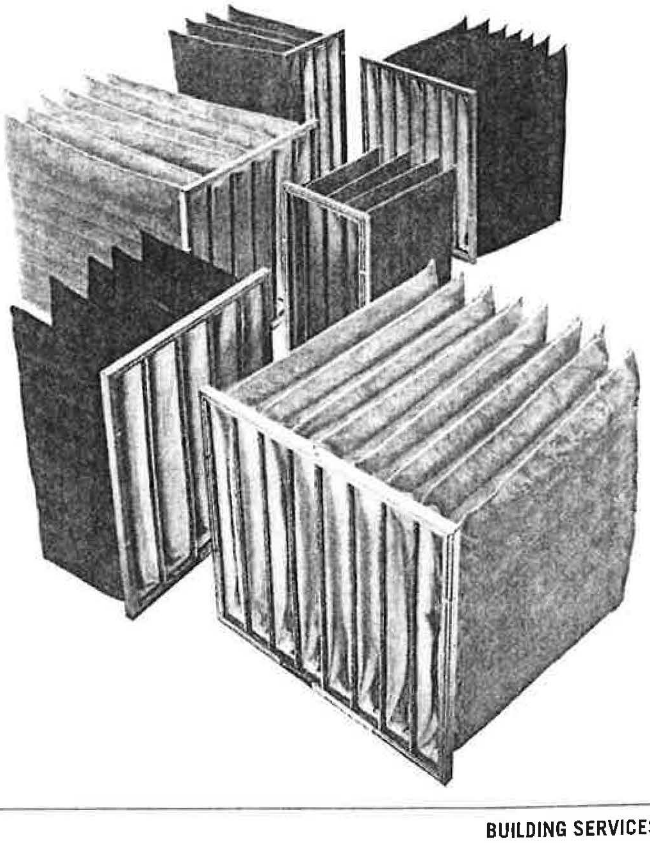
Concerns surrounding indoor air quality in commercial buildings have focused attention on the need for stringent filter performance testing. The CIBSE engineer should be aware of several test standards.

WANDER TER KUILE REPORTS

Test standards for air filtration

benchmarks for better buildings

Wander ter Kuile is technical manager with Vokes Air Filtration.



Air filters can play a major part in improving indoor air quality, their primary role being the provision of clean, fresh air for the workforce.

They are also used to protect the various components of a building's ventilation system from possible contamination.

Particulate and chemical (gaseous) contaminants are present in the outside air, processes and building fittings/ furnishings, ranging from particulates generated by construction and demolition through to oil and exhaust fumes from traffic and other combustion processes.

Other particulates include salts, sand, pollen, moulds and bacterial spores, while gaseous contaminants can include formaldehyde from furnishings and carpets and ozone from electrical equipment.

More local pollutant sources are ourselves – particulate matter generated by the shedding of skin and fibres from the clothes we wear.

Given that high levels of particulates in the working environment can affect health and, ultimately, productivity, it is clear that the installation of the correct grade and quality of filters is essential to maintain satisfactory indoor air quality.

Recirculation of indoor air

Once inside a building, air is constantly recontaminated by internally generated particulates from work processes, or the occupants and building fittings.

To maintain a clean air environment, the air is re-filtered through a separate filter installation, namely the recirculation system. Typically, such systems may operate on a 90% recirculation with 10% make up of fresh, conditioned air.

In design terms the number of air changes in an occupied space should be appropriate, based on building occupancy and function, ensuring that the filters used for recirculation are also of an appropriate grade. Compliance with standards such as the ASHRAE's *Standard 62* or *Eurovent 12/1* recommended practice will need chemical filters to remove gaseous contaminants such as nitrogen and sulphur dioxide.

The range of applications and operating conditions varies enormously. This has led to the development of an extensive range of filtration devices and systems and, in turn, to the development of standards to control the design of systems or the performance of filtration devices.

The growth of the hvac industry in the 1960s and 1970s – and the consequent need to be able to achieve comparisons and evaluations – spawned a number of filter test standards on both sides of the Atlantic, all of which were application limited, none of them addressing the problem of how to test all the various types of air filters available.

ASHRAE launched its *Standard 52-68*, which was subsequently updated to form the most widely adopted test standard in existence, ASHRAE *Standard 52-76*. The British Standards Institution (BSI) then adopted this standard as *BS 6540:1985*.

Eurovent 4/5 recommended practice used the EU classification ideas from *DIN 24185* in conjunction with ASHRAE *Standard 52-76* to produce a test standard that was widely adopted within Europe, although the basic methodology was unchanged.

ASHRAE *Standard 52.1-92* made some refinements to the original standard, but the major change relating to the EU classification system originated in Europe.

CEN adopted *BS EN 779* – the European standard for ventilation filters – in 1992, superseding all related standards.

BS EN 779 is based on *Eurovent 4/5* and ASHRAE *Standard 52.1-92*, and is the current applicable general ventilation air filter test standard. *BS EN 779* uses the same filter performance grading system to which the industry has become accustomed. The only difference is that the EU indicator has been replaced by G for coarse filters (G1-G4) and by F for fine filters (F5-F9) (table 1).

Standards under development

For the past 20 years, the characteristics of general ventilation filters have been established using the ASHRAE *Standard 52-76* test method.

However, the conventional nature of the test method is no longer sufficient to reflect the increasingly more technical approach used to describe both filters and filtration characteristics.

The significant developments in aerosol metrology have allowed individual particles to be characterised by size. The effectiveness of filters in terms of removing specific particle sizes, otherwise known as their fractional efficiency, affords a good opportunity to examine their behaviour.

Indeed, concern over indoor air quality, added to the cleanliness requirements for industrial processes, means that designers must have a sound knowledge of fractional efficiency characteristics so that they can select the appropriate type of filter.

Eurovent 4/9 recommended practice has been developed with this very need in mind, and will be issued during 1997. The objectives of the new test method are to:

- establish filter characteristics in terms of human health risk from given aerosols;
- establish filter characteristics in terms of cleanliness constraints within a process;
- define filter characteristics that will allow those established as a result of using test rigs to be transposed to in-service characteristics;
- provide a set of technical information to establish a baseline for filter ageing;
- contribute to the establishment of a quicker and simpler test method to achieve more control of the testing process;
- if required, transpose the test method directly into an on-site filter testing recommended practice (the currently proposed *Eurovent 4/10*).

Eurovent 4/9 establishes the requirement concerning the equipment needed and defines the analysis and presentation of the results. Application is limited to general ventilation filters with a face velocity of at least 0·6 m/s.

The test method for fine filters (>EU4) uses a test aerosol of either latex or dispersed oil particulates in the range 0·1-5 microns. An optical particle counter is used to size the particulate upstream and downstream of the filter under test. The counts for identical size bands can be compared and the filter effectiveness, or fractional efficiency, established for each size range.

Filters are then dust-loaded to a specified pressure loss interval, where the fractional efficiency measurements are repeated. The dust loading and fractional efficiency cycle is repeated until the recommended final pressure loss is reached.

The classification system is similar to the current *BS EN 779*, although the dust spot efficiency values are now equivalent to the fractional efficiency at 0·4 microns. Dust arrestance is only quoted for the coarse filters.

The obvious difference between this test method and the current *BS EN 779* is that atmospheric air is no longer used as the challenge, and therefore eliminates the previous major source of inconsistency.

Overall, the test method is straightforward and much quicker than the current *BS EN 779* approach, but the initial capital cost is greater.

It is important to note that CEN has committed to revising *BS EN 779* to include *Eurovent 4/9* recommended practice as the standard test method of the future. This new standard is scheduled for completion in the year 2000.

TABLE 1: PROPOSED EU FILTER CLASSIFICATIONS

This is a typical selection guide to filters which incorporates *prEN 1822* and *prEN 779 (Revision 3)* where A-D represent coarse prefilter grades and E-I represent fine filter grades. Note that the range A-I are termed general ventilation filters. Grades J-N are HEPA filter grades, and O-Q are ULPA filter grades. The letters used are a representation of products currently offered by filter manufacturers.

Classification to *prEN 779*			
Product	Grade	E_m @ 0·4 µm, A_m = average arrestance	
A	GI	$A_m < 65$	
B	G2	$65 \leq A_m < 80$	
C	G3	$80 \leq A_m < 90$	
D	G4	$90 \leq A_m$	
E	F5	$40 \leq E_m < 60$	
F	F6	$60 \leq E_m < 80$	
G	F7	$80 \leq E_m < 90$	
H	F8	$90 \leq E_m < 95$	
I	F9	$95 \leq E_m$	
Classification to *prEN 1822*			
Product	Grade	E_m @ 0·3 µm	E_m @ MPPS
J	H10	>95	>85
K	H11	>98	>95
L	H12	>99·99	>99·5
M	H13	>99·997	>99·95
N	H14	>99·999	>99·995
Classification to *prEN 1822*			
Product	Grade	E_m @ 0·12 µm	E_m @ MPPS
O	U15	>99.9995	>99·9995
P	U16	>99.99995	>99.99995
Q	U17	>99.999995	>99.999995

Note **MPPS: most penetrating particle size**

Testing HEPA and ULPA filters

prEN 1822 is the European test standard for HEPA and ULPA filters that describes filter testing by way of automatic scanning.

prEN 1822 has been under preparation since 1994. It is basically a duplication of the German *DIN 24193*, and will supersede all relevant national standards currently in use.

It is a new test method that has been developed without the use of working standards, other than *DIN 24183:1995*, which has been drafted in parallel.

The standard is primarily for use with terminal HEPA filters (but is also applicable to in-duct HEPA filters), and uses concentrations of natural and oil-based aerosols.

As with *Eurovent 4/9* or the proposed revision of *BS EN 779*, this standard is based on particle counting with light scattering particle counters.

Over a number of years there has been an increased use of particle detectors that count individual particles to scan the filters. In most cases the instrument is a laser light source particle counter that also sizes the individual particles. In some cases condensation nuclei counters are used.

Conversion of this standard to a full European norm is not expected until late 1997.

Filter performance and iaq

Current practices relating to the design of ventilation systems are being reviewed to take account of the requirements for indoor air quality. For instance, the ASHRAE has recently produced a draft revision of its *Standard 62: Ventilation for acceptable indoor air quality.*

Similarly, Working Group 7 of CEN Technical Committee 156 is preparing a standard on ventilation systems discussing the requirements of indoor air quality on filter selection.

These standards will be comprehensive working documents for the design of systems for the control of both particulate and gas phase contaminants. *Eurovent 12/1* recommended practice also addresses these issues.

For ventilation filters concerned with particulate removal, current practice recommends the use of F7 (EU7) grade primary inlet filters, with second stage F8/9 (EU8/9) grade filters if needed.

If large particulates are present in the intake air, prefilters of G3/4 (EU3/4) can be installed upstream of the primary filters. Components in air exhaust systems can also be protected by the use of F7 (EU7) grade filters.

HEPA filters may be specified to remove pollens, bacteria and even viruses. In Europe they are graded in a similar way to general ventilation filters. *prEN 1822* for HEPA and ULPA filters classifies the performance by efficiency against 0·3 or 0·12 micron particles.

The grading ranges from 95% at 0·3 microns (EU10) to 99·999995 at 0·12 microns (EU17). These high efficiency filters operate at lower face velocities than are used in most ventilation systems, with cost implications in terms of installation and maintenance.

Gas-phase filtration of odours and other gases for good indoor air quality forms part of the standards under development. The next stage will be the development of practical filter testing standards specifically for gaseous filters.