The Barn Raiser

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Air Pollution Control
Common Hood Mistakes

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In most industrial environments, the air pollution control system is underappreciated and given very little attention. It is the non-productive portion of the operation, so many are uninterested in investing money for a properly designed and efficiently operating air pollution control system. That baghouse out back is considered to be a necessary evil - something that is needed for worker safety or environmental compliance, but not an area where most plants want to focus their capital.

Moreover, when it comes to industrial ventilation systems, frequently most of the attention is on the ductwork and the pollution control device. The important element which is often overlooked and doesn't get enough focus is the hoods and the hood design. If you cannot capture the dust or the fume at the source, it doesn't matter how well designed the ductwork is or what the transport velocity measures or how efficient the filtration device is. Additionally, as is commonly explained, you only get one chance to capture the dust at its point of generation; once the dust gets away from the source and becomes fugitive dust, it's only a matter of where it will settle.

This article will look at the most common hood mistakes that we see during our plant visits, why they are a problem and how they can be done correctly. Perhaps you've seen these hoods in your travels as well.

• Velocity versus Volume

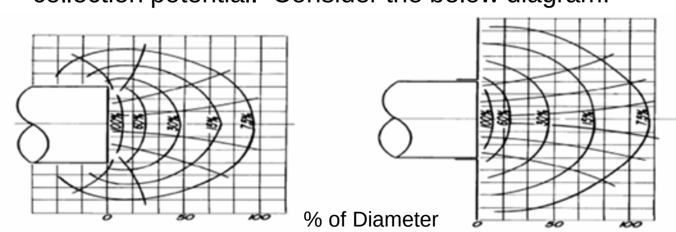
The effectiveness of a ventilation hood is directly tied into the air volume being drawn through the hood, not the velocity of the air into the hood. Let's take a look at the formula for deriving the air volume required for a simple hood:

$Q = V(10X^2 + A)$	
where:	Q = Air Volume (CFM)
	V = Capture Velocity (dependent upon conditions)
	X = Distance from Hood to source
	A = Face area of Hood

As we can see from this formula, there is no component for face velocity of the hood. Yet, many times, we observe where plant personnel have partially closed off the face of a hood in order to increase the velocity of the air entering the hood. It's important to remember that suction does not project. Unlike the case of positive pressure, where putting your finger over the end of a water hose can increase the spray distance, with negative pressure, we do not see the same benefit. You can push air 40 times greater than you can pull it. A colleague of mine often suggests as an illustration of this, try to suck out a candle. We've all blown out the candles on our birthday cake, but in order to extinguish a candle with negative pressure, you would have to get so close that you would burn your lips on the flame. To reiterate, suction does not project.

• Plain End Duct Entry versus Flanged End Duct Entry

In many instances, you will observe a flex hose positioned over a dust source, either with a raw end or a small duct expansion to increase the area covered. An important thing to bear in mind is that a plain opening will waste some of the available airflow drawing from the area opposite the source, thus wasting a portion of the collection potential. Consider the below diagram:



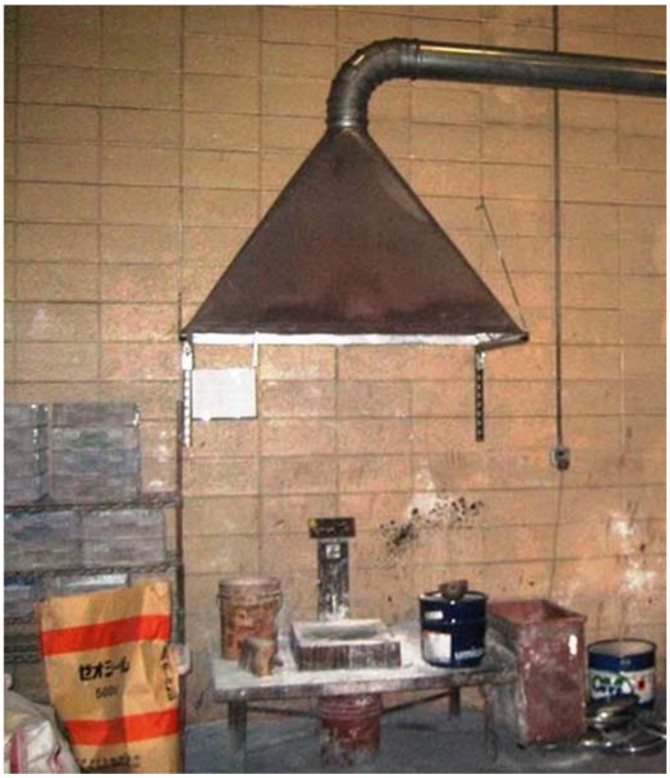
Plain Opening % of Diameter Flanged Opening

As you can see, with a plain opening, a portion of the airflow is lost due to the turbulence of the air entering the opening, where the flanged opening is more focused towards the source. Note also that the point at which the air velocity is reduced to 7.5% is further away with the flanged opening (> 1 duct diameter) than with the plain opening (<1 duct diameter). Additionally, the energy lost with the plain end opening is almost twice that of a flanged end opening, a ratio of 0.93 to 0.56 between the two conditions. Regardless of whether or not there is transition, we would recommend that a flange be included around the hood opening.

Air Pollution Control (cont'd)

- **Canopy Hood versus Backdraft Hood**

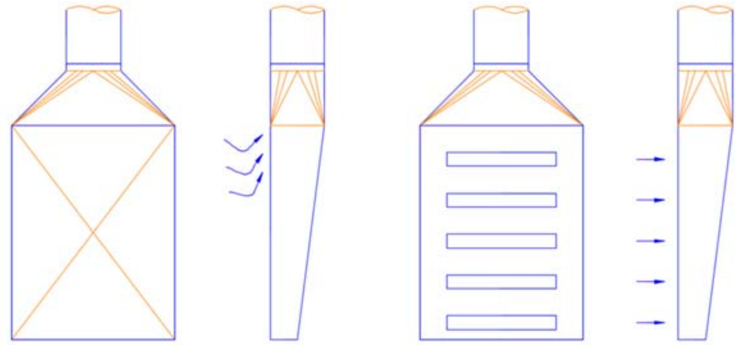
Take a look at the following photograph of a weighing operation:



Besides the fact that this particular hood is too far away from the source, the use of a canopy hood in this case is simply the wrong selection. In the case of an operator pouring dust into a bucket on the scale, by positioning the hood above the operation, you would be pulling the dust (or fume in some cases) across the breathing zone of the personnel. While canopy hoods are commonly used to cover a large area of dust generation, they are limited functionally in cases where there are not thermal forces causing the pollutant to rise. The better hood to use in cases such as the weigh station shown above would be a backdraft hood. A backdraft hood would pull the dust away from the operator and, in this case, a backdraft hood could be installed much closer to the dust source while remaining out of the way.

- **Slot sizing**

One mechanism for focusing airflow on the source is through the use of slots. The backdraft hood mentioned above is a classic example of a hood that would typically feature slots, designed to provide uniform airflow across the face of the hood. The principle at play here is the concept of "path of least resistance".



In the absence of slots on a backdraft hood, the air would simply short-circuit, with all of the air coming in at the top near the duct takeoff and little to no air movement at the bottom of the hood. By adding slots, the inflow would be distributed across the entire face of the hood. This concept is well-known and applied across all industries. However, the common flaw in its application comes from the sizing of the slots. While we can easily see that having no slots would result in the lack of air distribution shown above, we also need to understand that too many slots or too large of slots creates the same issue. Think about it this way - in the above sketch on the right, air will come in through the top slot until which point the resistance to more air coming through that slot gets to be so great that it is easier to come in the second slot. Under ideal design, this condition continues down the hood face until the equilibrium condition is met where the resistance is the same through all of the slots. The slots need to be designed so as to be small enough to generate the requisite resistance that the balance is met.

The next time that you are out on the plant floor, take a look around and see how many of these problem hoods you can spot. As I stated earlier, hoods are often taken for granted, yet most of the problem systems that I am asked to troubleshoot can trace their biggest issues back to poor hood design. Understanding how to implement the right hood for a specific application is critical to keeping a facility's fume and dust issues under control.