Hoods: How they work

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Hoods:
The single most important factor in the establishment of a system’s volume!
Overview

You will learn about:

- Hood types
- Hood nomenclature
- Capture velocities
- How to distribute air over a large area
- Hood “losses”
- Minimum duct design velocities
- Push-pull systems
First Step- Establish Q!

Anybody can remove a HUGE amount of air and remove the pollutant-

- BIG Control Equipment ($$$),
- BIG replacement air costs ($$$),
- BIG Fans with BIG motors ($$$).
Local Exhaust Hooding

When we can predict the location of a release of dust or other contaminant, we can pull a small amount of air immediately next to the source to remove the contaminant effectively.
Your Challenge:

To remove the smallest amount of air with the greatest concentration of pollutant-

- Smallest Control system (save $),
- Smallest replacement air costs (save $),
- Small Fans, small motors (save $)
Q - Volumetric Flow Rate

Volume over time - cubic feet per minute

The continuous removal of a volume of air over time is what gets the pollutant

*Not the capture velocity!*
Simple Hood

A hood with a face velocity less than 1000 fpm where only one entry loss is considered.
Compound Hood

A hood with two or more entry loss points
Enclosing Hoods

Hoods which completely or partially enclose the process or contaminant source.

- Paint Spray Booth,
- Lab Hood,
- Grinding Hood.
Enclosure & Operator Equipment Interface

ENCLOSE

ENCLOSE THE OPERATION AS MUCH AS POSSIBLE. THE MORE COMPLETELY ENCLOSED THE SOURCE, THE LESS AIR REQUIRED FOR CONTROL.

DIRECTION OF AIR FLOW

LOCATE THE HOOD SO THE CONTAMINANT IS REMOVED AWAY FROM THE BREATHING ZONE OF THE OPERATOR.
Enclosing hood
Enclosing hood
Vibrating Screen
Exterior hoods

Hoods located near an emission source without enclosing it.
Exterior hood - "fishtail" slot
Exterior hood - Barrel filling
Slotted hoods

Slots are used for proper distribution of air across a large area of contamination dispersion.

An increased slot velocity **does not** increase the hoods’ effectiveness.
Slotted hood
Canopy hood
Effects of Gravity

LOCATION

SOLVENT VAPORS IN HEALTH HAZARD CONCENTRATIONS ARE NOT APPRECIABLY HEAVIER THAN AIR. EXHAUST FROM THE FLOOR USUALLY GIVES FIRE PROTECTION ONLY.

Example:

- Density of air: 1.0
- Density of 100% amyl acetate vapor: 4.49
- Density of lowest explosive mixture: 1.038
- Density of T.L.V. mixture: 1.0003
Solvent vapors in health hazard locations are not appreciably heavier than air because:

- **Density of air**: 1.0
- **Density of Gasoline vapor**: 2.97
- **Density of LEL mixture**: 1.04
- **Density of TLV mixture**: 1.0006
Range of Minimum Duct Design Velocities

<table>
<thead>
<tr>
<th>Nature of Contaminant</th>
<th>Examples</th>
<th>Design Velocity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vapors, gases, smoke</td>
<td>All vapors, gases and smoke</td>
<td>Any desired velocity (economic optimum velocity usually 1000-2000 fpm)</td>
</tr>
<tr>
<td>Fumes</td>
<td>Welding</td>
<td>2000-2500</td>
</tr>
<tr>
<td>Very fine light dust</td>
<td>Cotton lint, wood flour, litho powder</td>
<td>2500-3000</td>
</tr>
<tr>
<td>Dry dusts &amp; powders</td>
<td>Fine rubber dust, Bakelite molding powder dust, jute lint, cotton dust, shavings (light), soap dust, leather shavings</td>
<td>3000-4000</td>
</tr>
<tr>
<td>Average industrial dust</td>
<td>Grinding dust, buffing lint (dry), wool jute dust (shaker waste), coffee beans, shoe dust, granite dust, silica flour, general material handling, brick cutting, clay dust, foundry (general), limestone dust, packaging and weighing asbestos dust in textile industries</td>
<td>3500-4000</td>
</tr>
<tr>
<td>Heavy dusts</td>
<td>Sawdust (heavy and wet), metal turnings, foundry tumbling barrels and shake-out, sand blast dust, wood blocks, hog waste, brass turnings, cast iron boring dust, lead dust</td>
<td>4000-4500</td>
</tr>
<tr>
<td>Heavy or moist</td>
<td>Lead dusts with small chips, moist cement dust, asbestos chunks from transite pipe cutting machines, buffing lint (sticky), quick-lime dust</td>
<td>4500 and up</td>
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</tbody>
</table>
Capture Velocity

“The minimum hood-induced air velocity necessary to capture and convey the contaminant into the hood”
Hood Static Pressure

Hood Entry Loss \( (h_e) \) 

+ Acceleration Energy “Loss” \( (VP_d) \)

Hood Static Pressure
Newton 1st Law of Motion

“Every object in a state of uniform motion tends to remain in that state of motion unless an external force is applied to it”
Newton’s 2\textsuperscript{nd} Law of Motion

\textit{Force} = \textit{Mass} \times \textit{Acceleration}
Acceleration “Losses”

The energy required to accelerate air from a dead stop to the velocity in the duct ($V_{P_d}$).

**Always Equals 1 Velocity Pressure!**
<table>
<thead>
<tr>
<th>HOOD TYPE</th>
<th>DESCRIPTION</th>
<th>HOOD ENTRY LOSS ($f_h$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PLAIN OPENING</strong></td>
<td></td>
<td>0.93</td>
</tr>
<tr>
<td><strong>FLANGED OPENING</strong></td>
<td></td>
<td>0.49</td>
</tr>
<tr>
<td><strong>TAPER OR CONE HOOD</strong></td>
<td></td>
<td><strong>SEE CHAPTER 10</strong></td>
</tr>
<tr>
<td><strong>BELL MOUTH INLET</strong></td>
<td></td>
<td>0.04</td>
</tr>
<tr>
<td><strong>ORIFICE</strong></td>
<td></td>
<td><strong>SEE CHAPTER 10</strong></td>
</tr>
<tr>
<td><strong>TYPICAL GRINDING HOOD</strong></td>
<td></td>
<td><strong>(STRAIGHT TAKEOFF)</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>(TAPERED TAKEOFF)</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.40</td>
</tr>
</tbody>
</table>
Flow Rate as Distance from Hood
Don’t take product with the dust!
The Effect of Flanging:

\[ Q = V (10x^2 + A) \]

\[ Q = 0.75V (10x^2 + A) \]
Push-Pull Hoods
In the field, the single greatest cause of a hood to not effectively work is:
Disturbing Air Currents

- Machinery motion - grinding wheel motion
- Material motion - bag dumping
- Work practices
- Room air currents - personnel fans!!!
A Volunteer!
Summary

- Better enclosed is better captured,
- The “secret” to air distribution - Slots!
- Air requires 1 VP just to move,
- It takes 4 times the air to pull twice the distance,
- $SP_H = h_e + VP_d$,
- You can push air 40 times farther than you can exhaust it,