WHITE PAPER

HVAC Air Filter Selection:

No compromise: Healthy air quality at the lowest operating cost

From: **Camfil Farr**
Date: **October 2012**

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Indoor Air Quality (IAQ) and Energy Efficiency *are two compelling issues for engineers who design and operate large public and commercial buildings in the UK and across the rest of Europe. Air filters combine these two issues.*

Comfort Air Filters are used in heating ventilating and air conditioning (HVAC) systems. It is important that the right HVAC filters are selected to deliver the required Indoor Air Quality. These filters clean the air and make it fit for building occupants to inhale without risk to health. The filters must use minimal energy.

Indoor air quality cleanliness is determined by measuring levels of pollutants in the air. These pollutants can originate from a source outside or inside the building.

The level of risk attached to each pollutant is based on the concentration and type of pollutant. The World Health Organisation (WHO) and other health and safety authorities publish reference levels for pollutants that give cause for concern.

Airborne pollution can be solid in form such as PM2.5 or PM10 fine combustion particles or gas phase such as O3 (Ozone), NOx, SOx, HCHO (form), C6H6 (benzene VOC), CO, CO2.
This table shows the range of pollutants covered in EN13779:2007 for ODA levels.

Description of air quality	Concentration levels*					Category of outdoor air
	CO_2 (ppm)	CO (mg/m^3)	NO_2 ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	
Rural areas with no significant sources	350	< 1	5 – 35	< 5	< 20	ODA 1
Smaller towns	400	1 – 3	15 – 40	5 – 15	10 – 30	ODA 2
City centres	450	2 – 6	30 – 80	10 – 50	20 – 50	ODA 3

***For most European cities you can check the current, daily concentration levels online over the Internet!**

The greatest risk to public health is currently held to be the toxic PM2.5 fine combustion particles because, when inhaled, they make deep penetration into the lungs. They can enter the bloodstream and caused increased levels of respiratory and heart disease. It is therefore important to select air filters with the required particulate efficiency to remove fine combustion particles from the airstream.

For gas phase pollutants at hazardous levels gas/molecular filters can be used but these filters in turn need to be protected by minimum F7 class particle filters. Gas filters are often used to remove unpleasant odours so some air quality issues can be subjective such as smell and personal perception plays its part.

EN13779:2007 table of filter classes are redefined by the new EN779:2012 this year and F5 and F6 and now medium class M5 and M6 for Outdoor Air Quality (ODA) levels.

Filter Recommendations according to EN 13779

Outdoor Air Quality		IAQ Indoor Air Quality			
		IDA 1 (High)	IDA 2 (Medium)	IDA 3 (Moderate)	IDA 4 (Low)
Pollution level ↓	ODA 1	F9	F8	F7	F5
	ODA 2	F7 + F9	F6 + F8	F5 + F7	F5 + F6
	ODA 3	F7 + GF + F9	F7 + GF + F9	F5 + F7	F5 + F6

Table refering to appendix "A3. Use of Air Filters" in The European Standard EN 13779:2007.

The European standard EN13779:2007 recommends the right class of particle filter that needs to be used and these are generally in the F7 to F9 class as will be redefined by the updated filter test standard EN779:2012. Shown in table 1.

A quick assessment of the filters available from manufacturers in the F7 to F9 class range reveals a short list of three performance needs.

3 Performance Needs
1. Consistent effective particulate efficiency (stopping dust)
2. Low cost to use (low Life Cycle Cost - short payback time)
3. Size and fitting (compatible with system, well sealed)

Table 2. Filter classifications as defined in new updated EN779:2012

Classification of air filters[1]

Group	Class	Final pressure drop (test) Pa	Average arrestance (Am) of synthetic dust %	Average efficiency (Em) for 0.4 µm particles %	Minimum efficiency[2] for 0.4 µm particles %
Coarse	G1	250	50 ≤ Am < 65	-	-
	G2	250	65 ≤ Am < 80	-	-
	G3	250	80 ≤ Am < 90	-	-
	G4	250	90 ≤ Am	-	-
Medium	M5	450	-	40 ≤ Em < 60	-
	M6	450	-	60 ≤ Em < 80	-
Fine	F7	450	-	80 ≤ Em < 90	35
	F8	450	-	90 ≤ Em < 95	55
	F9	450	-	95 ≤ Em	70

NOTE

[1] The characteristics of atmospheric dust vary widely in comparison with those of the synthetic loading dust used in the tests. Because of this, the test results do not provide a basis for predicting either operational performance or service life. Loss of media charge or shedding of particles or fibres can also adversely affect efficiency.

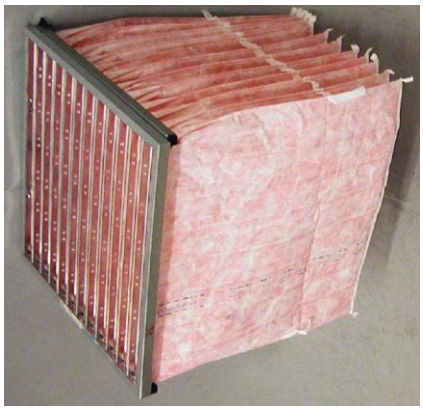
[2] Minimum efficiency is the lowest of any of the following three values: initial efficiency, discharged efficiency or efficiency throughout the test's loading procedure.

The most important new development is the mandatory minimum efficiency (ME) for the important F7 to F9 filter classes. For F7 there is a minimum efficiency of 35%. Any filter that falls below 35% ME cannot be classed as F7. There are two main types of air filter media on the market synthetic media and micro-fibre glass media. Low cost synthetic filter media relies on the electrostatic charge in the media to deliver particulate efficiency. The problem is that over the first few weeks of its working life this electro-static charge is almost completely lost causing a catastrophic loss of performance. It is thought that airborne fine combustion particles play a key role in the discharging process of the electro-static charge from synthetic media because of the conductive composition of these particles.

For example an initial efficiency of 70% can go down to as low as 10% minimum efficiency (ME) 7 TIMES LOWER. This is clearly unacceptable for a filter that may have a working life of a year or longer. Hence the need for a minimum efficiency (ME) of 35% for synthetic media filters.

This problem does not occur with micro-fibre glass media. Camfil Hi-Flo filters are manufactured from this (MFG) media and have a consistent high particulate efficiency throughout their working life typically 55 to 60% in real working conditions. For these filters a ME of 50% at F7 would have been better.

Some manufacturers will be tempted to reduce their specification of glass media filters down to 35% ME because they can cut filter costs and still meet the requirements of EN779:2011. The reduced operating pressure drop will reduce the energy required to push air through the filter. This however would be a false economy if Indoor Air Quality was compromised and the filters were up to 40% less effective. So use a good F7 class filter.



Award winning F7 Low Energy Bag Filter

2. Low cost to use (low Life Cycle Cost, short payback time)

Energy use is important to consider when selecting air filters. Typically a filter will use between 10 and 20 times its initial cost in energy over its working life. Clearly it makes sense to consider using the right Low Energy Air Filters. Life Cycle Costing (LCC) is a useful tool that allows comparison between different filter solutions.

LCC compares all the cost elements of running a filter system. The filter cost + the energy cost+ the maintenance cost + the installation cost + disposal cost + other system costs.

The filter option that gives the lowest Life Cycle Cost is the award winning M7 F7 bag filter. This filter has the unique feature of being able to give good F7 single stage performance or to be used as a two stage system to give F9 overall efficiency. It does require 700mm plenum length per stage

3. Size and fitting (compatible with system, well sealed)

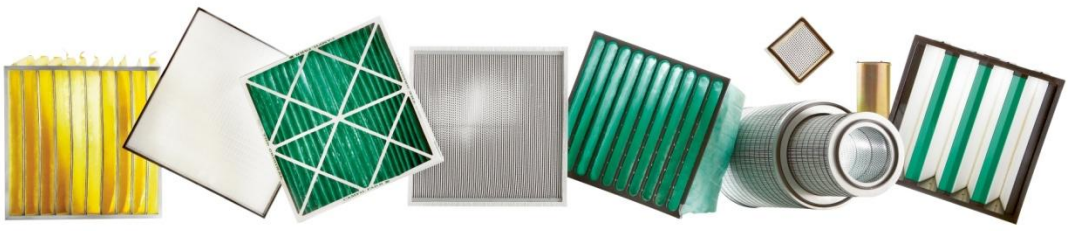
Space considerations in Air Handling Unit design should not prevent the use of Low Energy Air Filters. At the design stage Air Handling Units can be configured to allow the required 700mm plenum length for the filters. This space can have a double function so that access can be allowed downstream for coil cleaning. Front withdrawal mounting frames should be used to ensure a well sealed filter system.

The combination of IAQ with high particulate efficiency and Energy Efficiency in HVAC Comfort Air Filtration will give optimised Low Energy Air Filter performance. A total cost value for money relationship is given by:

Total Filter Life Cycle Cost = Value for money IAQ factor

% particulate efficiency

As the performance of HVAC filters comes under ever increasing scrutiny this relationship and measure of performance will become ever more important.



About EN779 : 2012

The new standard forces air filters to perform better

At Camfil, we have always put every effort into improving indoor environments. Thus, no one is more pleased than us that, from 2012, a new air filter standard imposes tougher requirements. Unfortunately, the requirements are not as tough as we would have liked. For example, our Hi-Flo XLT7 (a class F7 filter) has a minimum filtration efficiency of 54 percent. For an F7 filter, the new standard requires no more than 35 percent. However, that does not meet the quality levels we have set for ourselves. Indeed, our development of the market's most efficient, energy optimised filters will continue.

What does EN 779:2012 do?

The new European standard for air filters (EN779:2012) comes into force in 2012. Its purpose is to classify air filters based on their lowest filtration efficiency. This latter is also referred to as minimum efficiency (ME). The standard is an initiative that we welcome and a step towards better indoor environments. The new standard will help to eradicate a number of problems. One of these is presented by electrostatic charged synthetic filters. While such filters can demonstrate good initial filtration efficiency, they discharge extremely rapidly. This entails a considerable deterioration in their air cleaning ability.

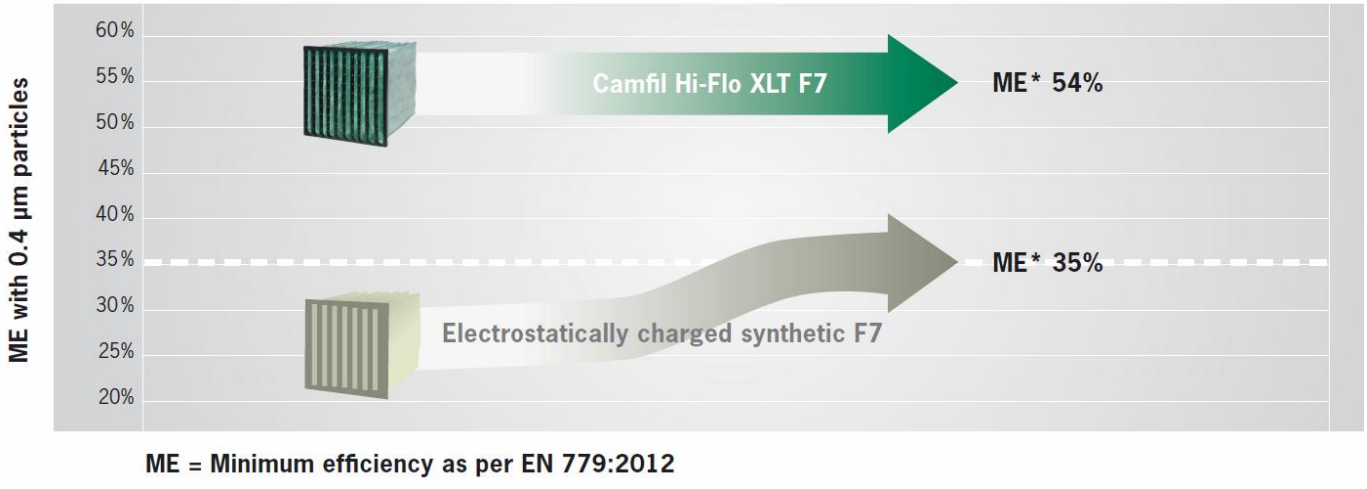
Unfortunately, one result of the foregoing is that far too many European properties are now using F7 class filters that have ME values of between 5 and 10 percent. This means that as much as 90 to 95 percent of the contaminants in the outdoor air find their way into buildings and pollute the indoor environment.

By basing classification on ME value, the new standard will force these filters out of the market. At the same time, it will contribute to the development of synthetic filter materials offering considerably higher particle separation. Regrettably, the price for this will include higher pressure drops and increased energy consumption.

Not all filters are the same -even when they are in the same class!

The problem with the new classification is that, although the worst filters will vanish from the market, there is room for good filters to be made worse. Although energy savings can be achieved by having the lowest possible pressure drop, such development could be retrograde. For example, with 0.4 µm particles, our Hi-Flo XLT7 (class F7) filter has an ME value of a full 54 percent. However, for classification as an F7 filter, the standard requires no more than 35 percent.

As we have already made clear, we will not be lowering the efficiency of our Hi-Flo filters. That would result in an approximately 40 percent worsening of air quality. However, there is a risk that other manufacturers will not think the same way. Instead, they may see the standard as an opportunity to reduce pressure drop and, thereby, energy consumption. This will result in poorer air quality.



Keep updated on Indoor Air Quality at www.keepthecityout.co.uk

See indoor air quality and the effects on energy consumption, health and productivity. http://www.keepthecityout.co.uk/2012/08/indoor-air-quality-and-the-effect-on-energy-consumption-health-and-productivity/

About Camfil Farr

Camfil Ltd is the UK subsidiary of Camfil AB which trades as Camfil Farr or the Camfil Farr Group. Camfil Farr is a world leader in the development and production of air filters and clean air solutions. Camfil Farr is also one of the most global air filtration specialists in the world with 23 production units and research and development centres in four countries in the Americas, Europe and the Asia-Pacific region.

Camfil Farr, headquartered in Stockholm, Sweden, has approximately 3,350 employees and sales in the region of SEK 4.6 billion (c. £440 million). International markets account for almost 90% of sales. The company's business is to provide customers with sustainable best-in class air filtration products and services within four main segments: Comfort Air; Clean Processes; Power Systems; and Safety and Protection.

With 49 years of experience in air filtration products and solutions, Camfil Farr delivers value to customers all over the world while contributing to something essential to everyone – clean air for health, wellbeing and performance.

See www.lowenergyairfilter.co.uk and www.keepthecityout.co.uk and www.camfilfarr.co.uk

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