Factors which should be considered to determine the potential hazard and degree of ventilation control required include.

1. Toxicity of materials, based on ACGIH Threshold Limit Values, AIHA Hygienic Guides or other references.
2. Concentration of airborne contaminant.
   a. Quantity of material handled
   b. State (fine powder, liquid, etc.)
   c. Physical properties (vapor pressure, hardness)
   d. Operation (boiling liquids, grinding, etc.)

II Laboratory Chemical Fume Hood Design

The type of ventilation most generally employed is bench type laboratory fume hood commonly called the chemical fume hood. These units provide local ventilation for a wide variety of operations and are the most satisfactory all purpose method of contaminant control.

Design

1) Face Velocity

The most important consideration in the design of a laboratory fume hood is the air velocity through the open face.

Recommended face velocities with the sash wide open.

<table>
<thead>
<tr>
<th>Average FPM</th>
<th>Minimum FPM</th>
<th>Conditions &amp; Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>50</td>
<td>Low toxicity or nuisance dusts and fumes, &lt;i&gt;e.g.&lt;/i&gt; (acetone or ethyl alcohol).</td>
</tr>
<tr>
<td>100</td>
<td>80</td>
<td>General purpose laboratory hood.</td>
</tr>
</tbody>
</table>
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Average FPM | Minimum FPM | Conditions
---|---|---
125 | 100 | Highly toxic and/or carcinogenic (beryllium) and/or carcinogenic
150 | 125 | Extremely toxic (nickel carbonyl and polonium)

If face velocities higher than 150 FPM appear necessary, some other types of ventilation with greater confinement, such as glove box, should be used.

Equations have been developed to determine adequate velocities. These will indicate face velocities outlined in the table above.

Normal heat loading will not effect the performance of a hood with an average face velocity of 100 FPM or more.

2) Entrance Configuration

The hood entrance should be kept free of obstructions and irregularities to minimize turbulence and reversal of direction of the air flow at the face of the hood. A slight improvement in the air pattern is obtained by air foils or a streamlined entrance. However, this does not justify a reduction in the average face velocities summarized above.

3) Sash

A sash is not essential for satisfactory operation of a hood. It can provide some protection against explosions and the face velocity can be increased by lowering the sash. Horizontal sliding sashes are used to maintain a recommended face velocity with smaller quantities of exhaust air by reducing hood face opening. This type of sash is useful when
laboratories are air conditioned. The horizontal sliding sashes sometimes restrict the operators movements and as a consequence are frequently removed. Sashes should be made of laminated safety glass or tempered glass and in no case should wire glass be used.

4) By-pass

When the sash is lowered, face velocities may be increased to a point, greater than 250 FPM, that will interfere with operations in the hood. Some type of by-pass may be employed to prevent this increase in air velocity.

The simplest bypass is one in which air is admitted to the hood over the top of the sash as the sash is lowered.

5) Slots

To assure a uniform face velocity a chemical fume hood should have slots at the top and bottom of the rear wall running the entire length of the hood. The slot velocity should be 1000 to 2000 FPM. Air flow through the slot can be regulated by adjustable slot width or by dampers in individual ducts leading to each slot.

7) Materials

Materials used for interior of laboratory hoods vary from stainless steel to plywood. Stainless steel is used because of ease of decontamination and its corrosion resistant properties. For most research laboratories asbestos cement board is satisfactory. Strippable paints may be used to facilitate decontamination.
6) **Utilities**

The standard laboratory hood should have the following utilities.

1. Compressed air
2. Vacuum
3. Natural gas
4. Sink with hot and cold water
5. 110 V. 3 prong receptacle

Special utilities that are sometime useful:
1. 220 V.
2. 110 V. with variac control
3. Chilled water and chilled water return.

The utilities such as compressed air or gas should be located with the outlet on the hood side walls with the controls outside the hood and color coded.

To provide ventilated chemical storage a 2 inch diameter duct should be extended from the hood exhaust plenum into the hood substructure storage area. Air is supplied through louvers in the front panel of the storage area.

9) **Lighting**

The lighting fixtures should be exterior to the hood. The level of illumination should be between 50 and 75 FC depending upon the work to be carried on in the hood.

6) **Location**

The second most important consideration to insure proper operation of the hood is the location in regard to cross currents of air in the room. Any of the following could
cause enough air turbulence of the hood face which could result in contamination escaping into the rooms:

1. Pedestrian traffic
2. Convection currents-room heating units
3. Room air supply
4. Open doors or windows

Cross currents of 50 FPM can be produced by a person walking past a hood. Convection currents from a heating unit may be as much as 100 FPM. Air supply grills and anemostats can seriously disturb the even flow of air into the hood. Air supplied through a perforated ceiling produces virtually no cross currents.

ii) Down Draft

Normally fume hoods are exhausted upward. This is the most economical arrangement and usually requires the shortest possible ducts.

Down draft for chemical fume hoods is less economical but has the following advantages:

1. Liquids resulting from condensation in the hood plenum or exhaust duct cannot run back into the hood.
2. This most feasible arrangement for duct wash down system. The wash water flow is away from the hood or hoods and not back through the hood or hood plenum.

iii) Individual blower versus system

Advantages for individual blower

1. Failure of blower means only one hood out of commission.
2. More flexibility to meet change requirements of face velocity.
3. Does not intermingle different dusts, fumes or vapors that might result in an explosive mixture.

Advantages for control system
1. Initial installation less expensive for multiple hoods in close proximity.
   a. one stack
   b. one filter bank
2. Balance of exhaust and supply less difficult to maintain than with individual control of hoods.

Blower Location
The blower should be located as near the discharge end or exhaust stack as possible in order to maintain a negative pressure in the conveying ducts. Any air leakage will be into the ducts instead of into the building. Locating the blower at a distance from the hood also reduces blower noise and vibration in the work area. The convenient locating of the blower on top of the hood is undesirable.

Type and Size
The selection of the proper blower size depends upon the quantity of air required and the pressure losses occurring in the exhaust system. Blower manufacturers furnish reliable data as to blower capacity at various static pressures. Centrifugal blowers are the type most generally used for hood exhaust systems.
Materials
Blowers constructed of materials suitable for handling corrosive and explosive atmospheres are available. An eductor type exhauster in which the fumes from the hood do not pass through the blower is also available.

13) Exhaust stack
The exhaust stack should be located with particular care in relation to building air intake to avoid recirculation of the exhaust fumes. The stack should discharge straight up without direction baffles or weather cap and be at least 10 feet above roof level.

14) Air Cleaning
In general operations carried on in chemical fume hoods do not require air cleaning for the exhausted air. Amounts of materials are relatively small and with proper location of the blower exhaust or stack, atmospheric dilution is adequate. However, when radioactive materials such as plutonium, enriched uranium; high toxic materials as beryllium; or carcinogens will be exhausted, air cleaning is employed. Types of air cleaning used include particulate filters, sorbents such as activated charcoal, and wet collectors.

15) Cost
The purchase price of a standard 5-foot chemical fume hood varies from approximately $500 for a molded fiberglass hood to $1300 for a stainless steel hood. This does not include blower, ductwork, utilities piping, electrical wiring and installation costs which can easily equal or exceed the basic cost of the hood. A custom built hood can be two to three times more expensive than that of a standard hood.
III. Special hoods

1. Auxiliary - air hood.

The auxiliary air hood has been developed to reduce the volume of refrigerated air needed in air conditioning laboratories.

In one type the auxiliary air is introduced at the sides and top of the face opening together with a relative low air flow (on the order of 25 ft/min.) from the room into the hood. Supplementary air is tempered in the winter, but not cooled in the summer. This design has proven to be unsatisfactory for handling highly toxic materials.

A second type of auxiliary air hood has supplementary air supplied just above the operators head. This design satisfies the basic criteria of a recommended air velocity past the operator into the hood. However, supplementary air passing over the head of the operator can be objectional.

2. Perchloric acid

Explosive hazards present when using perchloric acid requires special design criteria. These are:

1. Use of nonporous and non-organic material for hood interiors. Type 316 stainless steel is generally recommended.
2. Each hood should have its own exhaust blower, duct work, and exhaust stack.
3. Duct work should be of non-porous, non-organic material, and as short and straight as possible.
4. Wash down systems should be provided for the entire exhaust system.
Maintenance

All new hoods should be checked before use for compliance with the design criteria established for the hood. Thereafter, periodic measurements should be made of the face velocity and inspections made of the exhaust ducts and exhaust blower. Face velocities can be measured using a deflecting vane anemometer or thermoanemometer. These instruments should be calibrated before reliance can be made on the readings.

Qualitative evaluation of hood performance can be obtained using smoke tubes or smoke candles. Tests of this type are most useful in determining air flow patterns resulting from thermal effects or from equipment in the hood.