University of Vermont

Chemical Fume Hood Handbook

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INTRODUCTION

Laboratory chemical fume hoods are considered the primary means of protection against inhalation of hazardous vapors and gases and yet there are many limitations to their effectiveness. Many of these limitations are created unknowingly by the user. Understanding this information will allow you to maintain optimal performance of your chemical fume hood to keep you as safe as possible.

COMMON CHEMICAL FUME HOOD MISCONCEPTIONS

Myth - The yellow certification stickers placed on UVM chemical fume hoods are an indication that the unit has been checked for 1) air flow (face velocity) and 2) fume hood containment which means it captures and exhausts hazardous gases and vapors.

The annual certification stickers are only an indication that the hood is functioning properly mechanically, meaning there is proper air flow at the front face of the hood. There is no testing done to verify capture and exhaust of hazardous gases and vapors during this process.

Myth - When working with hazardous materials, the higher the face velocity the better.

While it is important to have a face velocity between 80 and 120 feet per minute (fpm), velocities higher than this can actually be harmful. When face velocity exceeds 120 fpm eddy currents can be created which allow contaminants to be drawn out of the hood, increasing worker exposures.

Myth - A chemical hood can be used for storage of volatile, flammable, or odiferous materials when an appropriate storage cabinet is not available.

Even though it is appropriate to keep chemicals that are being used during a particular experiment inside the chemical hood, hoods are not designed for permanent chemical storage. **Each item placed in the hood interferes with the directional airflow**, causing turbulence and eddy currents that allow contaminants to be drawn out of the hood. Even with highly volatile materials, as long as a container is properly capped evaporation will not add significantly to worker exposures. Unlike a chemical hood, flammable materials storage cabinets provide additional protection in the event of a fire.

Myth - The airfoil on the front of a hood is of minor importance. It can safely be removed if it interferes with my experimental apparatus.

Airfoils are critical to efficient operation of a chemical hood. With the sash open an airfoil smooths air flow over the hood edges. Without an airfoil eddy currents form, causing contaminants to be drawn out of the hood. With the sash closed, the opening beneath the bottom airfoil provides for a source of exhaust air.

SAFE WORK PRACTICES FOR CHEMICAL FUME HOODS

The health and safety of laboratory personnel and building occupants must be the primary goal of laboratory management. Properly functioning fume hoods help achieve this goal with respect to the hazards of chemical vapors and other harmful airborne substances. It is important to remember that a fume hood is not a storage area. Keeping equipment and chemicals unnecessarily in the hood causes airflow blockage. Here are a few health and safety tips concerning fume hoods :

- **Confirm that the hood is operational.** If fitted with a local on/off switch, make sure the switch is in the "on" position; check the airflow gauge if so equipped. In the absence of a gauge, tape a piece of tissue paper to the corner of the sash. Airflow can be visually assessed by noting that the paper is pulled gently into the hood. The most recent hood test data and optimum sash height are indicated on the yellow label affixed to the hood face. Never work with a malfunctioning hood; report problem hoods to UVM Service Operations for repairs and the Environmental Safety Facility for recertification.
- **Maintain operations at least 6" inside the hood face.** Vinyl tape can be attached to the work surface to serve as a visual reminder.
- **Lower sash to optimum height.** Optimum height is the sash height at which airflow is maximized without creating turbulence, generally 100 feet per minute. A yellow label placed on the hood face indicates the most recently recommended sash height. With unattended or potentially explosive processes, conduct the operation behind a lowered sash or safety shield.
- **Keep head out of hood** except when installing and dismantling equipment.
- **Keep hood storage to an absolute minimum.** Keep only items needed for the ongoing operation inside the hood. Keep the back bottom slot clear at all times as it serves as an exhaust port for chemicals generated near the work surface. Raise large objects at least 1 1/2 inches off the hood surface to minimize air flow disruption.
- **Minimize foot traffic around the chemical hood.** A person walking past a chemical hood can create competing currents at the hood face, causing vapors to flow out. Other sources of competing air currents such as open windows, open doors, and fans must also be avoided while using a chemical hood.
- **Use extreme caution with ignition sources** inside a chemical hood. Ignition sources such as electrical connections and open flame can be used inside a chemical hood as long as there are no operations involving flammable or explosive vapors. If possible, ignition sources should remain outside the hood at all times.
- **Replace hood components prior to use.** Every component of a chemical hood, whether airfoil, baffle, sash, or side panel plays a vital role in preventing the escape of hazardous materials from the hood. Any hood components removed to conduct maintenance or repair activities, or to set up experimental equipment must be replaced prior to using the hood for contaminant control.
- **Raise equipment 1 1/2 to 2 inches** to maintain proper air flow to the back of the fume hood.

POLLUTION PREVENTION TIPS FOR FUME HOODS

1. Keep caps on chemical reagent bottles tight and check fittings on laboratory glassware to minimize vapor losses.

2. Do not use hoods for chemical storage - keep the smallest amount of chemicals in the hood needed to conduct the procedure at hand.

3. Substitute less hazardous or (at least) less volatile chemicals where possible.

4. Look for process changes that not only improve safety, but reduce losses to the environment.
(e.g.,more accurate chemical delivery systems vs. pouring volatile chemicals from bottles)

5. Develop a process to evaluate research proposals ahead of time for potential emissions and look for opportunities to reduce them.

BASIC COMPONENTS OF LABORATORY CHEMICAL FUME HOODS

A laboratory chemical fume hood is a partially enclosed workspace that is exhausted to the outside of the building. When used properly, hazardous gases and vapors generated inside the hood are captured before they enter the breathing zone. This serves to minimize your exposure to airborne contaminants. The typical components of a chemical hood and their major functions are:

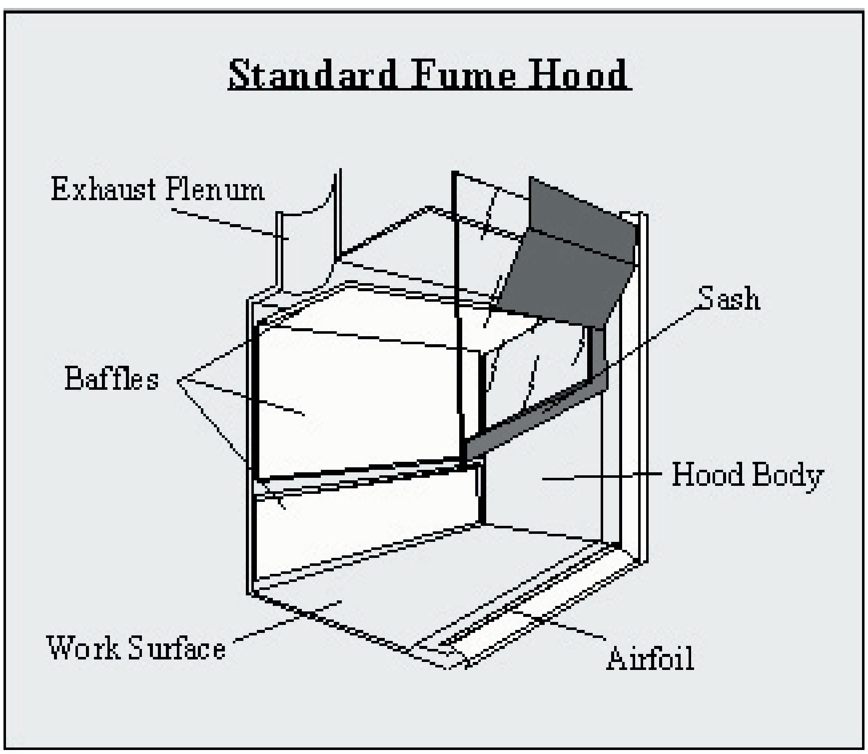

Figure 1 Basic features of a standard fume hood.

Hood Body -- The visible part of the chemical hood that serves to contain hazardous gases and vapors.

Sash -- The sliding "door" to the hood. By using the sash to adjust the front opening, airflow across the hood can be adjusted to the point where capture of contaminants is maximized. Each hood is marked with the optimum sash configuration. The sash should be held in this position when working in the hood and closed completely when the hood is not in use. The sash may be temporarily raised above this position to set up equipment, but must be returned to the optimum sash height setting prior to generating contaminants inside the hood.

Airfoil -- Located along the bottom and side edges the airfoil streamlines airflow into the hood, preventing the creation of turbulent eddies that can carry vapors out of the hood. The space below the bottom airfoil provides a source of room air for the hood to exhaust when the sash is fully closed. Removing the airfoil can cause turbulence and loss of containment.

Work surface -- Generally a laboratory bench top, but also the floor of a floor-mounted hood, this is the area under the hood where apparatus is placed for use.

Baffles -- Moveable partitions used to create slotted openings along the back of the hood body. Baffles keep the airflow uniform across the hood opening, thus eliminating dead spots and optimizing capture efficiency.

Exhaust plenum -- An important engineering feature, the exhaust plenum helps to distribute airflow evenly across the hood face. Materials such as paper towels drawn into the plenum can create turbulence in this part of the hood, resulting in areas of poor airflow and uneven performance.

Face -- The imaginary plane running between the bottom of the sash to the work surface. Hood face velocity is measured across this plane.

DESIGN STYLES OF CHEMICAL HOODS

There are many types of hoods, each with its own design and function. To identify which hood type is present in your lab, a list of definitions describing hood features is provided below.

• **Constant Air Volume (CAV) Hoods --** With constant volume hoods the volume of airflow into the hood remains more or less constant. As the sash is closed the velocity of the airflow entering the hood increases. Proper positioning of the sash is vital to maintaining the optimum face velocity (80 or 120 feet per minute). Raising the sash too high lowers face velocity, allowing contaminants to escape from the hood. Setting the sash too low will result in very high face velocities. Face velocities in excess of 120 feet per minute can cause excessive turbulence and loss of containment.

• **Conventional Hoods --** Conventional hoods represent the original and most simple of the hood design styles. With a conventional hood the volume of air exhausted is constant, regardless of sash height. As the sash is lowered the opening area decreases, resulting in an increase in face velocity. Since face the sash at its velocity changes linearly with sash position it is particularly important when working with conventional hoods to maintain optimal height as indicated by the yellow label attached to the hood frame.

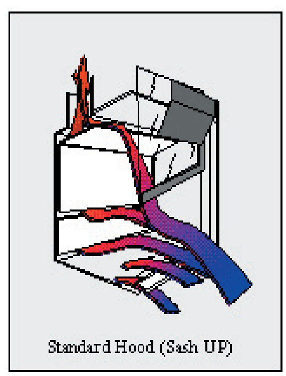

Figure 2 Standard hood flow path.

• **Bypass Hoods --** Bypass hoods have an added engineering feature and are considered a step up from conventional hoods. An air bypass incorporated above the sash provides an additional source of room air when the sash is closed. As the sash is lowered the bypass area becomes exposed, effectively increasing the face opening and reducing the rate of increase of the face velocity. This reduces the chance for turbulence and loss of containment as the sash is lowered. However, it remains important to utilize the optimum sash height as indicated on the yellow label attached to the hood frame.

• **Auxiliary Air Hoods --** With this type of hood a dedicated duct supplies outside air to the face of a bypass hood. The main advantage of an auxiliary air hood is the energy savings realized by reducing the amount of heated or air-conditioned room air exhausted by the hood. While energy savings can be substantial,the uncondi-tioned airflow can cause discomfort for those working near the hood. It is important to keep in mind, however, that the auxiliary air supply is necessary for proper functioning of the hood. Any alteration of the air supply system, such as sealing off the auxiliary air duct, will adversely affect hood operation and may result in hazardous chemical exposures. If the sash of an auxiliary air hood is kept closed most of the unconditioned air will bypass through the hood, reducing its effect on room temperature and humidity. Remember to check the optimum sash height since it will affect face velocity in a manner similar to that for bypass hoods.

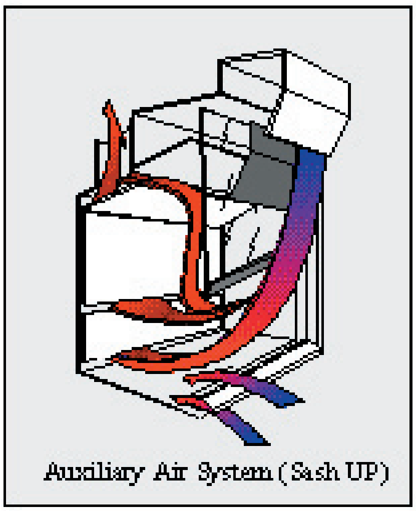

Figure 3 Auxiliary air flow path.

While energy savings can be substantial, the unconditioned air flow can cause discomfort for those working near the hood. It is important to keep in mind, however, that the auxiliary air supply is necessary for proper functioning of the hood. Any alteration of the air supply system such as sealing off the auxiliary air duct will adversely affect hood operation and may result in hazardous chemical exposures. If the sash of an auxiliary air hood is kept closed most of the unconditioned air will bypass through the hood, reducing its effect on room temperature and humidity. Remember to check the optimum sash height since it will affect face velocity in a manner similar to that for bypass hoods.

• **Perchloric Acid Hoods --** When heated above ambient temperature, perchloric acid will vaporize and may condense on hood, duct and fan components. In addition to being highly corrosive, condensed vapors can react with hood gaskets, greases and other collected materials to form explosive perchloric salts and esters. A perchloric acid hood is built with welded stainless steel hood surfaces, duct work, and fan to minimize the corrosive and reactive effects. More importantly, perchloric acid hoods have a wash-down system of water fog nozzles dispersed throughout the hood and exhaust system. By washing down the hood following each use of heated perchloric acid, any materials deposited within the system are removed, preventing the buildup of hazardous perchlorates.

Variable Air Volume (VAV) Hoods -- Variable air volume (VAV) hoods are the most sophisticated of the hood types, requiring technically proficient design, installation and maintenance. The primary characteristic of VAV hoods is their ability to maintain a constant face velocity as sash height changes. As the sash is moved the exhaust volume is adjusted so that the average face velocity is maintained within acceptable parameters. It is best to use this type of hood with the sash in the half-open position, as this provides more even airflow, and a degree of face protection in case of an unexpected spill, fire or explosion in the hood. When not in use the sash should be closed to save energy.

FUME HOOD REPAIR INFORMATION AND TIPS

The laboratory researchers, ESF staff, and Facilities maintenance personnel must work together to ensure that faulty or non-operational fume hoods are identified, workers are trained in their proper and optimal use and that the fume hoods operate correctly.

Environmental Safety Facility (ESF) Staff measure fume hood face velocity annually and notify Service Operations when repairs are needed to re-establish the correct face velocity. Face velocity is the average speed of the air current across the face of the hood and an indicator of how the fume hood is operating.

If you have reason to believe that a fume hood in your laboratory may not be functioning properly, contact the Environmental Safety Facility staff at 656-5400. An ESF staff member will test for proper face velocity. If the problem is an obvious malfunction, such as no air flow, contact Service Operations directly at http://www.uvm.edu/fss to place a work order (or call 656-2560 and dial '1' if the repair is an emergency).

When any work that may have changed the air flow balance has been completed on a fume hood please remember to contact the ESF for recertification. Do not use a hood that has an ESF 'DO NOT USE' sticker placed on the sash.