

## **A Guide to Laboratory Fume Hoods**

### **1. Introduction**

- a. Laboratory fume hoods serve to control exposure to toxic, offensive or flammable vapors, gases and aerosols. Fume hoods are the primary method of exposure control in the laboratory. Laboratory fume hood is a type of local exhaust ventilation system (engineering control). A typical fume hood is a cabinet with a moveable front sash (window) made out of safety glass. A properly used and properly functioning fume hood exhausts hazardous gases, dusts, mists, and vapors from a confined location and helps protect workers from inhalation exposure.
- b. All laboratory hoods work on a very basic principle of containment. Negative pressure relative to the exterior is maintained within the interior of the hood to prevent any toxic vapors from escaping and air is drawn at a consistent rate into the hood opening. Experimental procedures are performed within the hood which is consistently and safely ventilated, usually by means of an extract blower and ductwork.
- c. When exhausted to the external environment, chemical fumes are diluted many times over in the atmosphere and has a negligible effect to human health. When environment concerns are of importance, an extract treatment system, often referred to as a scrubber is installed to remove most of the vapors from the exhaust air stream. A suitable hood face velocity (the speed at which air is drawn into the opening of the hood) is of importance to the safe and effective operation of a fume hood. While excessive face velocities can often result in turbulence and reduce containment, insufficient velocities can also compromise hood performance.
- d. In general, a hood inflow velocity of 0.5 m/s or 100fpm is recommended. Most of the hoods are commonly sized for a minimum inflow velocity (e.g. 0.5 m/s or 100 fpm) at full sash opening. However, when energy concerns are paramount, an economical way to decrease the amount of tempered air removed from the hood is to size the minimum face velocity of the hood at half-sash opening instead of full-sash opening.

### **2. Important components of a Fume Hood**

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

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

### 3. Important Facts about Laboratory Fume Hoods

- a. A fume hood is not designed to contain high velocity releases of particulate contaminants unless the sash is fully closed. The hood is not capable of containing explosions, even when the sash is fully closed. If an explosion hazard exists, the user should provide anchored barriers, shields or enclosures of sufficient strength to deflect or contain it. Such barriers can significantly affect the airflow in the hood.
- b. A conventional fume hood must not be used for perchloric acid. Perchloric acid vapors can settle on ductwork, resulting in the deposition of perchlorate crystals. Perchlorates can accumulate on surfaces and have been known to detonate on contact, causing serious injury to researchers and maintenance personnel. Specialized perchloric acid hoods, made of stainless steel and equipped with a wash down system must be used for such work. Many fume hoods are equipped with flat or rounded sills or air foils which direct the flow of air smoothly across the work surface. Sills should not be removed or modified by the hood user. Objects should never be placed on these sills. Materials released from containers placed on the sills may not be adequately captured. In addition, an object on the sill may prevent the quick and complete closure of the sash in an emergency. Tubing is frequently used to channel exhaust to the hood from equipment located some distance away. This is not an effective control method.

- c. Occasionally, a researcher may need local exhaust ventilation other than that provided by an existing fume hood. A new device may not be connected to an existing fume hood without the approval of the manufacturer. Adding devices to even the simplest exhaust system without adequate evaluation and adjustment will usually result in decreased performance of the existing hood and/or inadequate performance of the additional device.
- d. Work involving harmful microorganisms should be done in a biosafety cabinet, rather than a chemical fume hood. A fume hood should not be used for waste disposal. It is a violation of environmental regulations to intentionally send waste up the hood stack.

#### 4. Guidelines for Using a Fume Hood Effectively

- a. The level of protection provided by a fume hood is affected by the manner in which the fume hood is used. No fume hood, however well designed, can provide adequate containment unless good laboratory practices are used, as follow: Adequate planning and preparation is the key. The hood user should know the Standard Operating Procedure (SOP) of the hood and should design experiments so that the SOP can be maintained whenever hazardous materials might be released. Items contaminated with odorous or hazardous materials should be removed from the hood only after decontamination or if placed in a closed outer container to avoid releasing contaminants into the laboratory air.
- b. When using the fume hood, keep your face outside the plane of the hood sash and remain alert to changes in air flow.
- c. Work at least 6 inches back from the face of the hood. A stripe on the bench surface is a good reminder.
- d. Always use splash goggles, and wear a full face shield if there is possibility of an explosion or eruption.
- e. Do not make quick motions into or out of the hood, use fans, or walk quickly by the hood opening. These will cause airflow disturbances which reduces the effectiveness of the hood. Substitute less hazardous or less volatile chemicals where possible.
- f. Look for process changes that improve safety and reduce losses to the environment (e.g more accurate chemical delivery systems vs. pouring volatile chemicals from bottles).
- g. Develop a process to evaluate research proposals ahead of time for potential emissions and look for opportunities to reduce them.
- h. Do not remove sashes from sliding sash hoods. The hood should be kept closed, except when working within the hood is necessary.
- i. Use sliding sash for partial protection during hazardous work.
- j. Do not remove sash or panels except when necessary for apparatus set-up.
- k. Keep the slots of the hood baffles free of obstruction by apparatus or containers.
- l. Keep the hood sash closed as much as possible to maximize the hood's performance.

m. Keep the sash closed when not in use to maximize energy conservation.

#### 5. Risks Involved with the Improper Use of Fume Hoods

- a. A fume hood is a piece of safety equipment that can be misused to the extent that they can be less effective than expected. Injury from misuse can arise from two causes:
  - i. From the fume hood not providing adequate flow rates for the work required (i.e sash being left open or from excess clutter that reduces the containment of noxious substances).
  - ii. From the hood itself (i.e. if the fan belts are slipping, the exhaust duct has blockage due to paper towels being sucked into the duct, the duct damper is restricted). Always realize the most likely person to be injured is the hood user. Escaping noxious material into the laboratory can also affect all laboratory occupants.
- b. Power Outages
  - i. In case of a power outage, the hood sash should be lowered within an inch to maintain a chimney effect to keep some air flowing into the hood.
- c. Exhaust
  - i. Care should be taken with use of paper products, aluminum foil, and other lightweight materials within a hood. For example, a single paper towel or chemical wipe can potentially decrease the airflow into the hood if it restricts exhaust flow.

#### 6. Good House Keeping Practices in a Laboratory using Fume Hoods

- a. Do not use the hood as a waste disposal mechanism. Apparatus used in a hood should be fitted with condensers, traps, or scrubbers to contain and collect waste solvents, toxic vapors or dust.
- b. Limit chemical storage in fume hoods. Keep the smallest amount of chemicals in the hood needed to conduct the procedure at hand.
- c. Store hazardous chemicals such as flammable liquids in an approved safety cabinet.
- d. Keep caps on chemical reagent bottles tight and check fitting on laboratory glassware to minimize vapor loss.
- e. Always use good housekeeping techniques to maintain the hood at optimal performance levels. Excessive storage of materials or equipment can cause eddy currents or reverse flow resulting in contaminants escaping from the hood.

#### 7. Testing and maintenance of Fume hood

- a. Hoods should be evaluated by the user before each use to ensure adequate face velocities and the absence of excessive turbulence.
- b. In case of exhaust system failure while using a hood, shut off all services and accessories and lower the sash completely. Leave the area immediately.

- c. The required face velocity is 100 feet per minute (0.5 m/sec). This velocity is capable of controlling most low-velocity cross drafts and turbulence created by normal working practices at the face of the hood. All hoods should have a sticker designating the maximum safe sash height. Keep the sash at the appropriate level to ensure optimal face velocity.
- d. Regular testing of the fume hood should be done to ensure that it is operating properly. Hoods are labeled to indicate the last inspection date.
- e. Laboratory fume hoods are one of the most important used and abused hazard control devices. We should understand that the combined use of safety glasses, protective gloves, laboratory smocks, good safety practices, and laboratory fume hoods are very important elements in protecting us from a potentially hazardous exposure.
- f. Laboratory fume hoods only protect users when they are used properly and are working correctly. A fume hood is designed to protect the user and room occupants from exposure to vapors, aerosols, toxic materials, odorous, and other harmful substances. A secondary purpose is to serve as a protective shield when working with potentially explosive or highly reactive materials. This is accomplished by lowering the hood sash.

#### 8. Misconceptions Associated with Fume Hoods

- a. When working with highly hazardous materials, the higher the face velocity the better.
  - i. While it is important to have a face velocity between 100 and 125 fpm, velocities higher than this are actually harmful. When face velocity exceeds 125 fpm eddy currents are created which allow contaminants to be drawn out of the hood, increasing worker exposures.
- b. A chemical hood can be used for storage of volatile, flammable, or odiferous materials when an appropriate storage cabinet is not available.
  - i. While 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 on the work surface 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.
- c. The airfoil on the front of a hood is of minor importance. It can safely be removed if it interferes with my experimental apparatus.
  - i. Airfoils are critical to efficient operation of a chemical hood. With the sash open an airfoil smoothes 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.