BS 7989:2001

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Specification for recirculatory filtration fume cupboards

ICS 13.040.30; 91.140.30

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee LBI/18, Laboratory furniture and fittings, upon which the following bodies were represented:

Association for Science Education
BLWA Ltd. — The Association of the Laboratory Supply Industry
British Educational Suppliers' Association
British Furniture Manufacturers' Federation
British Occupational Hygiene Society
Chartered Society of Designers
Chemical Industries Association
CLEAPSS — School Science Service
Department for Education and Employment
Furniture Industry Research Association
Health and Safety Executive
Institution of Mechanical Engineers
Manufacturing Science Finance
Medical Research Council
Research and Development Facilities Consortium
Royal Institute of British Architects
Royal Society of Chemistry
United Kingdom Fume Cupboard Association
Universities Safety Association

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Contents

Foreword

This British Standard has been prepared under the direction of the Sector Committee for Materials and Chemicals (I/-) by Technical Committee LBI/18, Laboratory furniture and fittings. It has been prepared in response to calls from industry for a standard for fume cupboards of the filtration type, which are not covered by BS 7258. It was intended originally that this work should be undertaken as part of the European (CEN) programme of work on fume cupboard standards, but this proved unfeasible in the short term.

The structure of BS 7258 has been used to some extent in this British Standard and, where possible, identical requirements have been specified. However, this British Standard should be considered as essentially separate and distinct from BS 7258. Attention is also drawn to Building Bulletin 88 [1], issued by the Department for Education and Employment in 1998.

Whenever a fume cupboard is used, it is necessary for the purchaser and/or user to assess the hazards associated with the materials to be manipulated, to ensure that the fume cupboard is satisfactory for its intended purpose and that current exposure limits for toxic substances are not exceeded.

Annex A and Annex B are informative. Annex C and Annex D are normative.

This British Standard calls for the use of substances and/or procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health at any stage.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 20, an inside back cover and a back cover.

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Introduction

The purpose of a recirculatory filtration fume cupboard is to contain a pollutant or pollutants released from a source or sources within the fume cupboard and, by a filtering device, to reduce substantially the concentration of specified pollutants prior to recirculating the air back to the room.

These devices should only be used with pollutants of documented hazard, which permits the selection of appropriate filter(s).

NOTE Several of the tests described in this British Standard require the use of hazardous substances. Appropriate risk assessment should be made and suitable precautions taken at all times.

1 Scope

This British Standard specifies requirements for fume cupboards designed to recirculate air back to the room after filtering out specified pollutants. This British Standard does not specify requirements for fume cupboards of the type dealt with in BS 7258.

This British Standard is not applicable to recirculatory filtration fume cupboards of the following types:

— recirculatory filtration fume cupboards for work on radioactive materials;

— recirculatory filtration fume cupboards for work on microbiological agents;

— high thermal load recirculatory filtration fume cupboards;

— recirculatory filtration fume cupboards employing wet scrubbing systems.

This British Standard is not intended to apply to small enclosures intended only for applications such as weighing, in which the filter retention capacity is likely to be small.

2 Normative references

This British Standard incorporates, by dated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. Subsequent amendments to, or revision of, any of these publications apply to this part only when incorporated in it by amendment or revision.

BS 7258-1:1994, *Laboratory fume cupboards — Part 1: Specification for safety and performance.*

BS 7258-2:1994, *Laboratory fume cupboards — Part 2: Recommendations for the exchange of information and recommendations for installation.*

BS 7258-3:1994, *Laboratory fume cupboards — Part 3: Recommendations for selection, use and maintenance.*

BS 7258-4:1994, *Laboratory fume cupboards — Part 4: Method for determination of the containment value of a laboratory fume cupboard.*

BS 7501:1989, *General criteria for the operation of testing laboratories.*

BS EN 292-1:1991, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology.*

BS EN 292-2: 1991, *Safety of machinery — Basic concepts, general principles of design — Part 2: Technical principles and specifications.*

BS EN 1822-1:1998, *High efficiency air filters (HEPA and ULPA) — Part 1: Classification, performance testing, marking.*

BS EN 12469:2000, *Biotechnology — Performance criteria for microbiological safety cabinets.*

BS EN 60529:1992, *Specification for degrees of protection provided by enclosures (IP code).*

BS EN 60651:1994, *Specification for sound level meters.*

BS EN 60804:1994, *Specification for integrating-averaging sound level meters.*

BS EN 61010-1:2001, *Safety requirements for electrical equipment for measurement, control, and laboratory use — Part 1: General requirements.*

3 Terms and definitions

For the purposes of this British Standard, the following terms and definitions apply.

NOTE Some of the definitions are identical with definitions given in BS 7258-1:1994.

3.1
air pollutant

gases, vapours, aerosols, fumes or particulate materials in air, constituting one or more of the following hazards:

a) toxicity (all injuries to health including asphyxiation, allergy, narcosis);

b) flammability (including risks of explosion);

c) chemical activity (including corrosion);

d) discomfort, e.g. lachrymosis, objectionable odours.

NOTE In the field of environmental pollution, fume is defined as an aerosol of solid particles, usually from metallurgical processes, generated by condensation from the gaseous state generally after volatilization from melted substances and often accompanied by chemical reactions such as oxidation.

3.2
area of opening

product of the average width of the opening (**3.20**) and the height of the opening (**3.8**)

3.3
baffle

plate installed to minimize the variation of face velocity (**3.4**) over the sash opening plane (**3.17**) and encourage scavenging throughout the fume cupboard

3.4
face velocity

velocity of air passing through the sash opening plane (**3.17**)

3.5
filter breakthrough alarm

substance-specific alarm designed to indicate when an unacceptable concentration of a specific pollutant is emerging from the filter

3.6
filter efficiency

gaseous phase filtration efficiency of a recirculatory filtration fume cupboard, defined as:

$$\frac{100(C_o - C_e)}{C_o}$$

where C_o is the concentration of a given pollutant in the fume cupboard and C_e is the concentration of that pollutant in the recirculated air (**3.13**)

3.7
gaseous phase filter

filter capable of adsorbing pollutant gases and vapours

NOTE The filter commonly contains activated carbon. Chemicals may be impregnated into the filter media to improve efficiency and filter life.

3.8
height of the opening

distance, measured in the plane of the sash (**3.16**), between the upper edge of the work surface (**3.21**) (or raised anti-spill lip where fitted) and the lower edge of the sash, sash airfoil or sash finger pull sections where fitted

3.9
high efficiency particulate air filter
HEPA filter

filter used to remove particles to submicron levels

NOTE Examples are classes H 13 and H 14, as specified in BS EN 1822-1:1998.

3.10
normal sash opening

maximum height (in the case of vertically adjustable sashes) or width (in the case of horizontally adjustable sashes) to which the sash should be opened during use of the fume cupboard and at which point a stop or other device is fitted to prevent the opening being exceeded under normal use

3.11
occupational exposure limit
OEL

time weighted average concentration limit (TWL) of a hazardous substance in air, which may be either an occupational exposure standard (OES) or a maximum exposure limit (MEL)

NOTE 1 Two time periods are used: long term (8 hours) and short term (15 minutes).

NOTE 2 An OES is a TWL set at a level at which (based upon current scientific knowledge) there is no indication of risk to the health of workers exposed to it by inhalation day after day.

NOTE 3 An MEL is the maximum concentration of an airborne substance, averaged over a reference period, to which employees may be exposed by inhalation under any circumstances.

3.12
pre-filter

filter used to remove particulates and protect HEPA (**3.9**) and/or gaseous phase filter(s) (**3.6**)

3.13
recirculated air

air that is passed back into a room after passing through the fume cupboard filter system

3.14
recirculatory filtration fume cupboard

fume cupboard that is fitted with an integral filtration system capable of reducing specified air pollutants (**3.1**) before the air is recirculated back into the room

3.15
retention capacity

mass of specified pollutant adsorbed by the gaseous phase filter (**3.7**) of a recirculatory filtration fume cupboard (**3.14**), under defined conditions, before the concentration in the filtered air reaches the OEL (**3.11**) of the pollutant

3.16
sash

transparent screen between the operator and the working space that can be adjusted by either vertically or horizontally moving panels or hinged panels

3.17
sash opening plane

plane of the sash (**3.16**) or, when the plane of the sash does not meet the work surface (**3.21**), non-vertical plane bounded at the top by the lowest point of the upper edge of the opening in the plane of the sash, at the bottom by the uppermost point of the lower edge of the opening and at the sides by the side edges of the opening

NOTE If the sash is formed by more than one transparent panel, then the plane used is that through the centre of the outermost section.

3.18
services

supplies of illumination, electricity, water, vacuum, compressed air, gas or other special fluids

3.19
volume flow rate

volume of air per unit time passed through the fume cupboard and filters

3.20
width of the opening

average distance measured between the two sides of the clear opening of the fume cupboard in the case of vertically adjustable sashes (including hinged panels), or the average distance between the vertical edges of the opening (between two sliding sash panels for centrally positioned openings or between one sliding panel and the inner edge of the outer vertical side of the opening) in the case of horizontally adjustable sashes

NOTE The gap between the end sash panels and the sash frame or edges of the side wall is not included in this dimension.

3.21
work surface

surface of the slab or platform above the spillage tray which acts as the base of the fume cupboard interior or, if no spillage tray is fitted, the upper surface of the base of the fume cupboard interior

4 Safety

4.1 General

Recirculatory filtration fume cupboards shall be designed to protect users and the working environment. This shall be achieved by:

a) minimizing the escape of hazardous concentrations or quantities of fumes from the fume-cupboard, either through the frontal sash opening or through the filters into the room;

b) efficiently purging the enclosure to reduce the potential for an explosive or hazardous atmosphere to develop within the enclosure;

c) providing some protection to the user against splashing of hazardous substances and minor explosions.

NOTE Attention is drawn to HSE Guidance Note EH40 [2] and Statutory Instrument 1999 No. 437 (The Control of Substances Hazardous to Health Regulations) [3].

4.2 Electrical

4.2.1 Electrical aspects of the construction of the fume cupboard shall be in accordance with BS EN 61010-1:2001.

4.2.2 Electric motors incorporated in the construction of the fume cupboard shall be non-sparking and of minimum enclosure ingress protection factor IP-44, as defined in BS EN 60529:1992. Other electrical components shall be isolated from the airstream.

4.3 Mechanical

Aspects of the construction of the fume cupboard relating to mechanical safety shall be in accordance with BS EN 292-1:1991 and -2:1991.

NOTE Attention is drawn to relevant regulations, such as the Safety of Machinery Directive 98/37/EC, as amended by 98/79/EC [4].

4.4 Specific

4.4.1 *Control of air entry*

The air entry profile of the front opening shall be designed such that the fume cupboard complies with clause **8**.

NOTE Good entry of air into the cupboard reduces the size of eddies at the boundaries and improves containment. This can be achieved by using aerodynamic styling of the opening, including top edge, sidewalls and sill and, where fitted, the sash handle.

4.4.2 ***Sash***

4.4.2.1 *Vertically sliding sash*

Vertically sliding sashes shall conform to **4.2.1** to **4.2.4** of BS 7258-1:1994.

4.4.2.2 *Horizontally sliding sash*

4.4.2.2.1 The sash panels shall be securely fitted when in position, but easily removable to allow installation of equipment and maintenance.

4.4.2.2.2 The sash panels and their runners shall be designed such that the risk of finger trapping during their operation is minimized.

4.4.2.3 *Hinged sash*

4.4.2.3.1 At least two hinges shall be fitted to each panel and these shall be corrosion resistant. If a panel is greater than 1.2 m wide, at least three hinges shall be fitted.

4.4.2.3.2 The working position of the hinged sash shall allow access and manipulation to be carried out in a safe and ergonomic manner. A vertically hinged sash shall have latches to secure it in its normal working position.

4.4.2.3.3 For the cleaning and installation of apparatus, there shall be a method for holding the hinged sash safely open at its maximum height.

4.4.3 ***Extract devices***

Extract design shall incorporate the necessary extract devices, such as fan(s), baffles, slots, profiles, etc. to ensure the filtration fume cupboard meets the requirements of clause **8**.

4.4.4 ***Flow indicator***

Flow indicators shall conform to **4.6** of BS 7258-1:1994.

4.4.5 ***Work surface***

The work surface shall be flat with a raised edge around the periphery able to contain spillages.

NOTE It may accommodate dripcups, sinks, troughs, taps and other service provisions.

4.4.6 ***Stability***

Mobile filtration fume cupboards shall be fitted with lockable front castors and shall be designed to be stable during use and movement to different locations.

4.4.7 ***Sound pressure level***

The sound pressure level of the fume cupboard in operation shall not exceed 65 dB(A), when the background noise level is less than 55 dB(A). The sound pressure levels shall be measured using a sound meter conforming with BS EN 60651:1994 or BS EN 60804:1994. For the measurement of noise emitted by the fume cupboard, the microphone shall be mounted at a distance of 1 000 mm from the face of the fume cupboard and at a height of 1 500 mm from the floor, with the fume cupboard operating as specified.

4.4.8 ***Ergonomics of filter fitting, testing and changing***

The design of the recirculatory filtration fume cupboard shall facilitate:

a) access to the filter housing and any filter test ports;

b) filter replacement without jeopardizing the integrity of the seals;

c) filter handling.

NOTE Attention is drawn to Statutory Instrument 1992 No. 2793 (Manual Handling Operations Regulations), relating to European Directive 90/269/EEC) [5].

4.4.9 ***Filter breakthrough alarm***

Where a gaseous phase filter breakthrough alarm is fitted, it shall incorporate a safe condition indicator and audible and visual alarms to signify breakthrough.

NOTE These alarms are secondary warning devices only and should only be used in support of filter system efficiency testing as described in Annex A.

4.5 Assessment of potential hazard before use (see also clause **11**)

The supplier shall draw the attention of the user to the necessity of correctly selecting, positioning, using, testing and maintaining the fume cupboard, in particular correct filter selection and subsequent monitoring.

NOTE 1 Attention is drawn to the Control of Substances Hazardous to Health (COSHH) Regulations (Statutory Instrument 1999 No. 437) [3], in particular Regulation 6 on assessment. In the case of recirculatory filtration fume cupboards, this will include:

— identification by the user of chemical pollutants released;

— volumes and likely release-rates of chemical pollutants within a specific period of time;

— Occupational Exposure Limits of chemical pollutants released;

— frequency of use;

— appropriate filter selection;

— assessment of estimated efficiency and useful service life of filters selected;

— user safety and work practices, including emergency procedures;

— siting of filtration fume cupboards.

NOTE 2 Attention is also drawn to **5.1** of BS 7258-3:1994 (which should be followed by the purchaser) and the need for adequate air change in the room where the fume cupboard is located (see also **3.3.8** of BS 7258-2:1994). Further documentation on air exchange may be found in CIBSE Guide, Vol. B *Installation and Equipment Data* [6] and DHSS Health Building Note 15 (Pathology Department) [7].

5 Materials of construction

Clause **5** of BS 7258-1:1994 shall apply with the following addition: in Table 1, poly(methylmethacrylate) (PMMA) shall be a permitted plastic material.

NOTE BS ISO 8257-1 and -2 give designation and test methods for PMMA.

6 Services

6.1 General

Clause **6.1** of BS 7258-1:1994 shall apply.

6.2 Electrical outlets

Clause **6.2** of BS 7258-1:1994 shall apply.

6.3 Lighting

Clause **6.3** of BS 7258-1:1994 shall apply.

6.4 Coupling of gas, water, electrical and drain connections

Care shall be taken to ensure that cables and hoses bringing services to a mobile recirculatory filtration fume cupboard do not present any hazard.

NOTE Users should be aware of any statutory regulations or mandatory codes of practice.

The gas supply to an outlet with a control on a mobile recirculatory filtration fume cupboard shall be fitted with an armoured hose that is securely attached to rigid fittings at both ends. It shall not be possible to disconnect the gas hose without the supply being cut off first or simultaneously at the fixed outlet.

The flexible drain on the mobile recirculatory filtration fume cupboard shall be made of a chemically resistant material. It shall be firmly attached to rigid fittings at either end. A warning notice shall be displayed to remind the user to flush out the drain hose before disconnection.

7 Filtration systems

7.1 Pre-filter

A sub-micron particulate pre-filter shall be fitted before the main filter to remove aerosols and extend the life of the main filter. This pre-filter shall be to at least class H 11 of BS EN 1822-1:1998.

7.2 Particulate filter

Where toxic powders and chemicals with sub-micron particulates are to be filtered, a filter to at least class H 13 of BS EN 1822-1 shall be fitted.

7.3 Gas and vapour phase filters

The selection of filter shall be by agreement between the supplier and the user.

NOTE Activated carbon is the most commonly used gaseous phase filter medium. Activated carbons will adsorb hydrocarbons, organic solvents and other specified chemical compounds. Chemically impregnated forms of activated carbon are used to filter specific inorganic gases and to improve the filtration efficiency for certain low boiling organic compounds.

Different filter types may be combined to provide efficient filtration of a wide range of gases and vapours. Filter media other than those based on activated carbon are employed for certain specified applications.

8 Type test procedures

8.1 General

Type tests shall be applied to one example of a production model of the fume cupboard to be tested. The type tests shall be carried out on the fume cupboard installed in accordance with the manufacturer's instructions in a test room. The test methods described in BS 7258-1:1994 and BS 7258-4:1994 shall be used for the airflow and containment testing. The test methods described in **8.4** and **8.5** of this standard shall be used for the filter testing.

NOTE 1 When the containment test with SF_6 is carried out, it is essential that a ducting adaptor, to remove the SF_6 passing through the filter and which does not affect the flowrate, is in place.

These type tests and procedures shall be performed in accordance with BS 7501:1989.

NOTE 2 Attention is drawn to recommendations for routine monitoring and maintenance by the user, set out in Annex B.

8.2 Airflow type test

The test method described in **7.1** of BS 7258-1:1994 shall apply.

8.3 Containment type test

The test method described in BS 7258-4:1994 shall apply.

8.4 Particulate filter and seal integrity type test

If installed, the particulate filter (**7.2**) and seal shall perform in accordance with Annex D of BS EN 12469:2000.

NOTE It will be necessary to remove the pre-filter to carry out this test.

8.5 Capacity type test for installed gaseous phase filter

8.5.1 *General*

Establish the retention capacity of the recirculatory filtration fume cupboard with its filters installed, using propan-2-ol as a test substance, in accordance with Annex C.

NOTE Propan-2-ol has been chosen as a test substance for its relatively low toxicity and ease of detection at low concentrations. To limit the risk from peroxidation, propan-2-ol should not be stored for long periods. Attention is also drawn to the highly flammable nature of propan-2-ol.

The test shall be carried out once and then repeated, using a second filter, or set of filters, of the same type as before, in the same cupboard. For the cupboard to comply with this standard, it shall pass both tests.

8.5.2 *Propan-2-ol test*

The filter, when challenged continuously at 800 ppm ± 50 ppm of propan-2-ol, shall maintain the concentration of propan-2-ol in the exhaust stream at below 40 ppm throughout the period of evaporation of 1 l of propan-2-ol and below 400 ppm throughout the period of evaporation of 2 l of propan-2-ol.

NOTE 800 ppm of propan-2-ol represents twice the Occupational Exposure Limit (8 h time weighted average), as defined in EH40/2000 [2].

8.6 Type test report

If the fume cupboard has been found to comply with the type tests, the manufacturer shall obtain a test report from the party that carried out the type tests for supplying to the purchaser.

The type test report shall include:

a) the make or model of the fume cupboard, and its serial number;

b) the name or trademark of the manufacturer;

c) the name and address of the organization carrying out the test;

d) the date of the test;

e) a reference to this British Standard, i.e. BS 7989:2001;

f) the normal sash opening height;

g) the results of the velocity surveys;

h) the face velocity specified by the purchaser and used in the test, and the extract volume flow rate;

i) any other test results;

j) information on limitations of use and, if relevant, on materials of construction;

k) the make and type of filter(s) fitted;

l) the gaseous phase filter performance.

8.7 Type test certification

When a fume cupboard has been tested, the manufacturer or a party acting on behalf of the manufacturer shall issue a copy of the certificate(s) to accompany the test report which shall certify that the fume cupboard has been tested in accordance with BS 7989, and that it complied with the requirements therein.

The certificate(s) shall be dated and carry a reference number(s) and shall identify clearly the type and make of the fume cupboard concerned.

9 Efficiency testing for installed gaseous phase filter

The efficiency of installed filters shall be tested using substances typical of those used in the fume cupboard under consideration.

NOTE Examples of procedures which may be used are given in Annex A.

10 Marking

10.1 The fume cupboard shall bear a plate in a permanently exposed position on which the following is clearly and indelibly marked by the manufacturer:

a) the manufacturer's name or readily identifiable mark;

b) the date and reference number of the certificate of compliance specified in **8.7**;

c) the face velocity used in the type test and/or the extract volume flowrate;

d) a serial number.

10.2 The following information shall be displayed on the front of the fume cupboard:

a) filter type(s) and date(s) of installation;

b) filter manufacturer.

10.3 A summary of filter applications shall also be displayed on the front of the fume cupboard.

11 Commissioning

The recirculatory filtration fume cupboard shall, prior to use, be commissioned using the test procedures described in Annex D.

The results of the tests shall be recorded and issued to the user.

NOTE It is recommended that some or all commissioning tests are repeated after relocation.

12 Information to be supplied with the fume cupboard

A manual to be supplied with the fume cupboard shall include the following information:

— suitability of the fume cupboard for intended use;

— limitations on the suitability of use of the fume cupboard;

— operating instructions;

— recommendations on the frequency and method(s) of monitoring of filters;

— recommendations on the changing of filters in a safe manner, including on manual handling, personal protective equipment and the disposal of used filters;

NOTE This should address the possibility of a change of use of the fume cupboard.

— filter retention capacities.

NOTE The type test certificate should be available on request.

Annex A (informative)
Gaseous phase filter tests for efficiency

A.1 General

Examples of procedures that may be used are given in **A.2**, **A.3**, **A.4** and **A.5**.

A.2 Test for filter efficiency using propan-2-ol

A.2.1 *Principle*

The rate of release of propan-2-ol vapour is calculated by evaporating a weighed quantity of propan-2-ol for a measured time. The filter challenge concentration and filter efficiency are then calculated as shown.

A.2.2 *Apparatus*

A.2.2.1 *Gas detection kit.*

A.2.2.2 *Propan-2-ol.*

A.2.2.3 *Anti-bumping granules.*

A.2.2.4 *Balance,* weighing to 0.1 g or less.

A.2.2.5 *Stopclock.*

A.2.2.6 *250 ml conical flask,* with a stopper.

A.2.2.7 *Hotplate.*

A.2.3 *Procedure*

A.2.3.1 Determine the air volume flow rate through the fume cupboard and record the value as F_a in m^3/min.

A.2.3.2 Pour about 100 ml of propan-2-ol into a preweighed, stoppered, conical flask containing a few anti-bumping granules. Record the weight of solvent added as M_1 in g.

A.2.3.3 Set up the hotplate in the fume cupboard. Switch on the fume cupboard, remove the stopper from the flask and place the flask on the hotplate.

A.2.3.4 As the propan-2-ol begins to boil, the vapour condenses on the cooler parts of the flask forming a boundary line. When the boundary reaches the top of the flask, start the stopclock.

A.2.3.5 After 60 s, take a reading of the concentration of propan-2-ol in the exhaust gas emitted by the fume cupboard using a gas detection kit with a suitable tube. Repeat the measurement at 5 min. Record the highest concentration in ppm. Convert the concentration from ppm to mg/m^3 using the formula given in **A.2.3.7** and record as C_e in mg/m^3.

A.2.3.6 When the last of the propan-2-ol has evaporated stop the clock, noting the time of the run as t in s.

A.2.3.7 Calculate the total volume V_a in m^3 of air passed through the fume cupboard during the test as follows:

$$V_a = \frac{F_a t}{60}$$

Calculate the challenge concentration in mg/m^3:

$$C_o = \frac{1\,000 M_1}{V_a}$$

Calculate the filter efficiency (%):

$$\text{Filter efficiency} = \frac{100(C_o - C_e)}{C_o}$$

Conversion from ppm to mg/m³:

$$\text{Concentration in mg/m}^3 = \frac{\text{Concentration in ppm} \times 60.1}{24}$$

NOTE 60.1 is the molecular weight of propan-2-ol, while 24 is the approximate molar volume, in litres, of a gas at normal ambient temperature and pressure.

A.3 Test for filter efficiency using sulfur dioxide

A.3.1 *Principle*

The rate of release of sulfur dioxide vapour is calculated by releasing a weighed amount of sulfur dioxide gas from a cylinder for a measured time. The filter challenge concentration and filter efficiency are then calculated as shown.

A.3.2 *Apparatus*

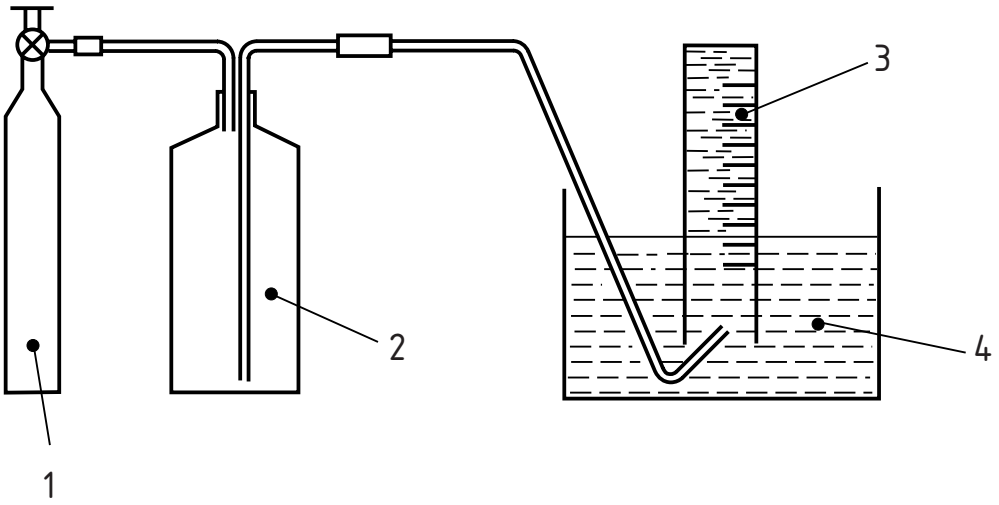
A.3.2.1 *Gas detection kit.*

A.3.2.2 *Sulfur dioxide cylinder.*

A.3.2.3 *Balance*, weighing to 0.1 g or less.

A.3.2.4 *Stopclock.*

A.3.2.5 *Apparatus for measuring sulfur dioxide release rate*, as shown in Figure A.1.



Key

1 sulfur dioxide cylinder
2 500 ml bottle
3 100 ml measuring cyclinder
4 water

Figure A.1 — Apparatus for measuring sulfur dioxide release rate

A.3.3 ***Procedure***

A.3.3.1 Determine the air volume flow rate through the fume cupboard and record the value as F_a in m^3/min.

A.3.3.2 Find the mass of the sulfur dioxide cylinder M_1 in g.

A.3.3.3 Set up the apparatus, as shown in Figure A.1, in the fume cupboard. Switch the fume cupboard on.

A.3.3.4 Open the valve on the gas cylinder very slowly. When bubbles appear in the measuring cylinder, start the stopclock. Adjust the valve so that 100 ml of gas bubbles into the measuring cylinder during a period of between 10 s and 20 s.

A.3.3.5 Without touching the valve, disconnect the cylinder from the apparatus.[1)]

A.3.3.6 After 60 s, take a reading of the concentration of sulfur dioxide in the exhaust gas emitted by the fume cupboard, using a gas detection kit with a suitable tube. Repeat the measurement at 5 min. Record the highest concentration in ppm. Convert the concentration from ppm to mg/m^3 using the formula given in **A.3.3.9** and record as C_e in mg/m^3.

A.3.3.7 Close the valve on the gas cylinder and stop the clock, noting the time of the run as t in s.

A.3.3.8 Find the mass of the sulfur dioxide cylinder M_2 in g.

[1)] An alternative to this procedure is to connect the sulfur dioxide cyclinder to a flow meter with a needle valve. The flow meter should be calibrated for sulfur dioxide. The volumetric flow rate may be set and visually monitored for the duration of the test.

A.3.3.9 Calculate the total volume V_a in m^3 of air passed through the fume cupboard during the test as follows:

$$V_a = \frac{F_a t}{60}$$

Calculate the challenge concentration in mg/m^3:

$$C_o = \frac{1000(M_1 - M_2)}{V_a}$$

Calculate the filter efficiency (%):

$$\text{Filter efficiency} = \frac{100(C_o - C_e)}{C_o}$$

Conversion from ppm to mg/m³:

$$\text{Concentration in mg/m}^3 = \frac{\text{Concentration in ppm} \times 64.1}{24}$$

NOTE 1 64.1 is the molecular weight of sulfur dioxide, while 24 is the approximate molar volume, in litres, of a gas at normal ambient temperature and pressure.

NOTE 2 The method given in clause **B.4.2** of Building Bulletin 88/1998 [1] is an acceptable alternative method.

A.4 Test for filter efficiency using ammonia

A.4.1 *Evaporation method*

A.4.1.1 *Principle*

The rate of release of ammonia vapour is calculated by evaporating a weighed quantity of 0.880 ammonia for a measured time. The filter challenge concentration and filter efficiency are then calculated as shown.

A.4.1.2 *Apparatus*

A.4.1.2.1 *Gas detection kit.*

A.4.1.2.2 *0.880 Ammonia.*

A.4.1.2.3 *Anti-bumping granules.*

A.4.1.2.4 *Balance,* weighing to 0.1 g or less.

A.4.1.2.5 *100 ml conical flask,* with a stopper.

A.4.1.2.6 *Hotplate.*

A.4.1.2.7 *Stopclock.*

A.4.1.3 *Procedure*

A.4.1.3.1 Determine the air volume flow rate through the fume cupboard and record the value as F_a in m^3/min.

A.4.1.3.2 Pour about 25 ml of 0.880 ammonia into a preweighed, stoppered, conical flask containing a few anti-bumping granules. Record the weight of solution added as M_1 in g.

A.4.1.3.3 Set up the hotplate in the fume cupboard. Switch on the fume cupboard, remove the stopper from the flask and place the flask on the hotplate.

A.4.1.3.4 As the ammonia begins to boil, the vapour will condense on the cooler parts of the flask forming a boundary line. When the boundary reaches the top of the flask, start the stopclock.

A.4.1.3.5 After 60 s, take a reading of the concentration of ammonia in the exhaust gas emitted by the fume cupboard, using a gas detection kit with a suitable tube. Repeat the measurement at 5 min. Record the highest concentration in ppm. Convert the concentration from ppm to mg/m^3 using the formula given in **A.4.1.3.7** and record as C_e in mg/m^3.

A.4.1.3.6 When the last of the ammonia has evaporated stop the clock, noting the time of the run as t in s.

A.4.1.3.7 Calculate the total volume V_a in m^3 of air passed through the fume cupboard during the test as follows:

$$V_a = \frac{F_a t}{60}$$

Calculate the challenge concentration in mg/m^3:

$$C_o = \frac{0.35 \times 1000 \times M_1}{V_a}$$

Calculate the filter efficiency (%):

$$\text{Filter efficiency} = \frac{100(C_o - C_e)}{C_o}$$

Conversion from ppm to mg/m³:

$$\text{Concentration in mg/m}^3 = \frac{\text{Concentration in ppm} \times 17.0}{24}$$

NOTE 17.0 is the molecular weight of ammonia, while 24 is the approximate molar volume, in litres, of a gas at normal ambient temperature and pressure.

A.4.2 ***Cylinder method***

A.4.2.1 *Principle*

Ammonia is released into the fume cupboard at a controlled rate for a measured time. The filter challenge concentration and filter efficiency are then calculated as shown.

A.4.2.2 *Apparatus*

A.4.2.2.1 *Gas detection kit.*

A.4.2.2.2 *Ammonia cylinder*, 99.9 % pure.

A.4.2.2.3 *Flow meter.*

A.4.2.2.4 *Top pan balance.*

A.4.2.2.5 *Stopclock.*

A.4.2.3 *Procedure*

A.4.2.3.1 Determine the air volume flow rate through the fume cupboard and record the value as F_a in m^3/min.

A.4.2.3.2 Connect the ammonia cylinder to a flow meter calibrated for ammonia gas.

A.4.2.3.3 Find the mass of the cylinder and flow meter combination on the top pan balance.

A.4.2.3.4 Switch the fume cupboard on. Set the ammonia flow rate to approximately 2 l/min and start the stopclock.

A.4.2.3.5 After 60 s, take a reading of the concentration of ammonia in the exhaust gas emitted by the fume cupboard, using a gas detection kit with a suitable tube. Repeat the measurement after 5 min. Record the highest concentration in ppm. Convert the concentration from ppm to mg/m^3 using the formula given in **A.4.2.3.7**. Record as C_e in mg/m^3.

A.4.2.3.6 After the final measurement has been made, turn off the ammonia and stop the stopclock. Note the weight loss from the ammonia cylinder M_1 in g.

A.4.2.3.7 Calculate the total volume V_a in m^3 of air passed through the fume cupboard during the test as follows:

$$V_a = \frac{F_a t}{60}$$

Calculate the challenge concentration in mg/m^3:

$$C_o = \frac{1000 M_1}{V_a}$$

Calculate the filter efficiency (%):

$$\text{Filter efficiency} = \frac{100(C_o - C_e)}{C_o}$$

Conversion from ppm to mg/m³:

$$\text{Concentration in mg/m}^3 = \frac{\text{Concentration in ppm} \times 17.0}{24}$$

NOTE 17.0 is the molecular weight of ammonia, while 24 is the approximate molar volume, in litres, of a gas at normal ambient temperature and pressure.

A.5 Test for filter efficiency using formaldehyde

A.5.1 *Principle*

The rate of release of formaldehyde vapour is calculated by evaporating a weighed quantity of 37 % formaldehyde solution for a measured time. The filter challenge concentration and filter efficiency are then calculated as shown.

A.5.2 *Apparatus*

A.5.2.1 *Gas detection kit*.

A.5.2.2 *Formaldehyde solution*, 37 %.

A.5.2.3 *Anti-bumping granules*.

A.5.2.4 *Balance*, weighing to 0.1 g or less.

A.5.2.5 *Stopclock*.

A.5.2.6 *100 ml conical flask*, with a stopper.

A.5.2.7 *Hotplate*.

A.5.3 *Procedure*

A.5.3.1 Determine the air volume flow rate through the fume cupboard and record the value as F_a in m^3/min.

A.5.3.2 Pour about 50 ml of 37 % formaldehyde solution into a preweighed, stoppered, conical flask containing a few anti-bumping granules. Record the weight of solution added as M_1 in g.

A.5.3.3 Set up the hotplate in the fume cupboard. Switch on the fume cupboard, remove the stopper from the flask and place the flask on the hotplate.

A.5.3.4 As the formaldehyde begins to boil, the vapour condenses on the cooler parts of the flask forming a boundary line. When the boundary reaches the top of the flask, start the stopclock.

A.5.3.5 After 60 s, take a reading of the concentration of formaldehyde in the exhaust gas emitted by the fume cupboard, using a gas detection kit with a suitable tube. Repeat the measurement at 5 min. Record the highest concentration in ppm. Convert the concentration from ppm to mg/m^3 using the formula given in **A.5.3.7** and record as C_e as in mg/m^3.

A.5.3.6 When the last of the formaldehyde has evaporated, stop the clock, noting the time of the run as t in s.

A.5.3.7 Calculate the total volume V_a in m^3 of air passed through the fume cupboard during the test as follows:

$$V_a = \frac{F_a t}{60}$$

Calculate the challenge concentration in mg/m^3:

$$C_o = \frac{0.37 \times 1000 \times M_1}{V_a}$$

Calculate the filter efficiency (%):

$$\text{Filter efficiency} = \frac{100(C_o - C_e)}{C_o}$$

Conversion from ppm to mg/m³:

$$\text{Concentration in mg/m}^3 = \frac{\text{Concentration in ppm} \times 30.0}{24}$$

NOTE 30.0 is the molecular weight of formaldehyde, while 24 is the approximate molar volume, in litres, of a gas at normal ambient temperature and pressure.

Annex B (informative)
Monitoring and maintenance — recommendations to the user

B.1 General

A fume cupboard should be regularly monitored and maintained to prolong its life and reduce risks to the operator. This monitoring and maintenance should include the recommendations given in **B.2**, **B.3**, **B.4**, **B.5**, **B.6**, **B.7** and **B.8**.

NOTE The frequency of testing will be determined by the risk assessment, taking into account factors such as the frequency of use, the nature of the chemicals, suppliers' recommendations and, where relevant, the age of the filter.

B.2 Visual inspection of overall condition

Visual inspection of overall condition should include, for example:

— sash mechanism;
— corrosion;
— pre-filter condition.

B.3 Inspection for electrical safety

Inspection for electrical safety should include, for example:

— portable appliance testing;
— airflow monitoring, calibration and operation;
— filter breakthrough alarms.

B.4 Airflow

Air velocities should be monitored as described in **D.1** at least once every 14 months.

B.5 Containment

It is recommended that a containment test is carried out at least once every 14 months. Where it is not practical to perform a test using SF_6 (see **8.1** and **8.3**), smoke tests, e.g. using smoke tubes, should be carried out to determine the flow movement at the face of the cupboard.

B.6 Particulate filter and seal integrity

The particulate filter, if fitted to the fume cupboard, should be monitored at least once every 14 months, using the method described in **8.4**, to demonstrate continued conformity to BS EN 12469:2000.

B.7 Gaseous phase filter monitoring

B.7.1 The filters fitted to the cupboard for normal use should be assessed for suitability and efficiency at least once every 14 months using a method such as one of those given in Annex A. If an alternative substance should be used, e.g. as dictated by the use of the fume cupboard, the filter should be challenged continuously at not less than twice the occupational exposure limit (OEL) and with a detection system having a detection limit of 10 % of the OEL or better.

NOTE 1 This is in accordance with the corresponding COSHH requirement.

NOTE 2 Typical filter efficiencies are greater than 98 %.

B.7.2 Routine monitoring of filter performance may be carried out whilst the cupboard is in normal use, by monitoring the exhaust stream with a suitable detection device, such as a stain length tube.

NOTE Testing may also be necessary following a major spillage or other incident.

B.8 Use of the fume cupboard

Assessment should be carried out regularly to determine if there has been any significant change of use and, if so, reassessment should be carried out using the criteria listed in **4.5**. The keeping of a log book may assist this.

Annex C (normative)
Gaseous phase filter test for capacity using propan-2-ol

C.1 Principle

NOTE The purpose of this test is to ensure that a recirculatory filtration fume cupboard is capable of meeting the filter capacity requirements specified in **8.5.2**.

The method involves challenging the equipment under test with propan-2-ol at a concentration of twice the occupational exposure limit (OEL) and measuring the exhaust air concentration when 1 l and 2 l of solvent have been evaporated.

C.2 Apparatus

C.2.1 *Peristaltic pump or other pumping system*, capable of delivering a flow rate of approximately 10 ml/min of propan-2-ol.

C.2.2 *Electrically heated hotplate*, of 400 W output.

C.2.3 *Heat resistant dish*, approximately 100 mm in diameter.

C.2.4 *Glass "anti-bumping" beads.*

C.2.5 *Connecting tubing.*

C.2.6 *Analytical grade propan-2-ol*, 2.5 l bottle.

C.2.7 *Electronic top pan balance*, capable of weighing to 4 000 g in 0.1 g units.

C.2.8 *Stopclock*.

C.2.9 *Detection apparatus*, capable of detecting 8 ppm of propan-2-ol.

C.3 Procedure

C.3.1 Determine the volume flow rate F_a (m^3/min) passing through the filter.

NOTE This may be determined by measuring the face velocity and multiplying this by the area of the opening.

C.3.2 Set the pump to deliver a volumetric flow of propan-2-ol according to the formula:

$$F_s = \frac{C_o F_a}{1000 S_d}$$

where

F_s is solvent flow rate in ml/min

C_o is challenge concentration in mg/m^3

F_a is air volume flow rate in m^3/min

S_d is solvent density in g/ml

e.g.

$$F_s = \frac{1998 \times 4.06}{1000 \times 0.78}$$

= 10.4 ml/min

C.3.3 Place the heat resistant shallow dish containing the glass beads onto the electrically heated hotplate centrally located on the base of the fume cupboard.

C.3.4 Using a suitable arrangement of plastic and glass tubing, connect a glass tube placed in a 2.5 l bottle of propan-2-ol through the pump to a discharge tube positioned over the centre of the dish.

C.3.5 Place the 2.5 l bottle of propan-2-ol on the top pan balance and record its weight.

C.3.6 Switch on the fume cupboard and start the pump and stopclock. Monitor the weight loss at measured time intervals to confirm that the solvent delivery rate is correct.

C.3.7 After 5 min of solvent evaporation, measure the concentration of propan-2-ol in the exhaust air C_e. Convert the challenge concentration C_0 from mg/m^3 to ppm. Calculate the filter efficiency using the equation in **3.6**.

If the filter efficiency is less than 99 %, the test should be discontinued.

C.3.8 When 780 g (1 l) of solvent has been delivered to the apparatus, measure the concentration of propan-2-ol in the exhaust air.

C.3.9 Repeat the measurement when 1 560 g (2 litres) of solvent has been delivered.

C.3.10 Stop the flow of solvent and record the time. Drain the contents of the tube system back into the source bottle. Note the total weight of solvent delivered.

C.3.11 Record the:

— date of the test;
— name of the manufacturer;
— model number or other product identifier;
— serial number;
— test solvent;
— volume flow rate (m^3/min);
— challenge concentration (mg/m^3 and ppm);
— outlet concentration at 1 l delivered (mg/m^3 and ppm);
— outlet concentration at 2 l delivered (mg/m^3 and ppm).

Annex D (normative)
Commissioning

D.1 Face velocity

Face velocities shall be measured either in accordance with **C.1** of BS 7258-1:1994, or Annex D of BS 7258-1:1994 as modified:

— for fume cupboards with a sash opening of 200 mm or less, the monitoring grid shall be modified so that there is one horizontal row of measuring points at the mid-height of the opening;

— for fume cupboards with a sash opening of 200 mm to 300 mm, the monitoring grid shall be modified so that there are two horizontal rows of measuring points located 75 mm above the lower edge of the opening and 75 mm below the upper edge of the opening.

D.2 Containment

A containment test shall be carried out. Where it is not practical to perform a test using SF_6 (see **8.1** and **8.3**), smoke tests, e.g. using smoke tubes, shall be carried out to determine the flow movement at the face of the cupboard.

D.3 Particulate filter and seal integrity

If a particulate filter is fitted, a commissioning test shall be carried out in accordance with **8.4**, to demonstrate continued conformity to BS EN 12469:2000.

D.4 Installed gaseous phase filter tests

The filters fitted to the cupboard for normal use shall be assessed for suitability and efficiency using a method such as one of those given in Annex A. If an alternative substance should be used, e.g. as dictated by the use of the fume cupboard, the filter shall be challenged continuously at not less than twice the occupational exposure limit (OEL) and with a detection system having a detection limit of 10 % of the OEL or better.

NOTE Typical filter efficiencies are greater than 98 %.

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