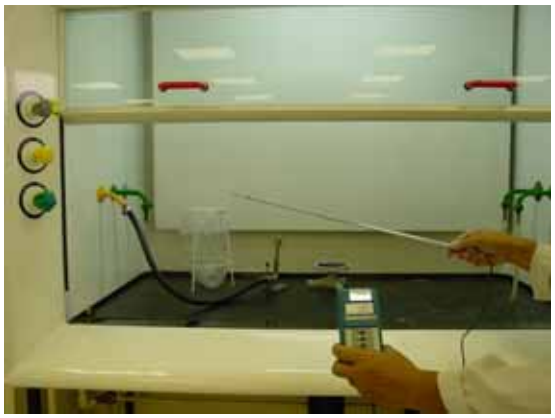
Laboratory Fume Cupboards



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The University of Hong Kong
Safety Office

Laboratory Fume Cupboards

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1. Introduction

Fume cupboards are widely used in the engineering, sciences and medical departments of the University. Fume cupboards are designed to ***contain gases, vapours and fumes at source and to dilute and disperse*** them to the external environment.

A fume cupboard is ***only a partial enclosure*** and cannot provide absolute protection against inhalation of substances used within it. The inward flow of air through the front opening into a fume cupboard is the mechanism by which the operator is usually protected. Hence the degree of protection is dependent on many factors such as toxicity and volatility of the materials to be handled, the velocity of air moving through the fume cupboard, aerodynamic airflow patterns, cross drafts and other random external air movements, and obstructions of the fume cupboard.

A fume cupboard does not function alone and a variety of external factors such as its location inside the laboratory and the laboratory ventilation can influence its performance. Users must ensure that the fume cupboard functions well in the laboratory system before work commences and it is properly used.

2. Components of a Fume Extraction System

A fume cupboard by itself is only one component of the fume exposure control system. The total system consists of:

2.1 The laboratory in which the fume cupboard is installed

2.2 The fume cupboard

2.3 The fume extract and dispersal system

2.4 In some cases, the air supply to the fume cupboard for auxiliary fume cupboards

The efficiency of a fume cupboard depends on how the total system is designed and installed. A well-designed fume cupboard will not be effective if located or installed incorrectly. Moreover even a well-designed and properly installed system can be ineffective if improperly use.

3. Function of a Fume Cupboard

3.1 To remove fumes effectively so as to keep the concentration of the contaminants in the breathing zone of the operator to below the exposure limits and also to prevent the build up of an explosive atmosphere inside the FC.

3.2 To place a physical barrier between users in the laboratory and the work inside the fume cupboard.

3.3 To provide an effective containment device and exhaust in case of accidental spills and emergency.

4. Types of Fume Cupboards

There are three major types of fume cupboards in the University: conventional fume cupboards, auxiliary air fume cupboards and re-circulatory fume cupboards.

4.1 Conventional Fume Cupboards

A conventional fume cupboard is a partial enclosure with a back baffle and a movable front sash. Contaminated air generated inside the fume cupboard is conveyed through the duct system and exhausted high up on the roof of the building to outdoors. Usually pollution control devices are not installed as the system depends on the dilution effect of the external air to

disperse the contaminants at acceptable low concentration. Much conditioned laboratory air will be exhausted through the fume cupboards and provision of make-up air is necessary to replace all the air exhausted through the fume cupboards.

Figure 1: A conventional fume cupboard with variable air volume control

About half of the fume cupboards in the University are of this type. All old conventional fume cupboards in the University operate on a ***constant air volume*** principle. The face velocity varies with the sash opening. When the front sash is lowered down, the high velocity attained may result in turbulence inside the FC. Hence a bypass is added to solve this problem. A bypass is a compensating opening above the sash that allows air to enter the fume cupboard when the sash opening is reduced and functions to prevent excessive face velocity.

In a ***Variable air volume (VAV) control fume cupboard*** the amount of laboratory air exhausted through the cupboard is altered while face velocity is maintained within a preset range. As the sash is partially closed, the exhaust air is proportionally reduced, hence a constant face velocity is provided. All new fume cupboards in the Faculty of Medicine Building are VAV control fume cupboards.

4.2 Auxiliary air Fume Cupboards

Auxiliary air fume cupboards are designed to reduce the amount of room air exhausted by the fume cupboard by introducing a source of supply air into the fume cupboard from outside the room. The amount of conditioned room air exhausted from the fume cupboard is reduced and energy is saved.

However, it is our experience that it is difficult to balance the exhaust and supply air volumes for this type of fume cupboard because the two air handling systems have different aging factors and can become unbalanced. As a result, the performance of the fume cupboards will be affected.

Figure 2: An auxiliary fume cupboard with supply air from the two sides behind the sash.

4.3 Re-circulatory or Ductless Fume Cupboards

A re-circulating fume cupboard directs the flow of exhaust air through a filtration system or other air-cleaning device, which is designed to retain specific airborne contaminants before the air is re-circulated into the work area. This type of fume cupboard does not require any exhaust ducting and does not upset any room balancing. The conditioned room air is not exhausted or lost.

However the protection depends on the efficiency and retention capacity of the absorption filters and /or scrubbers. The filtration or air cleaning system in use must be effective against the contaminants generated in the fume cupboard.

Since all filters have a finite lifetime, re-circulatory fume cupboards are suitable only for small-scale operations and regular monitoring is required to detect when filter replacement is necessary to maintain the effectiveness of the fume cupboards. Misuse of this type of fume cupboard can result in contaminated air being re-circulated into the work environment.

There are about 100 re-circulatory fume cupboards in the University, some with filters only and others with both vortex scrubber and filters. All the re-circulatory fume cupboards in Kadoorie Biological Sciences Building (KBSB) have both filters and scrubbers, and can be exhausted to outdoors in case of emergency.

Figure 3: A re-circulatory fume cupboard with vortex scrubber and filters.

4.4 Other Fume Cupboards

There are some fume cupboards that are designed to provide protection to the users from specific reagents or operations such as perchloric acid fume cupboards and radioisotope fume cupboards.

In a ***perchloric acid fume cupboard***, the construction materials have to be selected to prevent a reaction with perchloric acid. Organic materials should not be used. A water wash down system is used to prevent deposits on the entire ductwork and the area behind the baffle of the fume cupboard to control reaction with perchloric acid. Sources of spark generation should be avoided in this type of fume cupboard.

A ***radioisotope fume cupboard*** should be strong enough to bear the weight of any necessary radiation shielding materials. It should also be easy to decontaminate and be able to contain spills.

Fume cupboards should not be used for hazardous microbiological substances, as they must be handled inside the appropriate class of microbiological safety cabinet.

4.5 Canopy Hood

Canopy hoods are not fume cupboards. They are used primarily to exhaust heat or unwanted odours generated by a particular bench top group of equipment, e.g. drying ovens. To be effective, the canopy hood should be located as close to the equipment under it as possible, no more than 12 inches.

5. Installation of Fume Cupboards

All new fume cupboards must be installed to British Standard BS7258: 1994, Australian Standard AS2243.8 (1992), German Standard DIN 12924, Canadian Standard CSA Z316.5 or other relevant international standards. These standards specify safety requirements for fume cupboards, methods of test to be used to

determine their performance, installation and maintenance. ***The installer must carry out commissioning tests on site after installation to ensure that the performance of the fume cupboards on site is in compliance with the standards, and must produce a commissioning report before the fume cupboard is put into service.***

6. Location of Fume Cupboards

The location of the fume cupboards should be considered at the initial stages in the planning of a new building or before modification of an existing building. The location should comply with the above standards.

A fume cupboard should be located away from normal traffic pattern, cross-draughts, air inlets and other sources of disturbance.

Figure 4: Supply air from the air conditioner installed on the ceiling affected the performance of fume cupboard.

A fume cupboard should not be sited in a position where exit from a work space to the only escape route will necessitate passing directly in front of the fume cupboard as there is a potential risk of fire or explosion in fume cupboards.

Fume cupboards should not be installed face to face or opposite a biological safety cabinet unless the distance between them is at least 3.0m.

The provision of sufficient make-up air necessary to replace the air exhausted by the fume cupboard should be considered before installation.

7. Performance Tests on Fume Cupboards

7.1 Face Velocity

Various professional organizations have recommended a face velocity ranging from 0.3 to 0.76 m/s. Most manufacturers continue to select 0.5 m/s as their specification for safe operation of the fume cupboard. A lower face velocity is specified for the re-circulatory fume cupboards in KBSB by the manufacturer for better filtration efficiency of the filters.

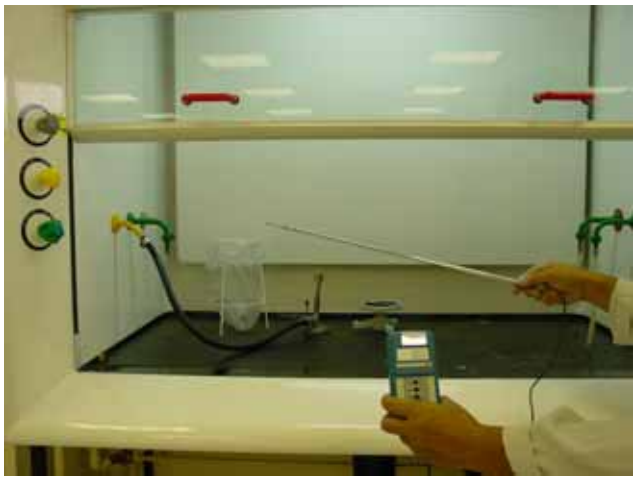


Figure 5: Measuring face velocity of a fume cupboard.

Face velocity alone is not a good predictor of hood performance, as it does not always predict containment. In some fume cupboards attaining face velocities within the suggested range,

insufficient containment is demonstrated by the smoke test.

7.2 Smoke Test

The smoke test gives a visual demonstration of airflow pattern around and into the fume cupboard, and hence an indication of the containment of the fume cupboard.

7.3 Sound Pressure

Sound pressure generated by the fume cupboard is measured to ensure that it complies with the specification of the purchaser.

Figure 6: Measuring sound level generated by the fume cupboard.

7.4 Light Intensity

Light intensity at the work surface is measured to ensure that adequate illumination is provided for the work inside the fume cupboard.

7.5 Filter Condition

Filter condition for re-circulatory fume cupboards is regularly checked to ensure its efficiency to remove contaminants generated inside the fume cupboard.

Commissioning tests should be carried out by the local installer to verify the satisfactory performance of the fume cupboards on site upon completion of the installation. ***The Safety Office provides regular inspection service on the performance of the fume cupboards.***

8. General Remarks on the Use of Fume Cupboard (FC)

A fume cupboard does not provide absolute protection for the materials handled inside the cupboard. However, for most exposures, a properly designed hood in a properly designed room can provide adequate protection if the following work practices is followed.

8.1 Before Use:

8.1.1 Clear the fume cupboard of all unwanted chemicals and apparatus. Excessive storage of chemicals or any apparatus in the hood will impair the performance of the chemical hume hood. Chemicals should NOT be stored in fume cupboards also used as working spaces.

8.1.2 Check that there is no equipment or other materials blocking the rear slots or interfere with air flow. Use equipment that has legs to raise them off the work surface and allow even air flow to the lower slots of the baffle.

8.1.3 Check the toxic properties of the substances you are working with and check that the fume cupboard is suitable for the intended use. All operations, which may generate air contaminants at levels above the exposure limit, must be conducted inside a hood.

8.1.4 Ensure that there is enough space in the FC for the work and place everything required inside the FC before starting operations.

8.1.5 Place apparatus & materials towards the back of the FC.

8.1.6 Close any doors or windows that reduced the performance of the FC.

8.1.7 Ensure that the FC is working correctly by a visual check of the airflow indicator or the direction of airflow (e.g. using a piece of tissue paper or smoke flow).

8.1.8 Ensure that a suitable fire extinguisher is at hand especially if using flammable solvents.

8.1.9 Using hazardous solids (powders) in hood may not be appropriate.

8.1.10 Do not open the sash beyond the sash stop except when necessary for apparatus set-up.

8.2 During Use:

8.2.1 Work as far into the FC as possible, at least 6 inches from the front edge.

8.2.2 Minimize pedestrian traffic in front of the FC, particularly during hazardous experiments.

8.2.3 Do not put your head in the fume cupboard or stand inside a walk-in fume cupboard when contaminants are generated during experiments.

8.2.4 Do not permit paper to enter the exhaust duct.

8.2.5 Do not use the hood as a waste disposal mechanism.

8.2.6 Do not place electrical receptacles or other spark sources inside the hood when flammable liquids or gases are present.

8.2.7 Use an appropriate barricade if there is a chance of explosion or eruption.

8.3 After Use:

8.3.1 Ensure that the FC is clean & free from contaminants.

8.3.2 Lower the sash & leave the fan on until the released fume is completely removed.

8.3.3 If adequate general laboratory ventilation will be maintained when fan is not running, fume cupboards not in use should be turned off to conserve energy.

9. Regular maintenance and check of the fume cupboard by users

A fume cupboard should be regularly maintained to keep its good performance, reduce the possibility of hazard to the user and to prolong its life.

9.1 Visual check all performance indicators and engineering control measures where possible, at least once every week. This is to identify potential problems so that they can be rectified before there is a significant deterioration of the system and its performance.

9.2 Clean the inner surfaces of the fume cupboard every six months or more frequently if dirty and immediately after any spill.

9.3 The users should check the direction of airflow before use. In case of break down or malfunctioning, inform the laboratory supervisor, the Estates Office and the Safety Office.

9.4 Maintenance staff should be advised of the need for any decontamination procedures before the work.

10. Regular Inspection and Testing

Staff of the Safety Office carry out annual inspections on all the fume cupboards in the University. These checks include the following:

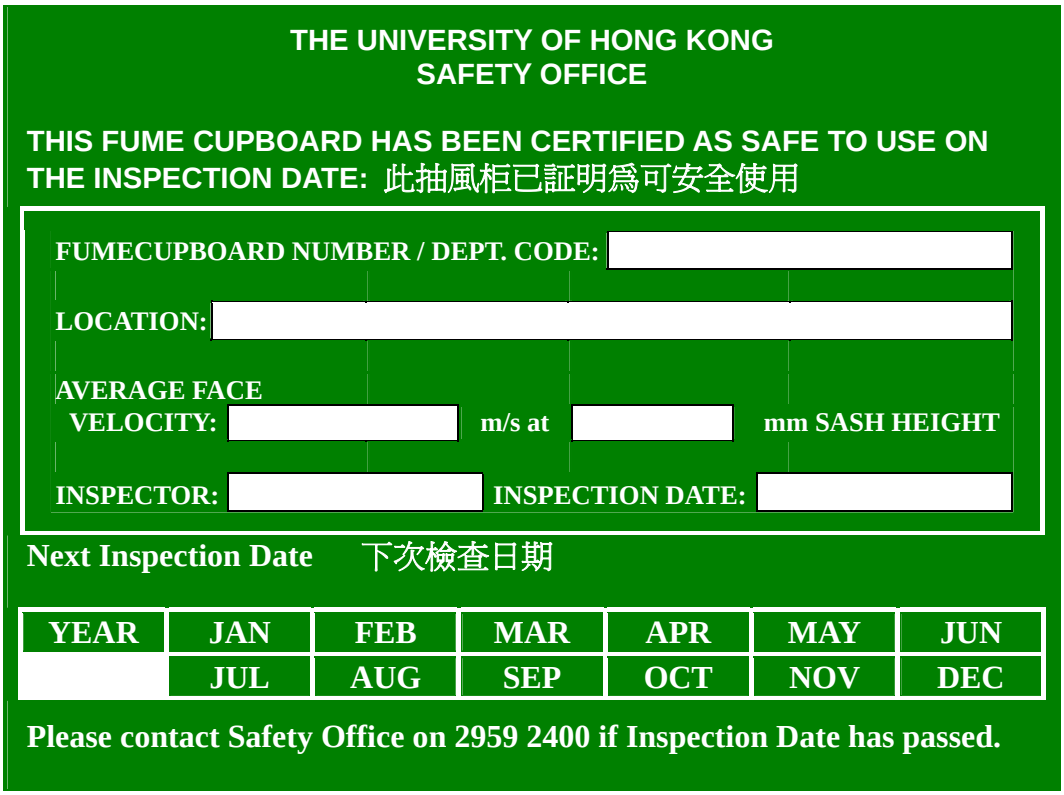
10.1 To check the sash stop or the label that indicates the maximum working opening are in place.

10.2 To check the internal condition of the fume cupboards and the working aperture which must be kept free of obstructions and irregularities.

10.3 To measure the face velocity of the fume cupboard with the sash set to the maximum working opening as marked on the FC. The average face velocity obtained should not be less than 0.5 m/s. This measurement is used to check the relative performance of the fume cupboard and is used to check whether there has been any deterioration in the performance of the fume cupboard since installation or the previous test.

10.4 To conduct the smoke test to visual check the containment of the fume cupboard.

Fume cupboards with face velocities at or above 0.5 m/s at 500mm sash opening and satisfactory smoke test results are classified as '***Safe***' for use and a green label is put on the FC.


THE UNIVERSITY OF HONG KONG
SAFETY OFFICE

THIS FUME CUPBOARD HAS BEEN CERTIFIED AS SAFE TO USE ON THE INSPECTION DATE: 此抽風柜已証明爲可安全使用

FUMECUPBOARD NUMBER / DEPT. CODE:

LOCATION:

AVERAGE FACE VELOCITY: m/s at mm SASH HEIGHT

INSPECTOR: INSPECTION DATE:

Next Inspection Date 下次檢查日期

YEAR	JAN	FEB	MAR	APR	MAY	JUN
	JUL	AUG	SEP	OCT	NOV	DEC

Please contact Safety Office on 2959 2400 if Inspection Date has passed.

Fume cupboards with face velocity at or above 0.5 m/s only with reduced sash opening are classified as '***Conditionally Safe***' for use and are issued a yellow label together with the maximum sash opening allowable marked on the fume cupboard with an arrow. The maximum sash opening recommended for safe use is based on the airflow measured and the smoke flow test results.

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THIS FUMECUPBOARD IS SAFE TO USE ONLY IF THE CONDITIONS SPECIFIED ARE MET. 此抽風柜只可在指定條件下才可安全使用

FUMECUPBOARD NUMBER / DEPT. CODE: _____

LOCATION: _____

AVERAGE FACE VELOCITY: _____ **m/s at** _____ **mm SASH HEIGHT**

INSPECTOR: _____ **INSPECTION DATE:** _____

CONDITIONS FOR USE: _____

使用時條件 _____

REMEDIAL WORK IS NECESSARY. 維修工作必須進行

CONTACT ESTATES OFFICE (FAX TO 2855 0346 OR E-MAIL TO estates@estates.hku.hk) TO ATTEDN AND AFTER REMEDIAL WORK CALL SAFETY OFFICE ON 2859 2400 FOR REINSPECTION AND TEST.

Fume cupboards with an average face velocity of less than 0.5 m/s even when the sash opening is reduced to 200 mm and unsatisfactory smoke test results are classified as '***Unsafe***' for use and cannot be used for chemical manipulation. A red label is put on this type of fume cupboard and Estates Office is contacted for improvement work.

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THIS FUMECUPBOARD IS UNSAFE
此抽風柜不安全
DO NOT USE
切勿使用

FUMECUPBOARD NUMBER / DEPT. CODE :

LOCATION:

INSPECTOR: **INSPECTION DATE:**

CONTACT ESTATES OFFICE (FAX TO 2855 0346 OR E-MAIL TO estates@estates.hku.hk) FOR URGENT ATTEDNTION AND AFTER REMEDIAL WORK CALL SAFETY OFFICE ON 2859 2400 FOR REINSPECTION AND TEST.

Request for inspection services on fume cupboards, please contact us at 29592403 or 28592400.

References

- 🕮 British Standard 7258 (1994) Laboratory fume cupboards.
- 🕮 Australian Standard 2243.8 (1992) Safety in laboratories Part 8: Fume cupboards.
- 🕮 Canadian Standards Association Z316.5 (1994) Fume hoods and associated exhaust systems.