



Updated May 2023

Energy Saving Methods

Reducing the energy consumption of fume cupboards is crucial for both cost savings and environmental sustainability.

The running costs of a fume cupboard are a combination of the energy required to:

- Extract air from the fume cupboard, i.e. to operate the extract fan (approx. 35% of the total energy usage).
- Supply and condition (cool/heat/filter) replacement air into the lab (approx. 65% of the total energy usage).
- Power the fume cupboard sockets, alarm panel and lighting (negligible in comparison to the above).

As an example, a 1500mm wide fume cupboard, maintaining an average face velocity of 0.5m/sec across a 500mm high sash opening, operating 24hrs a day, 365 days a year, will, at today's typical energy rates (May 2023) cost approx. £7,500 per year to run.

There are a number of ways of reducing the running costs but careful consideration should be given to the specific requirements of the laboratory and the nature of the experiments conducted to determine the most suitable method. Below are the most common and effective means, in order of cost payback period:

1. Reduced Hours of Operation

Switching off the fume cupboard extraction overnight and during weekends can result in significant energy cost savings. Continuing the example above, the cost of single 1500mm wide fume cupboard operating 8 hours a day, 5 days a week would reduce to approximately £2,500.

Building Management Systems (BMS) or time-switches can be utilized to automate the process of switching off fume cupboards when users are absent. However, it is important to have a method of locally overriding this feature when experiments need to run overnight.

Airflow monitors with built-in extract fan controls offer a solution for local switching and override, allowing users to manage the fume cupboard operation as needed.

It is worth noting that in some cases, fume cupboards are used as replacements or supplements for the general laboratory extraction system. In such instances, they may need to run continuously. However, during these periods, they are unlikely to require full capacity operation, and energy consumption can be reduced by utilizing inverters or Variable Air Volume (VAV) systems (see below).

Cost	Energy Saving	Payback Period
Zero / Negligible	Up to 70%	Instant

2. Lower Face Velocity

Traditionally, fume cupboards have been designed with an average face velocity of 0.5m/sec across the sash opening. However, it is possible to achieve significant energy savings by reducing the face velocity, while maintaining effective containment of fumes.

By reducing the face velocity to 0.4m/sec, an instant 20% reduction in extract volume can be achieved. Further reducing it to 0.3m/sec results in a 40% reduction. Well-designed, modern aerodynamic fume cupboards can still provide excellent containment performance at these lower face velocities.

It is important to note that careful consideration must be given to the laboratory design and operation when utilising low-velocity fume cupboards. The robustness of fume containment can be compromised at lower face velocities, particularly when there are air disturbances caused by users, equipment inside the fume cupboard, or local air conditioning units. As a result, some clients may be hesitant to operate fume cupboards at lower face velocities, especially where there are higher-risk chemicals and processes involved.

Cost	Energy Saving	Payback Period
Zero / Negligible	Up to 70%	Instant

3. Reduced Sash Opening

The conventional standard for the maximum working height of a fume cupboard sash is typically set at 500mm above the work surface. However, by reducing this maximum opening height to 400mm, a smaller volume of air is needed to maintain the same average face velocity within the fume cupboard. This reduction in required airflow results in an immediate energy saving of approximately 20%.

It's important to ensure the sash is not raised above the maximum working height during use, ideally by a physical stop with override function and suitable labelling. Note that while this energy-saving offers tangible benefits, it comes with some practical considerations. Depending on the specific use of the fume cupboard, the reduced opening height could potentially limit access to the interior or make it uncomfortable for certain users.

Cost	Energy Saving	Payback Period
Zero / Negligible	20% (400mm)	Instant

4. Inverter Driven Extract Fan

The power absorbed by a fan motor is directly related to its speed, with a cubic relationship. This means that even a small change in the speed of the fan motor can have a significant impact on the energy consumption.

Cost	Energy Saving	Payback Period
£300+ depending on fan motor size	10—50%	Typically Less than 6 months



For example, reducing the speed of a fan motor by 20% results in a substantial energy savings of nearly 50%.

Traditional extraction systems typically utilise a fan motor that operates at a fixed pole speed. To fine-tune the fume cupboard face velocity, a manual volume control damper is adjusted within the duct. By incorporating an inverter to control the extract fan, the need for a volume control damper is eliminated (except in cases where multiple branches are present). During the commissioning process, the inverter is used to fine-tune the speed of the extract fan, ensuring that the desired face velocity is precisely achieved.

Inverters offer further advantages compared to traditional control systems. They come equipped with on-board diagnostics, simplifying the troubleshooting process and overall system maintenance, as well as enhanced protection and reliability for the extraction system. Night-setback speeds can be programmed to maintain a reduced level of ventilation throughout the laboratory, the fume cupboards, and any connected storage cabinets during periods of inactivity or when they are not in use. This feature helps conserve energy while ensuring a minimum level of ventilation for safety and air quality purposes.

Many older extract systems utilise belt-driven fans. These are inefficient, require frequent maintenance (belt tensioning, replacement etc) and are considerably less reliable than modern direct-drive inverter driven fans.

5. Stepped-Speed Control System

Fume cupboards connected to inverter driven extract fans can be configured and controlled in such a way that they operate at two (or more) extract volumes, linked to the sash opening height, whilst still maintaining the required average face velocity.

With good user discipline, (i.e. lowering the sash whenever possible) energy savings up to 50% are achievable.

Cost	Energy Saving	Payback Period
£800+	Up to 50%	Typically 1 year

6. PIR Operator Alarm

Designed for use with stepped speed or VAV control systems, the PIR operator alarm monitors the sash height and user activity in front of the fume cupboard. If the sash is in its raised position and no activity is detected after a preset time delay, the system will sound an intermittent alarm designed to encourage nearby users to close the sash and allow the control system to run at a more energy-saving level. This is a considerably more cost-effective and reliable system than the automatic sash closure system described below.

Cost	Energy Saving	Payback Period
£400+	20-50%	Typically 1-2

7. VAV Control

VAV (Variable Air Volume) control systems are designed to maintain a near constant face velocity at the fume cupboard, regardless of the sash opening height. VAVs offer significant energy savings on installations with multiple fume cupboards served by a single extract system, although the initial equipment cost is higher compared to conventional setups.

A VAV system operates by continuously monitoring the fume cupboard face velocity and modulating a fast-response motor-driven damper in the duct above to increase or decrease extract volume as required. If face velocity decreases, e.g. due to the sash being raised or a local fluctuation or disturbance in airflow, the damper proportionally opens. If face velocity increases, e.g. due to the sash opening being reduced, the damper proportionally closes.



The extract fan serving a VAV fume cupboard typically works at a single fixed speed. A fresh-air bleed inlet is installed close to the extract fan at roof level, or within the plantroom, to introduce atmospheric air into the extract system and ensure a constant volume/velocity of air passes through the duct and exits the top of the discharge stack. This is essential to ensure fumes are sufficiently dispersed. The bleed inlet monitors the pressure within the duct and proportionally opens or closes. As less conditioned air is drawn from the fume cupboards in the laboratory, so more atmospheric air is drawn through the bleed inlet, and vice versa.

Because of the requirement of a bleed inlet at the extract fan, it is more cost-effective to have multiple VAV fume cupboards served by a single VAV extract system, rather than individual or smaller numbers of fume cupboards on multiple extract systems.

Cost	Energy Saving	Payback Period
Upwards of £2,500 per fume	Up to 85%	Typically 1-3 years

8. Automatic Sash Closers

Designed for use with stepped speed or VAV control systems, automatic sash closer systems monitor activity in front of the fume cupboard, via a PIR sensor. After a period of no activity a motor will slowly drive the sash to the closed position, allowing the stepped or VAV system to reduce the volume of air extracted from the fume cupboard.

Although in principle this would appear to be an excellent idea, our experience is that they are often unpopular with users and maintenance requirements are high. A considerably more cost-effective solution is good user discipline coupled with the PIR operator alarms above.

Cost	Energy Saving	Payback Period
£2,000+	20-50%	Typically 3+ years



Other Considerations and Requirements

The operation, suitability and energy-saving potential of all options above are dependent on the design and operation of the extract and supply air systems.

Extract System

The size, material, location and route of the extract system is carefully considered and selected at design and installation stage to suit a particular control methodology and extract volume. Any subsequent alterations to the control method or extract volume may have an adverse impact on the extract system. For example, the velocity of the air passing through the duct and exiting the top of the stack will reduce when less volume of air is extracted. This could result in vapours condensing and leaking from the duct and/or fumes not being sufficiently dispersed and entering open windows or pedestrian areas.

When designing new extract systems, or modifying existing ones, the advantages of individual and common extract systems should be considered:

Individual Extract Systems (each fume cupboard served by one extract duct and fan).

- Best for constant volume and stepped speed operation.
- Energy efficiency is maximized by switching off the extract when the attached fume cupboard is not in use. Common extract VAV system are usually configured so that the fan runs continuously.
- In the event of an extract fan failing, or the extract duct becoming damaged, only the one fume cupboard will be out of service. On a common system, all attached fume cupboards will be out of service.
- Less maintenance and greater long-term reliability than a VAV system.
- Possibly the least expensive option. Large ducts and fans used on common extract systems are often disproportionately more expensive than smaller ducts and fans.
- No risk of incompatible fumes from different fume cupboards mixing within the duct.
- Only one fume cupboard needs to be out of operation during preventative or planned maintenance.

Common Extract Systems (many fume cupboards served by one common extract system and fan).

- Best for VAV operation.
- Smaller number of discharge stacks means planning approval may be easier to achieve.
- Often easier to route one large duct through the building, rather than multiple smaller ducts.
- Often (but not always) less expensive to install than many smaller individual extract systems.

Supply Air / Make up Air Systems

Supply air needs to be introduced into the laboratory to replace the air being extracted by the fume cupboards. This can be via passive means, through door grilles etc, or active means, through air handling units. The cooling and heating of this supply air is the largest contributor to the running costs and potential energy savings.

To ensure the pressure regime in the lab remains constant at all times, the supply air volume should be balanced to the extract air volume and similarly follow any variations, such as those experienced with VAV or stepped speed controls. Room controllers and supply air controllers for this purpose are available from Fumair.

We would be pleased to help you evaluate the potential, practicality and suitability of all the above options, giving consideration to your specific laboratory setup, number of fume cupboards, anticipated usage patterns and extract and supply air systems configuration. Please contact Fumair to discuss your requirements and/or arrange a free on-premises review and consultation.