7.6 Fume Hood Filtration and Wash-Down Systems

EPA WaterSense

Overview

A fume hood is a ventilated enclosure where hazardous materials can be handled safely to limit exposure. Fume hoods draw contaminants within the work area away from the user to minimize contact and exhaust fumes through a ventilation system to remove contaminants from the building.

As a first step, a facility should determine if treatment is needed prior to exhausting fumes through the building ventilation system. Dry exhaust fume hoods use a fan to draw in air containing hazardous contaminants before expelling it without providing contaminant treatment. These systems might be appropriate depending upon the hazard level associated with the exhaust being ventilated. If minor treatment of exhausting fumes is necessary, a facility should consider using condensers, cold traps, or adsorbents such as activated charcoal, or neutralizing or converting toxic substances into other less hazardous species.[40]

When dealing with certain hazardous substances requiring more intensive treatment, a fume hood with a filtration system might be needed. There are two types of fume hood filtration systems typically used to handle hazardous substances: gas-phase filtration (includes wet scrubbers) and particulate filtration.[41] Wet scrubbers require the consumption of water to remove hazardous substances. Other gas-phase filtration or particulate filtration systems might be suitable alternatives to wet scrubbers in certain circumstances, as discussed below. In all cases, laboratories should follow manufacturer instructions and facility health and safety guidelines in order to ensure safe operation of fume hoods.

This section focuses on fume hood filtration systems, including those that use water (e.g., wet scrubbers) and fume hood wash-down systems. It also describes systems that do not use water that could be considered as an alternative to wet scrubbers.

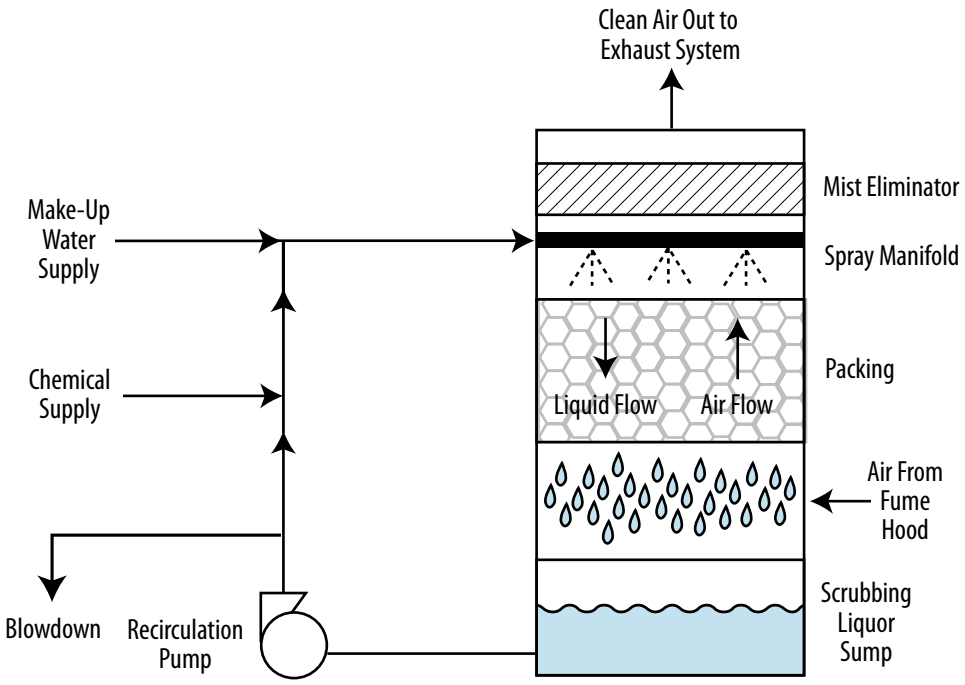
Fume Hood Filtration Systems

Wet Scrubbers

Fume hoods with wet scrubbers that use water to capture and trap hazardous substances are also known as liquid fume hood scrubbers. Contaminated air enters the scrubber system from below and passes through a packed bed. The packed bed is wetted from above with a liquid spray. As the contaminated air comes into contact with the water, water-soluble gases, vapors, aerosols, and particulates become dissolved. The trapped contaminants fall with the water and are discharged into a scrubbing liquor sump. The "scrubbing liquor" is recirculated, with make-up water added as needed to replace water that has evaporated. The scrubbing liquor is removed periodically through a blowdown valve to control total dissolved solids. The treated air is released through an exhaust system. See Figure 7-4 for a schematic of this process.

[40] Hitchings, Dale T. September 1993-January 1994. "Fume Hood Scrubbers—Parts I, II, and III." *Laboratory Building Design Update*. Page 1. www.safelab.com/resources.htm.
[41] *Ibid*. Pages 6-8.

Figure 7-4. Fume Hood Wet Scrubber



Other Gas-Phase Filtration

Besides wet scrubbers, there are two other basic types of gas-phase filtration systems for fume hoods: inert adsorbents and chemically active adsorbents, which do not require water use. Inert adsorbents include activated carbon, activated alumina, and molecular sieves. Chemically active adsorbents are simply inert adsorbents impregnated with a strong oxidizer, such as potassium permanganate, that react with and destroy the organic vapors.[42]

Because contaminants build up in the adsorbent and can be desorbed if the concentration is too high or if the adsorbent has a higher affinity for another contaminant, the adsorbent must be changed or regenerated regularly. Adsorbent systems are not effective in removing high concentrations of contaminants (i.e., spills inside the hood). Since these systems require a consistent check on contaminant concentrations and maintenance of the adsorbent, these factors should be taken into account when evaluating alternatives to fume hood wet scrubber systems, keeping in mind the contaminant and concentration that needs to be removed to ensure that the hazard is fully abated.[43,44]

[42] *Ibid*. Page 6.
[43] National Research Council, et al. 1995. *Prudent Practices in the Laboratory—Handling and Disposal of Chemicals*. Washington, DC: National Academy Press. Page 188. www.nap.edu/openbook.php?record_id=4911&page=188.
[44] Hitchings, Dale T., *op. cit.*, Pages 6-7.

Particulate Filtration

If radioactive or biologically active materials or other hazardous particulates are present, a particulate filter might be necessary. HEPA filters are often used for this purpose. Proper procedures for changing filters should be taken into account to ensure the safety of workers.[45] If considering a particulate filtration system instead of a wet scrubber system, it's important to evaluate the contaminant and concentration that need to be removed to ensure that the hazard is fully abated. HEPA filters are often only recommended for highly toxic particulates.[46]

The fume hood filtration systems discussed above are summarized in Table 7-2.

Table 7-2. Fume Hood Filtration Systems

Filtering Mechanism	How Does It Work?	How Is Contaminant Removed?	Does It Use Water?	What Are the Special Considerations?
Wet Scrubber	Packed bed system that is wetted with recirculated scrubbing liquor captures contaminants from air and releases cleaned air.	Scrubbing liquor with dissolved contaminants is blown down and the liquor is periodically replenished with fresh water.	Yes	None
Inert Adsorbents	Inert adsorbents such as activated carbon, activated alumina, and molecular sieves, adsorb contaminants.	Spent adsorbent must be changed or regenerated regularly.	No	Adsorbent systems are not effective in removing high concentrations of contaminants (i.e., spills inside the hood). These systems require a consistent check on contaminant concentrations and maintenance of the adsorbent.
Chemically Active Adsorbents	Inert adsorbents impregnated with a strong oxidizer such as potassium permanganate react with and destroy organic vapors.	Spent adsorbent must be changed or regenerated regularly.	No	Adsorbent systems are not effective in removing high concentrations of contaminants (i.e., spills inside the hood). These systems require a consistent check on contaminant concentrations and maintenance of the adsorbent.
Particulate Filtration	HEPA or other filters remove contaminants.	Filter must be changed regularly.	No	This is useful for radioactive or biologically active materials or other hazardous particulates. HEPA filters are often only recommended for highly toxic particulates.

[45] *Ibid*. Page 7.
[46] National Research Council, *op. cit*.

Fume Hood Wash-Down Systems

Perchloric Acid Wash-Down Systems

Perchloric acid wash-down systems are a specialty fume hood used to remove perchloric acid. A laboratory using perchloric acid, a highly corrosive inorganic compound, requires a specialized fume hood. To prevent corrosion and reduce explosive perchlorate buildup, perchloric acid fume hoods use a system of nozzles to wash down the fume hood and exhaust system surfaces after each period of use.[47] Laboratories should follow instructions for washdown provided by the manufacturer of the fume hood or facility health and safety guidelines, but might be able to minimize perchloric acid wash-down system water use if shut-off valves are used to control the flow of water.

Operation, Maintenance, and User Education

For optimum fume hood wet scrubber efficiency, consider the following:

- Turn off water flow when systems are not in use.
- Ensure water flow rate does not exceed manufacturer specifications.
- In recirculating systems, make sure the liquid level controller and water supply valve are functioning properly to avoid excess water overflow from the recirculation sump.
- In recirculating systems, calibrate the blowdown process so that it is sufficient to remove entrained contaminants, without being overly excessive. In general, constant overflows or continuous blowdown wastewater.
- Consider using onsite alternative water sources to supply water for use in the fume hood. See *Section 8: Onsite Alternative Water Sources* for more information.

For optimum perchloric acid wash-down system efficiency, use systems only when necessary for perchloric acid handling.

Retrofit Options

There are currently no retrofit options available on the market to increase the efficiency of fume hood filtration systems.

For facilities requiring a perchloric acid wash-down system, it might be feasible to retrofit the system with shut-off valves to control the flow of water. However, facilities should be sure to follow manufacturer-provided instructions for perchloric acid wash-down systems and facility health and safety guidelines to ensure that any changes will not affect health and safety or the performance of the system.

[47] University of Louisville. 2012. *Laboratory Chemical Hood User's Guide*. louisville.edu/dehs/ohs/fumehoods/users_guide.html.

Replacement Options

When purchasing a new fume hood filtration system or perchloric acid wash-down system or replacing older equipment, consider the replacement options outlined below.

Fume Hood Filtration System Replacement

For facilities that need a fume hood filtration system, consider installing a gas-phase filtration system, such as activated carbon, that does not require water consumption. Replacing an existing fume hood wet scrubber system with an adsorbent dry filter system will eliminate water used to trap and contain hazardous substances. Because these systems require a consistent check on contaminant concentrations and maintenance of the adsorbent, these factors should be taken into account as an alternative to fume hood wet scrubber systems. Particulate filtration might also be considered, depending upon the type of contaminants present. Keep in mind the contaminant and concentration that needs to be removed to ensure that the hazard is fully abated.[48,49]

Keep in mind that a wet scrubber is sometimes necessary for the handling of highly toxic contaminants. Adsorbent dry filters should not be used if safety will be compromised as a result.

Perchloric Acid Wash-Down Retrofit or Replacement

For facilities requiring a perchloric acid wash-down system, consider a system with automatic shut-off valves, which limit the amount of water used during the wash-down process by controlling the duration of the wash-down cycle. Water savings will be dependent upon the reduction in wash-down cycle length and the flow rate of the wash-down sprayers.

Savings Potential

Sufficient information is not available to estimate the savings potential associated with these products.

Additional Resources

East Bay Municipal Utility District. 2008. *WaterSmart Guidebook—A Water-Use Efficiency Plan Review Guide for New Businesses*. Page MED4. www.ebmud.com/for-customers/conservation-rebates-and-services/commercial/watersmart-guidebook.

Hitchings, Dale T. September 1993-January 1994. "Fume Hood Scrubbers—Parts I, II, and III." *Laboratory Building Design Update*. www.safelab.com/resources.htm.

Lab Manager Magazine. Fume Hood Homepage. www.labmanager.com/?articles.list/categoryNo/2042/category/Fume-Hoods.

[48] National Research Council, *op. cit.*
[49] Hitchings, Dale T., *op. cit.*, Page 6.

National Research Council, et al. 1995. *Prudent Practices in the Laboratory—Handling and Disposal of Chemicals*. Washington, DC: National Academy Press. Page 188. www.nap.edu/openbook.php?record_id=4911&page=188.

University of Louisville. 2012. *Laboratory Chemical Hood User's Guide*. louisville.edu/dehs/ohs/fumehoods/users_guide.html.