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Dust Hood Design

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Introduction

Hood design is one of most important areas to consider when designing Local Exhaust Ventilation (LEV). It influences the effectiveness of the system in terms of contaminant control and the amount of air captured, which in turn influence ducting, air mover and air cleaner size.
The aim of this paper is to provide information that will help the reader to identify the correct type of hood for the particular application.

Problems with poor hood design

There are many problems that can be associated with poor hood design:-

- Inadequate capture of the contaminant, thereby leaving the operator exposed to the hazard.
- Excessive air volumes being captured, resulting in larger air movers, air cleaners and generally a more expensive system when compared with a correctly designed system.
- Restriction on the required user activity.
- Too much product being removed from the process and potentially wasted.

Advantages of good hood design

With good hood design the contaminant is correctly and effectively controlled and the captured air volume is restricted to the minimum. This leads to smaller ducting, smaller air filter and smaller air mover thereby providing the most efficient design and giving the following benefits when compared with poor design :-

- Lower initial purchase price
- Generally lower installation costs
- Lower running costs
- A solution the user is less likely to interfere with
- Compliance with legislation – CoSHH, EPA, ATEX etc
- An LEV that is meeting its specification

These are important considerations and commercially should not be ignored.

How to select the correct hood type

Good hood design starts with a thorough understanding of the contaminant to be captured, the process that is generating the contaminant, type of source (large, small moving) and how the user interacts during the process that generates the contaminant.

All of these factors will determine:-

- The type of hood used

- The position of the hood
- Any requirement for enclosing the source
- The size of the hood
- If the hood is fixed or moving

Contaminant to be captured

The purpose of this guidance is to cover hood design types and therefore will not spend a great deal of time on the type of contaminant other than state that gases, vapours, dust, fibres, fumes and mists are all forms of contaminants that we are often faced with when designing hoods. Each one has its own properties but once in air the cloud will move with the air surrounding it – i.e. into the hood and through to the air cleaner.

These contaminant properties need to be taken into account when designing the hood.

Processes

The process carried out influences the way the contaminant is generated and there are many (for example blasting) that can create mist, vapour or dust. Crushing would create dust as the contaminant.

Understanding the process will also give greater understanding of the creation of the source and also determines the possible control mechanism and hence the type of hood.

The source

This is where the process generates the contaminant and provides information that is used to determine what method of capture is required. For example how large the contaminant cloud is, how it is presented into the air and what direction it takes.

Types of hoods

There are three basic types of hood:-

Enclosing (fully or partially enclosing)
Receiving
Capturing

Enclosing Hood

Also known as a containment hood this type is often considered the most effective type. The source to be controlled will be located internal to the hood and is so designed to prevent escape of the contaminant due to the side wall constraints and the in draft of air from any openings.

As the name suggests the hood fully, or in some cases partially, encloses the source completely, only having openings to allow for any required processes to take place and introduce the air required to capture the airborne contaminant and transport it to the discharge point. Typical processes that use this type of hood would be bag or sack tipping.

Figures 1 and 2 show typical enclosing hoods.

Figure 1 – Enclosing hood.


Figure 2 – Bag tipping operation

<u>**Receiving Hood**</u>

Less effective than the enclosing hood is the receiving hood which has the contaminant source external to the hood and relies upon the inertia and direction of the source to guide the contaminant into the suitably designed and positioned hood.

Typical processes that would require a receiving hood would be ones that use high speed cutting, grinding or blasting.

This type of hood can either be fixed or moveable. If moveable, it is good practice to provide the user with instruction on how the hood should be positioned to remain effective.

The hood should be adequately sized and have a high enough velocity of air to ensure that the contaminant is captured.

Figure 3 - Fettling of a metal component with a grinder

Figure 4 –Receiving hood over circular saw blade (above and below).

Capturing hoods

Again less efficient than the enclosing hood, this is the most commonly used hood type in Local Exhaust Ventilation (LEV) where the process and source are external to the hood. This type of hood relies on the air flow into the hood to capture and control the contaminant.

Whilst the position of the receiving hood is critical for performance, this is even more so for the capturing hood. Ideally the hood should be fixed in the correct position relative to the source where the contaminant is pulled away from the operator. However, often the hoods are moveable to match the process taking place and, in these cases, it is important to provide the user with a clear instruction on how the hood should be used in order to be effective.

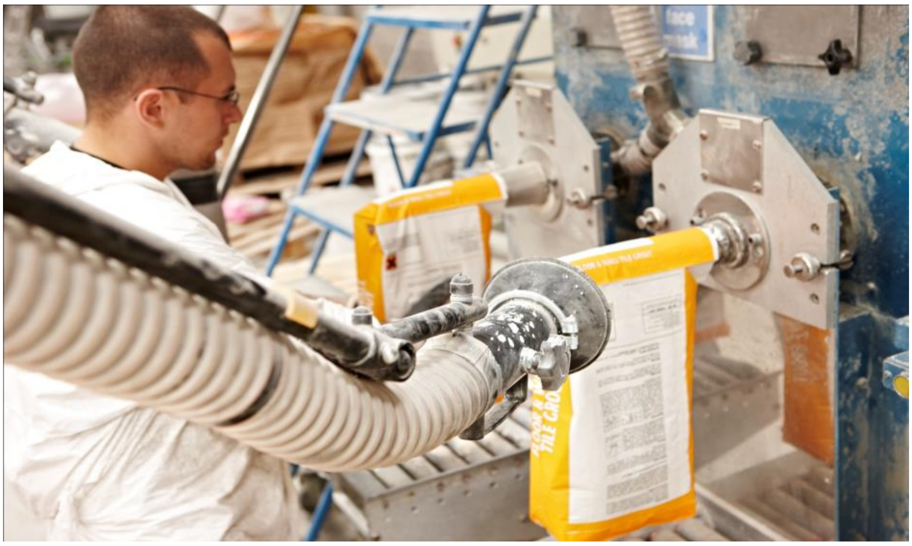

Figure 5 - a bag filling operation using a moveable capture hood

Capture hoods are often used where the enclosing or receiving hood types are not suitable and where the contaminant has no strong movement and direction.

One way to demonstrate how important the position of the hood is to the effectiveness of the control is to look at a velocity contour map – see figure 6 below.

The particular velocity contour map is for a circular plain opening and it can be seen clearly that the velocity falls off rapidly with increasing distance from the hood opening - velocity decreases inversely with the square of the distance from the hood. At a distance of just one diameter from the opening, the velocity has fallen to below 7.5% of the velocity at the opening.

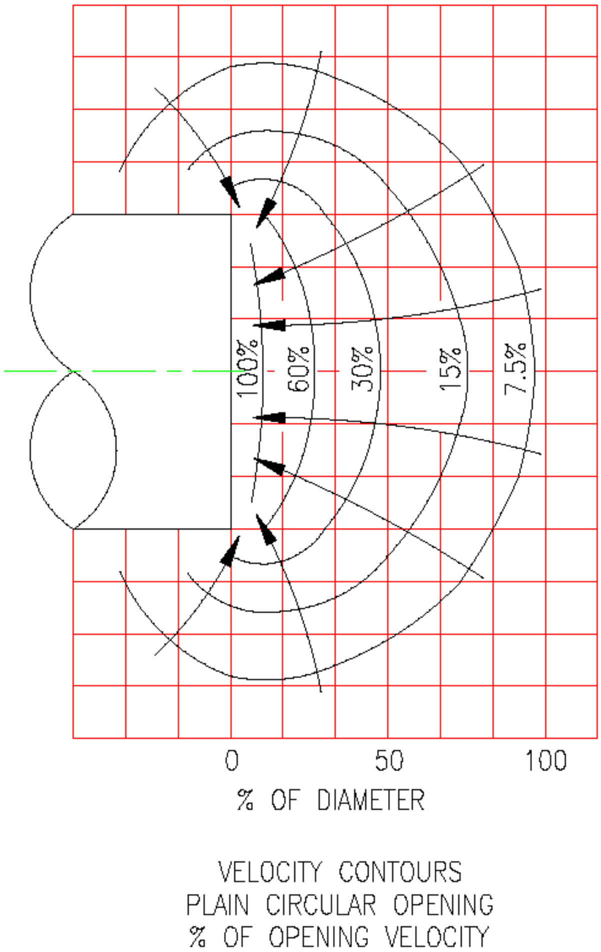

Figure 6

Since there is no particular movement of the source into the hood, movement must be generated from the hood itself.

Capture relies upon the velocity of the air at the location of the source, where the actual velocity required is dependent on the how the source is presented and any influencing factors such as other air movements such as draughts etc. The position of the hood is therefore critical to maintain the velocity at the point of capture.

The following example shows the effect on distance of the hood from the source on the air volume required.

An articulated arm (see figure 7) has an open face area equivalent to a 250 mm diameter opening (0.05 m^2) and needs a capture velocity at the point of source of 0.5 m/s. The hood will be placed 250 mm away from the source to allow the process to take place.

The required air volume is obtained from the following:-

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

Q = air volume.
V = capture velocity at distance X from the hood.
X = distance of the hood from the source.
A = open face area of the hood.

$Q = 0.5\ (10 * 0.25^2 + 0.05) \quad = 0.34\ m^3/s \quad 1215\ m^3/hr$

If however the distance from the hood to the source was increased to 300 mm the required air volume would increase to:-

$Q = 0.5\ (10 * 0.3^2 + 0.05) \quad = 0.48\ m^3/s \quad 1710\ m^3/hr$

40% increase in air volume required for 20% increase in distance.

If this is not understood at the design or user stage, the effect is to design a system suitable for a capture velocity at source of 0.5 m/s requiring a total air volume of 1215 m^3/hr BUT be faced with a system that delivers inferior results, which may not control the contaminant when the hood is placed further away as in the example above.

LEVs are designed to handle a given air volume and the result of placing the hood at a further 50 mm from the source results in the capture velocity reducing to just 0.36 m/s.

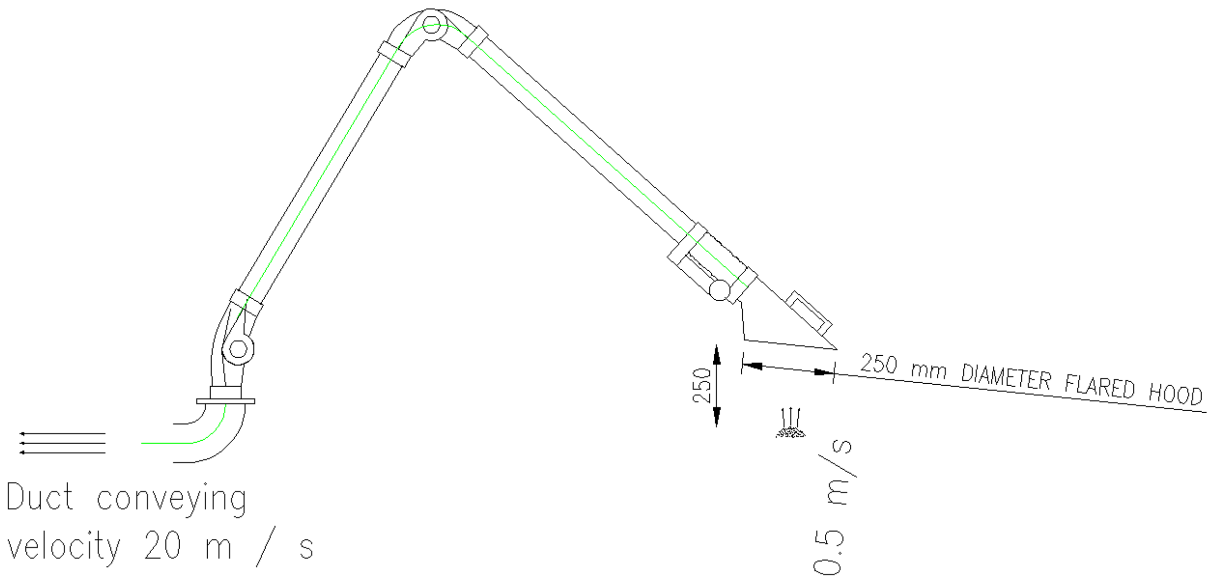

Figure 7 – Articulated arm

<u>Finally.</u>

The above describes the three basic types of hoods that are used in LEV but there are variations on these types for example slotted, canopy and fish tail to mention some of the common ones. Each hood has been created to handle specific processes and type of source of contaminant.

Figure 8 – slotted barrel filling hood.

Some hoods are used in a push-pull arrangement where a jet of air is pushed across the contaminant source into a receiving hood. When used on open tanks for example, it works due to the pushed jet of air maintaining its velocity over large distances, pushing the contaminant into the capture zone of the receiving hood.

Any designer of a hood should ask themselves:

"What type of hood requires the LEAST air volume to control the contaminant when considering the process and source?"

and should bear in mind:

- It is better to enclose
- It takes four times the amount of air to pull twice the distance
- You can push air forty times farther than you can pull it
- Consider disturbing air movements that may affect capture hoods
- If extracting large amounts of air consider the impact on the local area – do you need to introduce lost air?

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