dust collector units with pulse-jet, compressed air cleaning are designed to run continuously and facilitate 24/7 production. With energy costs rising, the energy efficiency of the system is an important consideration when specifying the chosen system supplier. It is possible to evaluate the *total cost of ownership* of the dust control unit, taking into account each aspect of the system operation. The fanset may be running continuously so the most efficient motor should be installed to keep the power consumption as low as possible. Variable Speed Drives (VSD's) can be installed where appropriate to regulate the system airflow and also help to reduce the energy consumption. The fanset should be sized to work at its optimum level; under-sizing or oversizing will impact both the system performance and energy efficiency.



Example of a dust collector unit showing various safety features, specified according to the particular dust and gas characteristics found in an application

The compressed air supply for the pulse-jet cleaning is also an aspect of the system with associated energy costs. The correct set-up of the dust collector unit during commissioning is therefore necessary to ensure the filter cleaning regime is operating as per the manufacturers' instructions. It is worthwhile monitoring the compressed air usage as any reductions can equate to significant energy cost savings.

These energy saving solutions however, must not be implemented at the expense of the dust extraction performance. A well designed, balanced system will be both effective in terms of performance as well as energy efficient. When replacing older dust control systems with new ones, the return on investment can be very quick when the energy cost implications are realised.

The dust collector and ducting will incorporate a number of safety systems depending on the risks associated with the application. The comprehensive risk assessment will help to identify these and the level of protection required. Many of these will be legal requirements under directives such as ATEX 94/9/EC directive concerning equipment and protective systems intended for use in potentially explosive atmospheres (for EU Member States). The protective systems include safe explosion venting solutions, dust collector reinforcement, antistatic and earthing features, spark minimising fans, explosion suppression systems and various forms of ducting safety valves.

Another critical consideration and one which is often overlooked, involves effective containment of potent dusts. Once the airborne dust is captured at source, it needs to be contained at every stage of the extraction process. This is a major consideration when preventing cross contamination of products. It will help to satisfy authorities such as the Food and Drug Administration (FDA) when investigating the Good Manufacturing Practice (GMP) across all production processes. Therefore, tight seals on the ducting joints, dust collector and any ancillary equipment, such as the protective systems, are imperative. Surrogate testing of the system once installed is recommended as this will give greater reassurance that all potent dusts are being contained.

Containment is also essential during maintenance of the dust collector unit. The filters will need replacing when they have reached the end of their service life, usually indicated by a constant rise in the differential pressure across the primary or HEPA filters. This filter change will either be carried out by a maintenance team or by a third-party contractor. For potent dusts there should be a

specific and integral safe change operation for both the dust discharge system (for safe disposal of the collected dust) and the filter change-out. The better the design of these operations, the easier it is to facilitate a safe change and so prevent any release of harmful dust, up to the point of safe disposal.

Example of a surrogate tested "bag in, bag out" safe change filter option for a dust collector

Summary

To summarise, when evaluating an existing dust control system for its suitability or designing a new installation, there are a number of key steps which will help towards a successful system installation.

1. Employ a specialist dust control company or specifier who will have the required experience and knowledge to assist at every stage of the project. This will prevent any costly mistakes and ensure the system specified and installed is fit for purpose with all the necessary levels of protection to satisfy the legal requirements. Look for evidence in terms of case studies of similar projects successfully completed, focusing on the system performance, system safety functions (including explosion prevention, safe explosion venting and safe-change operations) and energy efficiency information.

2. Understand the ingredients/products being used and in particular, their characteristics and potential hazards when in dust form. If there is any doubt, or if there is some critical information missing, then get the dust tested. Determine the exposure limits for each material and the relevant Personal Protection Equipment (PPE) if required.

3. Undertake a full risk assessment of the existing or proposed production processes to determine the potential hazards. Identify where any dust will be generated, whether the workforce will be exposed to it, whether there will be fire and/or explosion potential or interference with machine moving parts/electrical componentry.

4. Choose and install the system which is the best solution to satisfy the specific requirements identified. Establish a maintenance schedule to monitor the system to maintain optimum performance and help identify further energy cost savings.

References:

1. HSE Website (UK)
www.hse.gov.uk

2. Camfil Air Pollution Control (APC)
www.camfilapc.com/europe

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About the author:

Richard Jones is Pharmaceutical Market Manager (Europe) at Camfil Air Pollution Control (APC). Richard has gained considerable experience over several years in dust control and across a wide range of industries. He joined Camfil APC in 2013 and now looks after the dust collector sales for the pharmaceutical industry in Europe and the surrounding emerging markets.

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