

**SHAPA TECHNICAL BULLETIN No.6.**

**10 KEY STEPS  
FOR COMPARING  
DUST EXTRACTION SYSTEM PROPOSALS**

## **Ten Key Steps** **For** **Comparing Dust Extraction System Proposals**

John Whitehead – General Secretary, SHAPA

### **Introduction**

Wherever solid particulate is being handled, processed or stored or is created, as a by-product of a process such as machining or finishing, dust is usually generated. This dust needs to be controlled to prevent environmental damage and risks to health. In general there are the 4 means of controlling dust as listed below in order of best effect:

- 1) Preventing the creation of the dust in the first place by using a different process or material
- 2) Containing the dust
- 3) Suppressing the dust
- Or
- 4) Extracting and collecting the dust

The first 3 approaches should always be given careful consideration as they do offer the most effective ways of solving the problem and are often the most economic. Dust extraction should only be considered as a last resort if none of the other methods are feasible.

In many instances, however, none of the first 3 preferred means are either operationally practical or compatible with the specification and/or quality requirements of the final product and the extraction and collection means is the only viable solution.

This paper outlines the 10 Key Areas that purchasers should focus on in their assessment and comparison of Dust Extraction System proposals.

### **1. Suppliers Assessment of Your Requirement**

The whole process starts with the recognition that there is a dust problem that needs to be handled and a number of potential suppliers are contacted.

The first measure of a potential supplier is the initial reaction you obtain from them and their willingness to provide a solution to your problem. Some suppliers will try to 'solve' the problem from their office but this is seldom satisfactory unless your requirement is merely for a single piece of equipment such as a silo venting filter rather than an extraction system.

To be able to fully and accurately assess your requirement a site visit by a competent dust control engineer is essential.

Once the engineer is on site you should ensure that you are given the opportunity to fully describe the problem as you see it and give the engineer as much information as

possible. Even applications that appear to be identical can require different solutions when all aspects of the specific application and local conditions are properly considered.

Do not allow the engineer to offer a solution until you are satisfied that he has all the relevant information concerning your particular application and is not making assumptions based either on previous work he has done or on the product he wants to sell.

Once the engineer has obtained all of the information he should be able to give you an outline of what he is going to propose as a solution to your dust problem. This should include: -

1. Method of dust capture
2. Type and position of dust collector
3. Method of collection of dust for disposal
4. Any health and safety issues and installation requirements.

Following the site visit you should receive a quotation for the system from which you should be able to assess the next key areas.

## 2. Dust Capture Method

The engineer, from his observations of the application, must design a suitable system to solve the dust problem. The solution should utilise the minimum amount of 'control air' possible to achieve a good level of dust control as in general costs involved are directly related to the quantity of control air employed.

The solution may take the form of the provision of localised hoods at each dust generation point or the use of an enclosure around a number of these points. In some cases a combination of these two methods of approach may be considered to be the best solution.

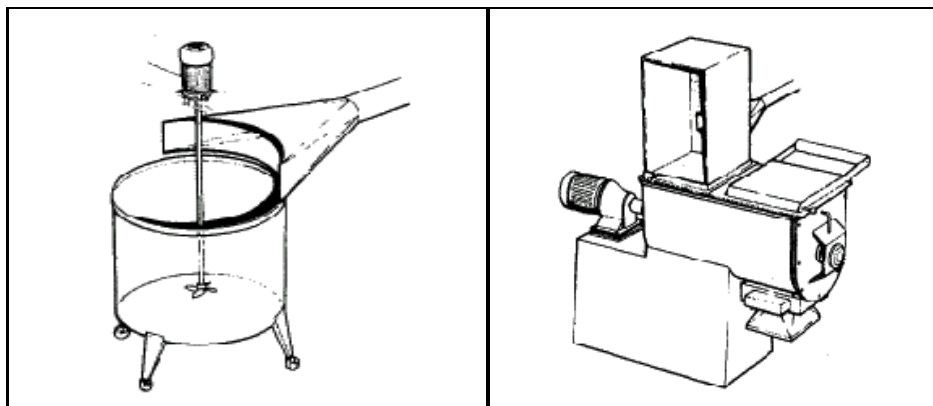


Fig.1 Example of Local proximity hood

Fig.2 Example of an Enclosure

The use of a local proximity hood applied to drum filling operation is shown in fig. 1. This hood is designed to pull a curtain of air over the top of the drum to capture the dust created while materials are being tipped into the drum.

The hood is shaped around the periphery of the drum to ensure that the hood face is as close as possible to any possible point of dust escape, as the effectiveness of an open face hood diminishes rapidly as the distance from the face increases.

A simple formula for calculating the quantity of air (Q) M<sup>3</sup>/ min required to provide a capture velocity (V) M/min for a dust at a varying distance (X) M from an open hood of face area (A) M<sup>2</sup> is:

$$Q = V (10X^2 + A)$$

The determination of the appropriate capture velocity is critical for each application if effective control is to be achieved. This can range from around 0.3 m/sec for applications such as the capture of evaporation fumes from a tank in a draught free area to up to 10 m/sec for capturing dust from applications such as grinding or abrasive blasting. (Fig.3 below)

Method of generation	Capture velocity (m/sec)	Typical processes
Released without noticeable movement	0.3 - 0.5	Evaporation of vapors, free jet shoblast room, thermal spray booth, welding fumes
Released with low velocity	0.5 - 1.0	Powder coating booth, weighing , packaging, low speed conveyor transfer points, oxy and laser cutting table ( 0.75 - 1 m/s)
Active generation	1.0 - 2.5	Plasma cutting table ( 1.0 - 1.25 m/s), shake out, high speed conveyor belt
Released with great force	2.5 - 10	Grinding

Fig.3 Range of Capture Velocities

The need for access to the process both in normal operation and for cleaning and maintenance should be taken into account. There usually needs to be some compromise between providing the very best design for achieving effective control and the requirements of the operator and/or process.

Consideration should also be given to how draughts can be either eliminated or reduced as the amount of air that has to be used to capture the dust increases significantly in the presence of cross draughts.

The use of an enclosure to control the dust created when loading a mixer is shown in fig.2. In using an enclosure, the dust control engineer is seeking to contain all the dust created by providing a controlling air velocity of typically 1m/sec across the open face of the enclosure through which the materials are being loaded. This is a very effective method of dust control as an enclosure eliminates the possibility of cross draughts that can be detrimental to the effectiveness of local proximity hooding.

The open face of an enclosure can often be reduced by the use of some form of either rigid or flexible sheeting which will reduce the quantity of control air needed and consequently reduce total costs. Care must be taken, however, to ensure that any reduction does not impede the operations inside the enclosure.

### 3. Ducting System

The design of the ducting system connecting the extraction points to the dust collector is a very important factor in the creation of a successful installation. The system design should take into account: -

1. The type, nature and quantity of dust to be handled.
2. The likelihood of internal wear from abrasion
3. The appropriate conveying velocity for the dust concerned to avoid either excessive power consumption and excessive wear or settlement in the duct. (see Fig.4 )
4. The need for inspection and cleaning

Material Conveyed	Conveying Velocity in ducts m/sec
Vapor, gases, fumes, very fine dusts	7.6 - 10.2
Fine dry dusts	15 - 18
Average industrial dusts	18 - 20
Coarse particles	18 - 23
Large particles	23 and higher

Fig.4 Range of Conveying Velocities for different types of dusts

The ducting construction should be of sufficient strength and thickness for the particular application, be dust tight and be adequately supported.

The ducting system should also be properly balanced by means of internal balancing cones if at all possible or fixable dampers to ensure that the correct quantity of control air is extracted from each point. An unbalanced system will provide more air than is required at some points, usually the smaller ones, whilst starving others and therefore providing inadequate extraction.

Internal balancing cones are the preferred method as once they are set they give consistent and reliable results. Dampers are often moved by operators throwing the system out of balance and the can be a source of material build up inside the duct.

### 4. Dust Collectors

There are a number of different types of equipment that can be used to separate the entrained dust from the conveying airflow. The most common are considered below outlining their strengths, weaknesses and variations to be considered:

#### □ Cyclones

The use of cyclones to provide separation of the entrained dust from the control air is the traditional and the most basic approach.

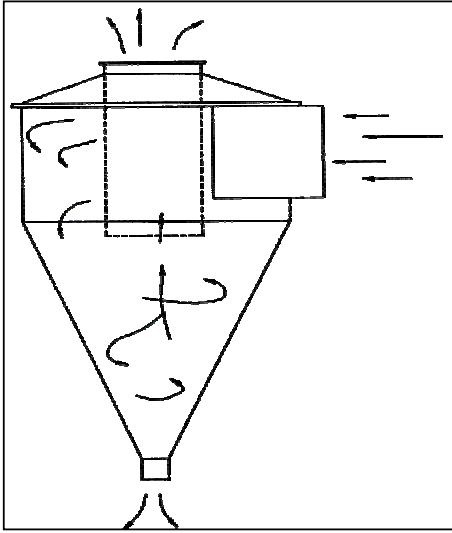


Fig.5 Typical Cyclone

The efficiency of separation provided by typical cyclones is, however, not particularly good when fine dust is involved and there is invariably some degree of dust carry over in the cleaned air discharge. As a result cyclones are normally only used on very coarse dusts, as a pre-separator prior to a more efficient method of collection or on specialist applications where the materials or temperatures involved prohibit the use of other methods. There are also some limited other applications where specially designed higher efficiency cyclones provide the best solution.

□ Wet Collectors

Wet Collectors, or scrubbers, are available in a number of designs with the most commonly used being either the low-pressure induced spray type or the higher-pressure venturi scrubber.



Fig.6 Induced Spray Wet Collector

Wet collectors have the ability to handle moisture-laden air and the collected dust is delivered from the collector in a wetted form so avoiding a secondary dust problem but disposal of the collected material in the wet state can be difficult and expensive.

Efficiency is a function of total energy input per m<sup>3</sup>/hr of air being treated, whether the energy is supplied to the air or to the water. This means that well-designed collectors by different manufacturers will provide similar efficiency if equivalent power is utilised.

One of the commonest uses of wet collectors is to handle potentially explosive dust from operations such as the grinding of aluminium, magnesium or titanium.

Generally speaking wet collection is now only used for applications where it is not possible to use dry collection.

#### □ Fabric Filters

Fabric filters are the most common type of dust collectors currently used. They can either be intermittently rated or, more commonly, continuously rated.

- Intermittently rated

In this type of filter, as illustrated in Fig.7, the air is drawn into the hopper of the collector and a coating of dust is built up on the filter fabric as the air passes through it towards the fan and the 'clean air' discharge at the top of the collector. A mechanical shaker mechanism has to be operated periodically, after typically 4 hours operation, to shake the dust that has built up on the fabric down into a dust collection device.

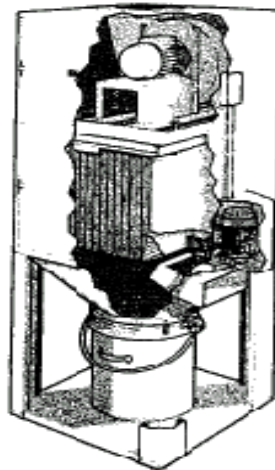


Fig.7 Typical Intermittently Rated Dust Collector

To achieve effective filter bag cleaning the mechanical shaking procedure can only be done under no flow conditions so the dust collector has to be taken out of service for a few minutes to allow this operation to be carried out, unless an elaborate and costly alternating system that closes off portions of the filter is built into the system.

Intermittently rated filters are therefore only normally used on applications, such as manually operated processes, where the system can be stopped periodically. This type of collector usually also relies on an operator to stop the process and initiate the shaking sequence.

- Continuously Rated

These have been the most commonly used type of dust collectors over the last 20/30 years. Unlike the intermittently rated type these dust collectors do not have to be stopped to allow the dust accumulated on the filter fabric to be cleaned down. Continuously rated filters are cleaned during operation by means of either reverse jet compressed air or low-pressure reverse flow.

The reverse jet cleaning type are the most commonly used for general work with the reverse air type being used to advantage sometimes in specific applications where high temperatures or highly abrasive materials are involved. The less severe cleaning method of the reverse air type of collector can reduce the risk of corrosion due to dew point conditions and also reduce fabric wear from mechanical abrasion.

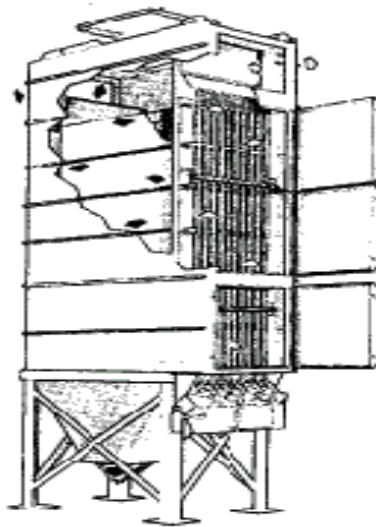


Fig.8 Typical reverse jet cleaned dust collector

There are a number of different designs of reverse jet dust collector. Some use cylindrical filter bags (socks) and others such as the one illustrated in Fig.8 use flat filter envelopes (pads).

In the illustrated collector the air is drawn into the inlet at the top of the front of the collector, it passes through the filter pads, that are mounted horizontally, leaving the dust on the outside of the pad with the 'clean air' passing through the internal centre of the pad to the outlet on the rear of the collector. The filter pads are cleaned in sequence with compressed air that is introduced into the centre of each pad.



- Fabric Filter Specification

The type of fabric and the filtration velocity are important issues to be considered when Fabric Filters are being specified.

The choice of fabric and filtration velocity, (the speed that the air passes through the filtering fabric), are determined from consideration of the following factors: -

- Dust characteristics
  - Type
  - Particle Size and shape
  - Dust loading
  - Temperature
  - Chemical properties
- Application characteristics
  - Source of dust
  - Emission limit to be achieved
  - Operating cycle

Fig.9 Guide to Properties of Common Synthetic Fibres

	Polypropylene	Polyester	Dralon	Ryton	Nomex	PTFE	P84
Maximum cont. dry	100	150	140	190	200	250	260
Maximum surge temp.	110	180	150	20	250	280	300
Maximum cont. moist	100	100	125	190	180	240	240
Hydrolysis resistance	E	P	E	E	P	E	F
Melting point or decomposition temp.	160	240	250	285	400	290	400+
Abrasion resistance	G	E	M	M	E	F	E
Acids	E	G	G	E	F	E	G
Alkalies	E	F	F	E	G	E	P
Oxidising Agents	F	G	G	P	G	E	M
Solvents	G	E	G	E	E	E	E

P = *Poor*      F = *Fair*      M = *Medium*      G = *Good*      E = *Excellent*

Typical filtration velocities for the different types of fabric filters are normally in the following ranges depending on the factors listed above:

Intermittently rated collector	0.6 to 1.8 M/min
Reverse jet continuously rated collector	1.5 to 3.5 M/min
Reverse Air continuously rated collector	0.6 to 1.5 M/min

It is critical that this assessment is done correctly as changing the filter media and/or adding additional fabric area can be very expensive. Sometimes it may even be impossible to extend the collector to allow additional fabric area to be provided.

If the collector has been sized with a filtration velocity that is too high the result will be a higher than design operating pressure which will in turn lead to an insufficient volume of air to control the dust generated by the application and a reduction in fabric life.

- Cartridge Filters

The use of reverse jet cleaned dust collectors fitted with filter cartridges, rather than filter bags, has increased significantly over the last decade as cartridge technology has developed.

Cartridge filters, whilst not as versatile as fabric filters, are very compact which allows them to handle a given air volume within a smaller cabinet than the equivalent fabric filter. They are also capable of achieving guaranteed low emission levels due to the rigid construction of the cartridge element and the lack of media movement when bearing pulse cleaned.

Applied to suitable applications cartridge collectors provide a very efficient and cost effective solution. They are widely used on applications where small particles are involved such as laser cutting, welding, pigments and powder spray.

Filtration velocities are normally in the range of 0.3 to 1.5M/min.

- Explosive Dusts

Many dusts are potentially explosive. This needs to be considered when choosing the type of collector to be used and the construction specification of the collector and ducting system.

Explosive dusts can be safely handled by the use of suppression, containment or venting methods. Many factors need to be considered when choosing which is the most appropriate for an application and is a whole topic in its own right which cannot be adequately covered in this paper. (see reference list)

## **5. Dust Disposal Method**

The collected dust has to be removed from all dust collectors. There are numerous ways in which this can be done and care must be taken to ensure that the correct one is selected to suit both your application and your working practices.

Some of the questions to be answered are: -

- Does the collected dust need to go back into the process?
- If so,
- At what point in the process and by what means?  
By: gravity, screw conveyor, rotary valve, pneumatically or other method?
- Or,
- Is the dust waste to be disposed of?
- If so,
- What is it to be held in? Bin, bag, skip or other container?
  - How will the dust be later removed from this container?
  - Can the dust collector be stopped to allow the dust to be removed?
  - If not, how can the container be isolated from the collector to allow dust removal?

Consideration of the answers to these questions should allow the dust control engineer to provide a suitable method which will take care of the collected without creating either a secondary dust problem or an unwanted disruption to the process

## 6. Operator Friendliness

An effective dust extraction system should remove the dust problem and ensure good working conditions without significantly inhibiting access to the operation or inconveniencing the operators.

The dust control engineer will have failed, even if the system he puts in eliminates the dust problem, if the operators do not freely adopt it because it makes their tasks more difficult. There is often a need for some compromise between ideal control conditions and operator needs and the dust control engineer should take time to initially listen to the operators to determine their needs and later to explain the benefits of the new system.

## 7. Emission Levels and Guarantees

Different types of dust collectors are capable of achieving different levels of emission when applied correctly to an application so care should be taken to ensure that the right type of collector is used and that it is correctly sized.

Typical levels of emission achieved by different types of correctly sized dust collectors (in mg/M<sup>3</sup>) are:

Cyclone (very dependant on dust size)	> 100 - 200
Wet Collector (dependant on dust size)	> 100 - 200
Mechanical shake filter	< 10 - 20
Reverse jet bag filter	< 5 - 10
Cartridge filter	< 2 - 3

To determine which type of duct collector is required for your application you should:

- Decide whether you want to discharge the cleaned air back into the workplace, to save on heating costs, or directly to the outside environment. (Limits for recirculation are lower than for discharging to atmosphere)
- Ascertain the requirement of the legal regulations.(see reference list)
- Determine whether the collector being offered can reliably achieve the level required without the need for further secondary filtration.
- Consider the implications of failure. Secondary filtration may be required to act as a 'policeman filter' to prevent dust release if the primary filter fails.

## **8. Maintenance and After Sales**

Other considerations when deciding on which dust extraction system to purchase should be: -

- How easy the system is to maintain
- How much downtime is required for maintenance
- Frequency of maintenance needed
- Availability of spares
- Cost of bag/cartridge change
- Frequency of need to change bags/cartridges
- Suppliers ability and availability for troubleshooting

The dust extraction system is an integral part of your production and needs to be kept running efficiently. Its reliability and the real costs of keeping it in good condition are critical and should be borne in mind when making the initial purchase decision.

## **9. Total Cost of Ownership**

The real cost of any dust extraction system is not merely the initial price. The total cost to the purchaser is this initial cost plus the costs involved in running the system over its complete life cycle.

It is very short sighted to purchase the lowest priced solution that you consider will solve the problem without taking into account the following in addition to the points already discussed: -

- The design standards employed
- The materials of construction
- All aspects of maintenance
- Costs of consumable and replacement parts
- The implications of malfunction

## **10. Supplier Assessment**

Whilst it is obviously important to select a solution that will provide an effective answer to the dust problem at an acceptable competitive cost in the lead time required, time should also be taken to assess the supplier.

The purchaser should take into consideration: -

- Company size and available resources
- Company history
- Financial strength and stability
- Whether the supplier has done any similar installations
- Customer references

Purchasers need to assure themselves that the company they are about to buy from has the knowledge and resources to solve the problem and support the installation in the long term.

### **Conclusion**

There are many facets to the purchase of a dust extraction system if you are to end up with an efficient, reliable and cost effective system that will give satisfactory performance over a long period. The wise purchaser will take all the issues raised in this paper into consideration before finally deciding on which system to buy.

Remember that once a system has been installed it can be very expensive and disruptive to alter if it does not give the level of performance that you need.

### **References**

- For all aspects of dust extraction and air movement  
'Industrial Ventilation' by the American Conference of Governmental Industrial Hygienists Inc, 6500 Glenway Ave, Building D-7, Cincinnati, Ohio 45211-4438
- For information on Dust Explosions  
'Dust Explosion Prevention & Protection – a practical guide' by John Barton, published by IChemE, Davis Building, 165-189 Railway Terrace, Rugby, Warwickshire, CV21 3HQ
- For UK Occupational Exposure Limits  
'EH40 - Occupational Exposure Limits' by Health and Safety Executive from HMSO

### **Acknowledgement**

- Donaldson Torit DCE, Leicester for assistance and providing chart material for inclusion in this paper.

The information included in this paper is based on the writer's years of experience in the dust control industry and is offered as a guide to any prospective purchaser of dust extraction equipment. No responsibility or liability can be taken for any specific application.

© Copyright, John Whitehead, General Secretary SHAPA Ltd, October 2002