EXTRACTION & CONTAINMENT OF FUMES & MICRO-ORGANISMS

PROTECTION OF ENVIRONMENT PRODUCT & OPERATOR

How to select the right Laboratory Cabinet?

Forward

Contents

This information has been compiled to serve as an aid in selecting ventilated laboratory cabinets. The information is intended to be unbiased and should provide you with an understanding of ventilated cabinets when discussing your needs.

Introduction

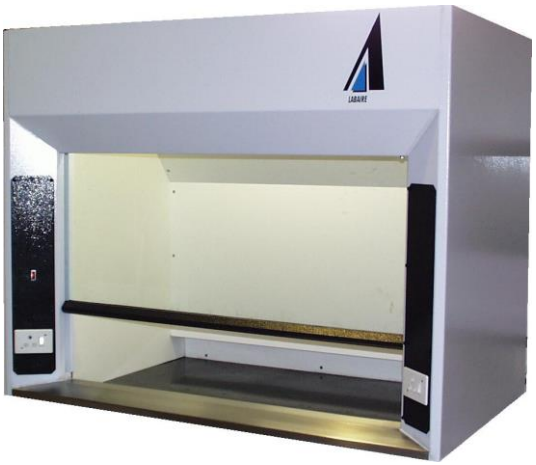
It is important to remember that a ventilated cabinet does not always function alone and a variety of external factors may influence its performance. Likewise the work being carried out in the cabinet may influence the surroundings. Your laboratory location, size, ventilation system amongst other factors, should be considered and discussed with a safety officer and/or a qualified consultant.

The choice of cabinet required to protect the operator and to either protect the product in the chamber or remove emissions from within while also protecting the environment can be a daunting one at best. Never mind the decision for the type of unit to be used for one specific chemical or analysis. We are often faced with more than one category of product being used within the same cabinet and therefore need a multi-purpose unit. Unfortunately the task does not stop once the type of unit is decided upon but rather a multitude of questions need to be answered before the model can be identified. Then the details of the cabinet's specification can be tabled. The decisions that have to be made are very important not only to ensure the safety of the operator, product and environment but also the damage that can be caused to the cabinet if the incorrect one is made. The units we are referring to are mostly bulky pieces of equipment and therefore careful planning has to be carried out. The details that follow hereon are set out to make your task a whole lot simpler and to reassure you of your decision. The equipment photographed is mostly Labaire product however the specifications and descriptions are broad and can be used with any brand name when purchasing or writing a specification.

There are six categories:

- Extraction Fume Cabinets
- Ductless Fume Cabinets [filtered]
- Down-flow Benches
- Microbiological Safety Cabinets
- Clean (Laminar Flow) Benches
- Other

Extraction Fume Cabinets



Why use an Extraction Fume Cabinet?

The following factors, amongst others, should have been taken into consideration when the decision to use an extraction fume cabinet rather than one of the other cabinets was made:

- Harmful fumes are being emitted
- Fumes are corrosive or aggressive.
- Fumes cannot be contained or removed (filtered).
- Product protection is not required.
- Emissions are not particulate or biological.
- Harmful micro-organisms are not being released.
- Excessive heat is not being generated.
- Procedures require space.

What is a Laboratory Fume Cabinet?

A laboratory fume cabinet, often referred to as a "fume cupboard" or " fume hood", is a ventilated cabinet where harmful or toxic fumes or vapors can be safely handled. Its purpose is to remove, capture and contain these contaminants preventing their escape into the laboratory and sometimes the atmosphere. This is achieved by drawing the contaminated air within the cabinet away from the operator. The removal of the air is achieved with an exhaust blower which "pulls or sucks" the air from the laboratory into the cabinet through an opening (work area) and into to the exhaust or extract system. This creates a movement of air at the opening of the cabinet known as the face velocity. A baffle, aerofoil and other aerodynamically designed components control the pattern of the air as it moves into and through the cabinet. The contaminated cabinet air with the laboratory air is exhausted to the atmosphere. This air may or may not be filtered to remove harmful gases, particles or fumes to reduce concentration levels to within an acceptable number (PPM).

Types of Extraction Fume Cabinets

There are basically two types of airflow within a fume cabinet:

- Conventional
- By-pass.

Conventional Fume Cabinets

The important concept to always revert back to is that a conventional fume cabinet does not have any additional air entering its air flow stream. The air that is being removed or exhausted flows directly through the front opening or work aperture of the fume cabinet. Energy saving devices may be fitted to the conventional airflow cabinets which control the amount of air being exhausted. This is sometimes linked to the supply of conditioned air to the laboratory.

The conventional cabinet does not have any air that by-pass the work aperture and therefore most of the exhaust air moves through the front sash opening. It is generally the least expensive to purchase, if no control mechanisms or features are installed. Closing the sash increases the work aperture face velocity unless a variable air volume [VAV] control device is fitted. The sash in the near closed position results in high face velocities which can disrupt procedures, disturb instruments, slow distillation rates down, cool hot plates, disperse material and cause general turbulence inside the cabinet.

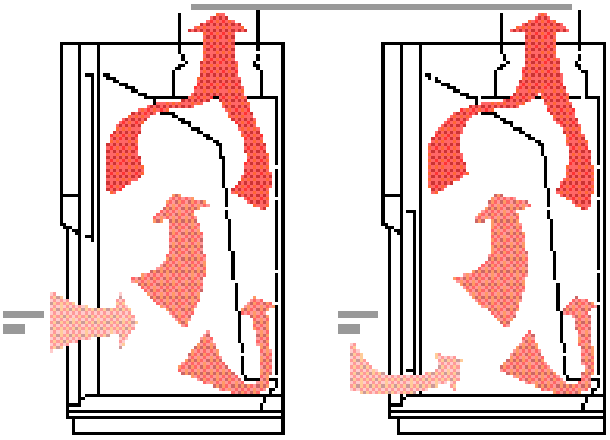


Figure 1. Conventional cabinet with sash open & closed

By-pass Cabinets

The by-pass cabinet generally operates on a constant air exhaust volume. The air is redistributed through the top of the cabinet and below the front working aerofoil when the sash is in the down position thus maintaining the inward face velocity. The by-pass openings above and below the front sash opening, reduce face velocity fluctuations when the sash is raised and lowered. By-pass cabinets comprise the majority of exhaust cabinets in the market. [Figure2]

Figure 2: Bypass fume cabinet with sash open and close.
Note the additional arrows indicating bypass air through the top and bottom.

Auxiliary-Air Cabinets

The auxiliary-air cabinet, or add-air system, is a variation to the by-pass cabinet whereby air from the outside the laboratory is introduced to the extraction fume cabinet system and therefore reduces the amount of conditioned air being removed from the laboratory by up to 70% [Figure 3]. When a laboratory does not have sufficient air to replace the air being removed by the extraction cabinet, the auxiliary air feeds the cabinet with make-up air. It also has energy benefits whereby the amount of heated or cooled laboratory air being exhausted is reduced. There are inherent disadvantages to the auxiliary-air cabinet that must be considered. The introduction of two ventilation systems with two fans requires precise balancing. Too much auxiliary-air results in turbulence at the face of the cabinet, which interferes with the airflow pattern. The auxiliary air must be clean, dry and tempered, which makes it expensive both to install and to maintain.

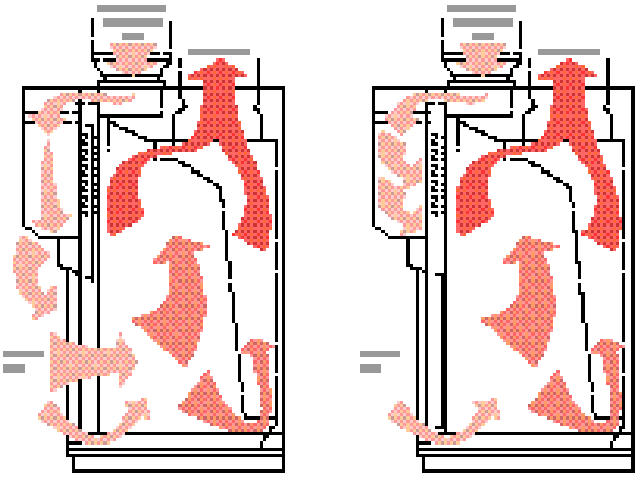


Figure 3. Auxiliary cabinet with sash open & closed

Variable Air Volume

Variable Air Volume [VAV] cabinets vary the amount of air being exhausted while maintaining the inward work aperture face velocity regardless of the sash height. They are generally conventional cabinets (not Bypass Cabinets) with sensors in the cabinet monitoring the volume of exhaust air or face velocity. A message is sent to a corrosion resistant VAV to vary the volume of air being exhausted. Although VAV systems are initially more expensive to install, they offer considerable energy savings and are very safe to operate. The constant flow of air regardless of sash position allows for precise experiments to be executed (Figure 5).

VAV systems with controls & monitor pad for fume cabinets may be linked to the BMS, alarm and air conditioning plant system thus controlling the entire lab environment. Information is relayed to the VAV devices in the supply air diffusers maintaining sufficient air volume to keep the lab under positive or negative pressure as so designed. The devices shown are for this complete lab control.

Figure 4. VAV device with control mechanisms.

Special Application Cabinets

Special procedures in the cabinet may require unique features to be added to the cabinet. Some of the more common requirements are listed below and form part of most standard equipment schedules.

Perchloric Acid Cabinet

Perchloric acid cabinets are dedicated for the use of perchloric acid only. They cannot be used with organic materials because of the explosive reaction. The internal construction should be of relatively inert and impervious materials such as ***type 316 stainless steel*** or ***type 1 unplasticised polyvinyl chloride [uPVC].*** The interiors are fully welded with an integral, coved work surface. Wash down scrubber features are essential to remove the collection of potentially explosive perchloric acid salts from ductwork and cabinet interior. Sharp turns and horizontal duct runs should be avoided to ensure thorough drainage. Each unit must have its own exhaust system. [Figure 5].

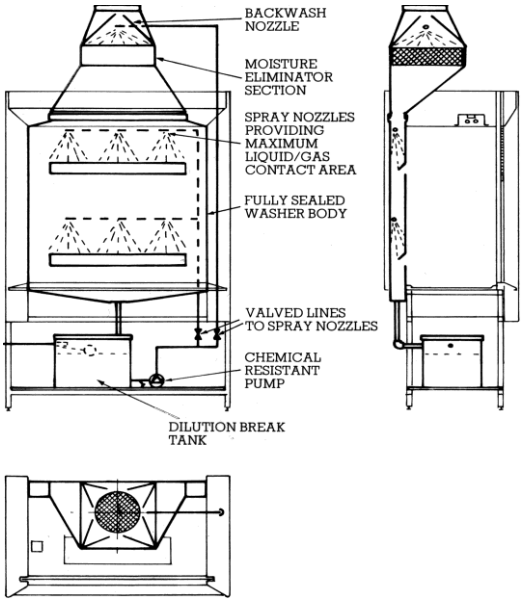


Figure 5: Perchloric Fume cabinet extract system

Radioisotope Cabinets

Radioisotope cabinets have fully welded interiors with integral, coved work surfaces to facilitate decontamination. Type 304 stainless steel should provide adequate resistance and impermeability to radioactive materials. Disposal of radioactive effluent should be observed by abiding with local codes. The cabinet must structurally accommodate the weight of lead sinks or brick shields and the provision for ***HEPA*** and ***Carbon Filters*** must be provided for in the exhaust system in applicable housings. [Figure 6]

Figure 6: Safe change filter housing mounted externally

Distillation and Walk-in

Additional height is required for the distillation and walk-in cabinets to accommodate large equipment. These cabinets may require extra depth and special attention should be taken to ensure all equipment can be fitted and procedures carried out. [Figure 7]

Oversized Cabinets

Every type of cabinet that is considered must be checked to see if the internal dimensions accommodate the applications required. Extra height, depth and width can be applied to virtually any type of cabinet as can a reduction in working area and subsequent overall dimensions.

Figure 7: Walk-in and distillation cabinets

Once it has been determined that an extraction fume cabinet is the correct choice the final decisions need to be made regarding fitted features and materials of construction.

Exterior of Fume Cabinet

Generally speaking the exterior of a fume cabinet is made from mild steel coated in a baked epoxy paint finish. Sometimes the aerofoil work aperture faces are made from stainless steel so that contact from loading and splashes of acidic and base substances do not corrode these panels. In very corrosive working environments the entire cabinet may be manufactured from stainless steel or polypropylene.

Stainless Steel Walk-in and Standard Fume Cabinets

Interior of Fume Cabinet

The interior liners of a fume cabinet should be robust and resistant to heat and fumes. A good example and the most widely used is ***6mm Solid Core Formica or Phenolic*** resin panels. Usually finished in a white layer for aesthetics, some materials have a highly scratch and corrosion resistant Electron Beam Cured film. Other material such as ***stainless steel*** and ***polypropylene*** can be used for special applications.

Work Surface

The work surface of a fume cabinet is where most of the protection is required. It could be subjected to heat, acids, solvents and abrasion. Materials of construction are:

Work Surface Selection						
Type	**Phenolic Resin**	**Epoxy**	**Ceramic**	**SS304**	**SS316**	**Polypropylene**
Chemical Resistance	Better	Better	Best	Good	Better	Best
Temperature Resistance	Good (110°C)	Good (165°C)	Best (1200°C)	Better (300°C)	Better (300°C)	Poor (50°C)
Cost	Mid Price	Mid Price	Premium	Low Price	Mid Price	Mid Price

The choice will depend on your application however the ***Phenolic Resin*** is by far the most widely used.

Valves & Fittings

Ensure whether these are required on one or both sides of the fume cabinet. Remote valve control positioned outside the work area with outlet inside is the most common. Piping to and from valves and fittings must be carried out by a professional team with Certificate of Compliance issued on completion. Drainage must be with polypropylene fittings.

Do not forget to request a Distillation grid if such is required.

Front Sash Window

Usually made from ***6mm Safety Glass***, the front sash can be moved vertically and sometimes horizontally. This will depend upon your application especially the loading of items into the work area and the subsequent procedures. The sash can be manually adjusted or with a motor. If motorized then precautions must be taken for safety when closing and opening (sensors applied for obstruction). Electric motor controlled sashes may be electronically positioned- as the operator encroaches so the sash moves up and lowers when departing. While the sash opens and closes, so the VAV for exhaust and supply will vary maintaining a constant air flow through work aperture and lab supply air diffusers thus maintaining pressure in the lab.

Alarm Systems

Alarms and monitoring systems are becoming more and more sophisticated. They generally sense and maintain the incoming face velocity, adjust the exhaust volume with respect to the height of the sash opening and provide timing and operating features- on/off, run time, low or high velocities, gas solenoid valve shut down etc.

Electrical Fittings & Protection

All fume cabinets have electrical sockets mounted on the front mostly on both sides. We strongly suggest protection in the form a mini ***Distribution Board*** with trip switches, isolators and earth leakage. This is mounted in the cabinet or the base stand.

Base Stand

The base stand for all fume cabinets, except Perchloric Acid (base stand is enclosed housing recirculation tank, pumps and piping), are either ***tubing*** stands or ***panelled enclosed*** cabinets.

The ***tubing*** stands may be height adjustable or fixed.

- Fixed with levelling feet.
- Manual adjustment
- Manual Hydraulic adjustment
- Electric adjustment.

Enclosed bases are either:

- Standard epoxy coated.
- Acid storage with Polyethylene lined interior
- Solvent storage with explosion proof latches & hinges.

A ***shelf with support*** must be stated separately.

Ventilation kits for enclosed bases must be stated separately. If ordered with a shelf then two vents one above and below shelf is provided.

Other Controlled Environmental Cabinets & Chambers

Once it has been decided that an extraction fume cabinet will not suffice for your particular application, you must look to other types of cabinets. We originally considered the following points- whether

- Harmful fumes are being emitted
- Fumes are corrosive or aggressive.
- Fumes cannot be contained or removed (filtered).
- Product protection is not required.
- Emissions are not particulate or biological.
- Harmful micro-organisms are not being released.
- Excessive heat is not being generated.
- Procedures require space.

Note that there has been no requirement for product protection as yet!

If harmful fumes are being emitted and they are not corrosive, or at least to any large degree, and the emissions are relatively low, you should determine whether these fumes could be filtered. If so then a portable fume cabinet can be considered.

Ductless Fume Cabinets

Often called portable fume cabinets, the ductless fume cabinet does not require an exhaust duct. They require a filter to contain or trap fumes from the air before it is re-circulated back into the room. The filters are made up of a combination of impregnated or treated activated charcoal or alumna to adsorb certain chemical fumes such as solvents, acids, ammonia, formaldehyde, lead or other toxic fumes. Different filters may be required for different applications and therefore repetitive procedures involving a limited number of chemicals require such enclosures. The cost of the replacement filters is high and therefore these cabinets are limited to applications with relatively low emission concentrations. Careful and regular monitoring of these cabinets is required and special care must be taken if the fumes are highly toxic or carcinogenic. Some more common filters would be used for the removal of the following:

- General solvents
- Radioactive iodine
- Cyanide
- Hydrogen sulphide
- Formaldehyde
- Diethyl ether
- Particulate matter
- Mercury
- Amines
- Inorganic acids

If your process emits fumes as mentioned above, and they are particulate, then a HEPA filter can be installed in parallel with the carbon filter.

Downflow Benches

Downflow benches are used primarily with the introduction of wet processes and the need to view your product. As mentioned, no product protection is required, but there are fumes being emitted and you need an open space within which to work. There is also a need to wash the work area regularly.
In this instance a downflow bench should be considered. These benches are often custom designed for applications such as specimen cut-up procedures, staining processes, autopsies and materials chemical etching.

We now enter the realm of cabinets where product protection is required (except in the case of the Class 1 Biological Safety Cabinet)

Biological Safety Cabinets

These cabinets are not referred to as fume extraction cabinets. They are designed to contain hazardous microbiological bacteria and viruses and not gases that pass through the filter system. They invariably re-circulate the cabinet air back into the laboratory and therefore stringent filter requirements are laid down for their use. When product, operator and environmental protection are required, such cabinets are usually specified. Details of how to select the correct biological safety cabinet are referred to in a separate brochure.

Cytotoxic Extraction Cabinets

Cytotoxic extraction cabinets are sometimes confused as laboratory fume cabinets because there extraction system is similar to that of a radioisotope fume cabinet however they perform within the scope of the biological safety cabinet. There are two different types of cabinets- one with no re-circulated air and one with. Both incorporate a total exhaust system. The supply of air and the manner in which the exhaust air enters the front opening, is governed by Biological Safety regulations.

Glove Boxes

Glove boxes often fall into this category of biological cabinets as the Class 3 biological safety cabinet is such a glove box. Glove boxes provide a physical barrier between the operator and the product inside by way of a viewing window and a transfer hatch to load and unload product. They are therefore used when applications require no inhalation and/or contact with the product being worked is allowed. Applications with low level radioisotopes and carcinogens often require such containment, as do atmosphere sensitive materials that cannot be exposed to oxygen for example. Isolation technology with robot arms maybe incorporated with these systems.

Clean Benches (Laminar Flow)

The clean bench provides product protection by blowing HEPA filtered air over a work area. This vertical or horizontal flow of air [known as 'Laminar Flow'] protects the work area from particulate contamination that includes dust and micro-organisms. They only provide product protection and in fact enhance the operator exposure to aerosols generated in the work area. Hazardous substances should never be worked within a clean bench.

Laminar Flow Systems

The protection of the product on a large scale requires the inclusion of the Laminar Flow 'Booths' either ceiling mounted or on legs. These may be many square meters in size and incorporate central air-conditioning systems. Our Laminar Flow Screen Technology is pictured below which offers unlimited coverage of the required protected area in question. In this instant it happens to be a Laminar Flow Theatre.

Please do not hesitate to contact one of technical staff for more detailed information. We trust the above will help you in making an informed decision in selecting a cabinet that is going to suit your procedural requirements and give you years of service.