EN-ISO 16890:2016

New global standard links filtration performance to outdoor air pollution

The International Organization for Standardization (ISO) has recently developed and introduced a new standard for the testing and classification of air filters titled "EN-ISO 16890:2016 – Air filters for general ventilation". This standard has been developed under the Vienna-agreement between CEN and ISO, therefore this new standard will replace the current filter test standard EN779:2012 after a few years, and in a longer perspective, it can potentially also replace the present North American test standard ASHRAE 52.2.

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Compared to EN779:2012 and ASHRAE 52.2, EN-ISO 16890 brings several improvements to filter testing and classification, of which the most noticeable is the link between filter performance and outdoor air pollution.

A standard that is air quality-oriented

Until now filtration performance has been determined by a filter's particle removal efficiency on specific particle sizes. This has made sense from a technical and scientific perspective because the particle removal efficiency has given laboratory technicians and engineers detailed and relevant information about the technical performance of air filter products. However, this performance data has provided little guidance to the end user in the process to select filters.

Most filters that are tested, classified and compared with general air filter standards are used in the ventilation systems of public, commercial and residential buildings, including offices, schools, hospitals and multistory apartment complexes. In general, the customers purchasing these filters are not experts in ventilation or filtration, although they usually have a basic level of environmental awareness. Like any person, they are concerned about the surrounding environmental conditions and their potential impact on health and wellbeing. In this respect, air pollution is one of the more important factors.

Today, air pollution is a hot topic anywhere in the world and especially poor air quality in densely populated urban centers. Many people have become familiar with the particle fractions in outdoor air pollution, designated PM_1, $PM_{2.5}$ and PM_{10}, while others have at least heard of these measurements for harmful airborne particulate matter.

On a regular basis around the globe, people are hearing news or reports that the air quality is so poor in their local environment that the limit values for several of these pollution measurements are being exceeded. It is known that traffic and industrial processes are major contributors to air pollution in urban environments and that much of the pollution is in the submicron range and highly respirable. These pollution concerns, which are serious and real, require solutions to mitigate the health risks and exposure.

Ambient air quality is normally improved by addressing the pollution source directly. These measures are usually difficult to implement and require long-term improvements driven by stricter legislation and regulations for controlling emissions from industry and transportation.

In contrast, indoor air quality (IAQ), in relative terms, is easy to take care of and improve when building ventilation systems are equipped with effective air filters. Given that modern-day citizens spend more than 90% of their time indoors, their exposure to air pollution can be considerably reduced by improving IAQ.

Until now, it has been difficult for end users to choose the right filtration solution for a given environmental situation. The new global standard for general filtration can now solve this because ISO 16890 directly links the outdoor air pollution measurements PM_1, $PM_{2.5}$ and PM_{10} to the filtration removal efficiency of air filters for general ventilation. Each filter tested according to ISO 16890 is now assigned a removal efficiency rating for these three particle fractions.

The particle removal efficiency is stated in percent [%] in relation to the PM_x particle fraction that is removed. In simple terms, this means that a filter rated ePM_1[60%] removes 60% or more of the particulates in the PM_1 range. In other words, the filter provides 60% protection against PM_1 air pollution.

With the new classification values, it will now be much easier for air filter customers to decide the level of protection they want in relation to outdoor air pollution levels and their expectations for indoor air quality. Let us now briefly examine how ISO 16890 is built up and how the new standard basically differs from ASHRAE 52.2 and EN779:2012.

EN-ISO 16890:2016 in brief

The ISO 16890 standard consists of four different parts:

1. Technical specifications, requirements and the classification system based upon matter efficiency (ePM).
2. Measurement of fractional efficiency and airflow resistance.
3. Determination of the gravimetric efficiency and airflow resistance versus the mass of the test dust captured.
4. Conditioning method to determine the minimum fractional test efficiency.

If you are interested in the full details, I recommend reading the entire standard. This article only aims to explain ISO 16890's basic differences and its advantages over existing or prior filter standards. Another goal of this article is to shed some light on how ePM efficiencies are calculated and used.

ISO 16890 in practice

In practice, the filter test is performed in five steps:

1. Efficiency and pressure drop measurement
2. Discharging conditioning
3. Post-discharging efficiency measurement
4. Dust holding and arrestance measurements
5. Calculation and ePM classification

Compared to ASHRAE 52.2 and EN779:2012, the main differences of the ISO 16890 testing process are as follows:

Efficiency measurement

When measuring efficiency, the tested particle range is broader than for EN779:2012 – from 0.3 µm to 10 µm, instead of from 0.3 µm to 3 µm – and the entire span is used for classification. This differs from EN779:2012, where the reported removal efficiency is calculated solely on one particle size (0.4 µm). This is like what is used today in ASHRAE 52.2. The advantage of using a wider particle span is that a broader range of filters can be given more relevant classification values.

Electrostatic discharge

The second big difference is the conditioning method for the filter. Conditioning serves to remove the electrostatic filtration effect in the filter. It is known that this filtration effect diminishes with time as the electrostatic charge is neutralized during use. Several methods have proven to be effective to simulate the drop in electrostatic effect.

EN779:2012 uses the method of soaking the filter media in isopropanol and then simply hanging it to dry before testing it again. While this is a very effective discharging method, it has the disadvantage of potentially damaging the fiber structure in the filter and it consequently affects other active filtration mechanisms.

ASHRAE 52.2 uses solid particles of potassium chloride (KCl) to discharge the material. This is a mild form of discharging and it is hard, even after long process times in the laboratory, to achieve full discharge. The advantage of this method is that it does not affect other important filtration mechanisms in the filter.

In the ISO 16890 standard, the isopropanol method has been chosen for its good discharging properties. However, the method has been developed and is now based on saturated gas-phase discharging. Although this method is slower and more complicated to conduct in the laboratory than a wet process, it discharges the filter 100% without affecting the fiber structure of the filter.

Dust loading

Compared to ASHRAE 52.2 and EN779:2012, the test dust in EN-ISO 16890 has been changed from the test dust in ASHRAE 52.2 to a finer test dust designated as L2 in EN-ISO 15957. This finer dust will take longer time to load in the laboratory, but it will simulate real-life conditions more accurately than the currently used method.

Classification and calculation

The main difference between EN-ISO 16890 and EN779:2012 and ASHRAE 52.2 becomes apparent in the final classification and calculation step. Through calculation, the measured test results are converted and related to the known outdoor air pollution measurements PM_1, $PM_{2.5}$ and PM_{10}.

PM is a mass measure expressed in [µg/m³] and the measurements in ISO 16890 are particle counts from an optical particle counter that are stated in numbers [#].

The values from the measurements need to be recalculated to become relevant and indicate their ability to remove outdoor air pollution. This is done with weighted efficiency calculations of the laboratory measurements that are related to a global standardized particle distribution from urban and rural environments. This particle distribution is bimodal, as can be seen in the two illustrations. In **figure** below, the urban curve shows that a larger portion of the particles from an urban environment is submicron, compared to the particle sizes in the rural curve.

As different filters are used for different purposes, the urban curve is used for weighted calculations of PM_1 and $PM_{2.5}$ efficiencies. It is assumed that fine filters will be used in urban areas where submicron particles represent a clear majority of the air pollutants. The rural distribution curve is used for coarse filters that target large particles for removal. This gives the consumer a relevant value for a filter's effectiveness for a specific filtration purpose (please refer to ISO 16890-1 for detailed information on weighting calculations).

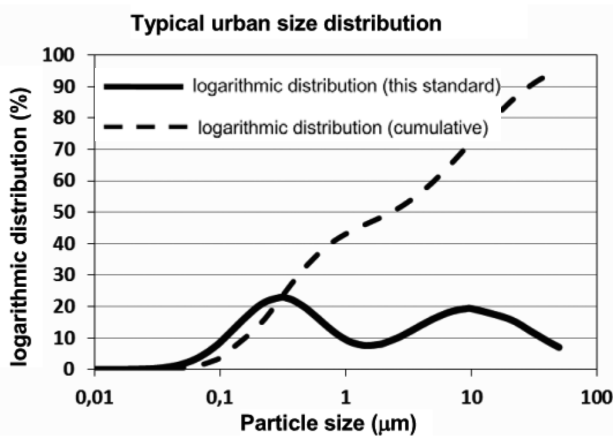
Once the efficiency data is weighted in accordance with the above distribution curves, the average efficiency is calculated. The average is calculated between the virgin filter efficiency and the conditioned discharged efficiency (also called the minimum efficiency of the filter).

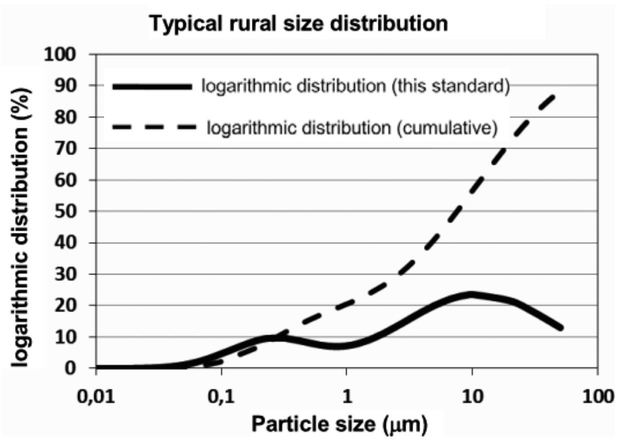
The efficiency calculation is made for three particle spans:

Particle span [µm]	ePM representation	Used particle size distribution
0.3–1.0	ePM_1	Urban
0.3–2.5	$ePM_{2.5}$	Urban
0.3–10	ePM_{10}	Rural

The average and minimum efficiency values are both used to classify a product. To classify a filter as an ePM_1 or $ePM_{2.5}$ product, the minimum efficiency must be above 50%. If the minimum efficiency is above 50%, the reported efficiency value will be the average efficiency value between the minimum and virgin efficiency. For ePM_{10}, there is no threshold demand for minimum efficiency, but the average efficiency has to stay above 50%. If a filter's efficiency drops below 50% on ePM_{10}, it will be classified as a "coarse" filter and only dust arrestance in percent [%] is reported:

Group designation	Requirement			Class reporting value
	$ePM_{1, min}$	$ePM_{2,5, min}$	ePM_{10}	
ISO Coarse	—	—	< 50%	initial grav. arrestance
ISO ePM_{10}	—	—	≥ 50%	ePM_{10}
ISO $ePM_{2,5}$	—	≥ 50%	—	$ePM_{2,5}$
ISO ePM_1	≥ 50%	—	—	ePM_1





Summary

The global applicability of EN-ISO 16890 will be of great significance in the years to come. The new standard marks the first time in history that the air filtration industry has agreed on a global testing and classification standard that makes it easier for customers to select the right filter for the right application. In addition, the standard includes a new efficiency rating for PM_1 – the smallest and most harmful airborne particles – to acknowledge that air filters have a positive influence on air quality and human health.

Although ISO 16890 for general air filters is technically demanding, it brings a wealth of value to end customers. For the first time, filtration efficiency, or filtration protection, can be related directly to common air pollution data.

When choosing the filter solution, the end user should ask a few questions: What is my local air pollution situation? Am I situated in a rural or urban environment? Am I affected by pollution emissions from nearby industries? What level of pollution protection do I want?

The filtration solution may look different, depending on the local situation and the desired minimum indoor air quality. In urban areas, where the majority of the particulate pollution will be submicron, the choice will primarily stand between filters in the PM_1 category. In more rural settings, a higher-grade $PM_{2.5}$ filter may be sufficient as the final filter. PM_{10} and coarse filters will be suitable for dusty environments, or as pre-filters in dual-stage installations.

Whatever the final choice, end users will now have a much clearer idea of what they can expect from the chosen filter solution. ■

Literature

EN-ISO16890:2016 Air filters for general ventilation – Part 1: Technical specifications, requirements and classification system based upon particulate matter efficiency (ePM).

Part 2: Measurement of fractional efficiency and air flow resistance (ISO 16890-2:2016, IDT)

Part 3: Determination of the gravimetric efficiency and the air flow resistance versus the mass of test dust captured.

Part 4: Conditioning method to determine the minimum fractional test efficiency.

EN 779:2012 Particulate air filters for general ventilation - Determination of the filtration performance.

ANSI-ASHRAE Standard 52.2-2012 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.