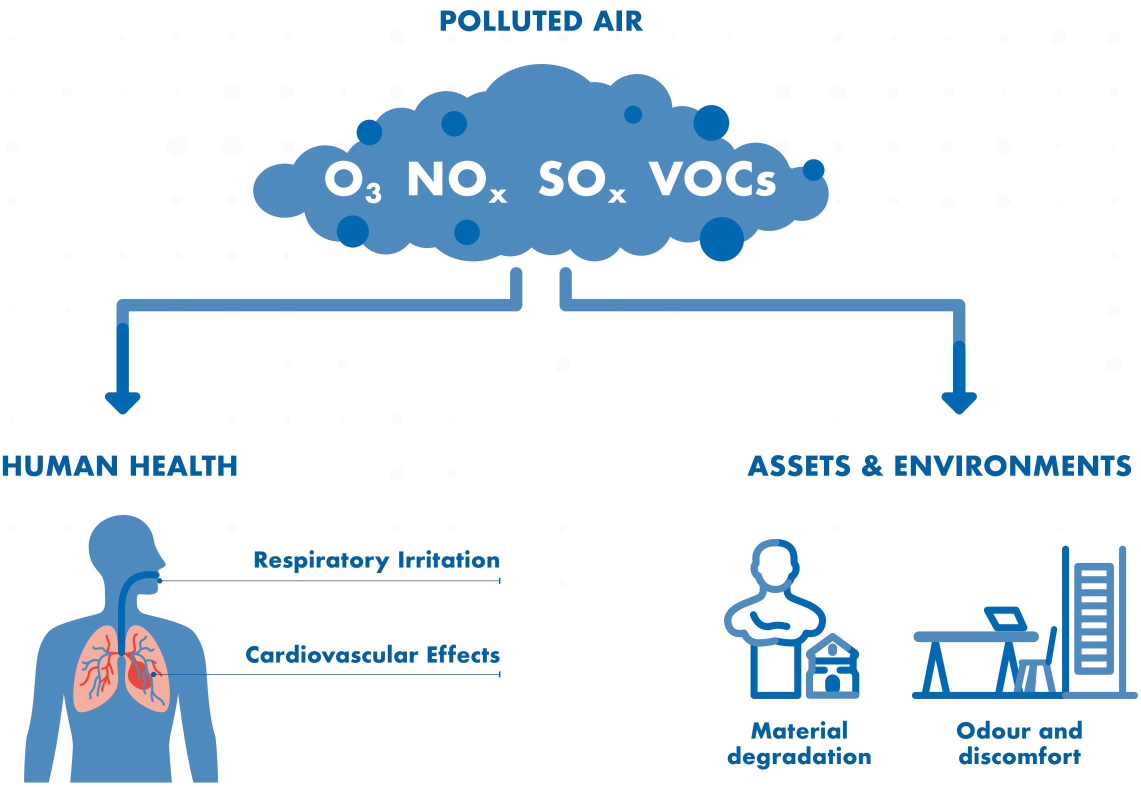
Selecting the Right Molecular Filter

A PRACTICAL GUIDE BASED ON ISO 10121-3

Why Molecular Filtration Matters

Outdoor air pollution does not only consist of particles. Many harmful contaminants are gases and vapours that cannot be removed by traditional particulate filters.

Typical gaseous pollutants include:



For this reason, many ventilation systems today require molecular filtration, especially in:

To simplify the specification of molecular filters, the ISO 10121 standard series provides internationally harmonised test methods and performance classification for gas-phase filtration.

What ISO 10121-3 Introduces

The newest part of the standard, **ISO 10121-3**, introduces something that was previously missing.

A classification system for molecular filters used in general ventilation

While earlier parts of the ISO 10121 series define **laboratory test procedures,** ISO 10121-3 provides a practical way to **classify and compare molecular filtration products.**

ISO 10121-1/2 — Test Procedures → **ISO 10121-3** — Performance Classification

In simple terms:	This enables:
ISO 10121-3 plays a role similar to **ISO 16890** for particle filtration. It allows filters to be classified according to their performance against **representative gaseous pollutants commonly found in outdoor air.**	- easier comparison between products - clearer specifications in HVAC projects - more reliable filter selection Instead of generic descriptions such as **"activated carbon filter"**, designers can now specify **a defined performance class.**

Reference Pollutants Used in ISO 10121-3

The classification system uses representative gases to reflect the most common pollution sources affecting supply air.

Typical reference gases include:

Ozone (O_3)
A strong oxidant generated by photochemical reactions in the atmosphere.

Nitrogen Dioxide (NO_2)
A traffic-related pollutant associated with combustion engines and urban smog.

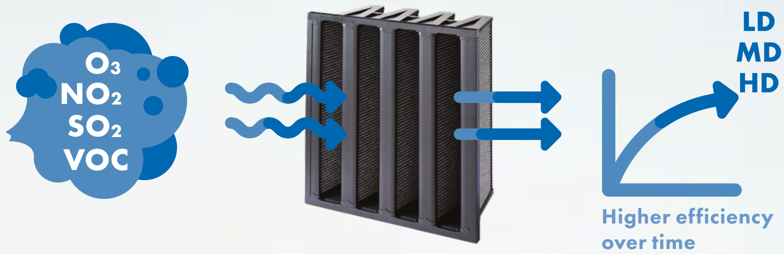
Sulphur Dioxide (SO_2)
Mainly associated with industrial emissions and fossil fuel combustion.

Toluene (VOC representative)
A commonly used marker for volatile organic compounds (VOCs).

These gases represent **different adsorption behaviours,** ensuring that the classification **reflects real-world filtration performance.**

How the Classification Works

ISO 10121-3 evaluates filters by measuring **gas removal efficiency** over time when exposed to specific gaseous pollutants.



During the test:	The resulting performance is then translated into a classification based on two key parameters:
1. A controlled gas concentration is introduced into a laboratory test rig. 2. The filter removes the pollutant through **adsorption or chemisorption.** 3. The removal efficiency is measured as the filter progressively loads with contaminants.	- average removal efficiency - filter lifetime Together, these parameters provide a realistic indication of how well a filter performs and **how long it can maintain that performance.**

Lifetime Classification: LD, MD and HD

ISO 10121-3 defines three **lifetime categories** that describe the expected operational durability of molecular filters under defined test conditions.

Lifetime class	Meaning	Typical applications
LD – Low Duty	Shorter service life under pollutant exposure	Low pollution environments
MD – Medium Duty	Balanced performance and adsorption capacity, four times higher than LD	Urban environments
HD – Heavy Duty	Extended lifetime and adsorption capacity, sixteen times higher than LD	Highly polluted urban or industrial environments
Filters having a lifetime below LD are classified vLD (very Light Duty)		

The lifetime class indicates how **long the filter can maintain effective gas-removal performance** before reaching breakthrough. In practical terms, this depends on several factors:

Quantity of adsorbent media and adsorption capacity of the material	Contact time between contaminates and media	Filter geometry and airflow distribution

Filters with **higher duty classes typically contain larger volumes of adsorbent media**, enabling longer service life and higher gas removal capacity.

Average Gas Removal Efficiency

In addition to lifetime classification, ISO 10121-3 also defines **average removal efficiency for the tested pollutants.**

This parameter represents the **mean efficiency of the filter during the defined test period,** rather than only the initial performance.

Average efficiency provides a more realistic indication of **actual filtration performance throughout the service life of the filter.**

It reflects:

Adsorption kinetics of the media	Interaction between pollutant molecules and the adsorbent surface	Progressive saturation of the filter

This approach avoids misleading comparisons based solely on **initial efficiency,** which may decline rapidly if the filter has limited adsorption capacity.

Practical Filter Selection Using ISO 10121-3

Selecting the correct molecular filter typically follows three steps.

1 Identify the Relevant Pollutants

Determine which gaseous pollutants are present in the outdoor air.

Useful sources include:

- National air-quality monitoring networks
- Environmental agencies
- Local pollution studies
- Airport or urban monitoring stations

Typical examples*:

Urban Areas	Industrial Zones	Airports (High Peaks)
NOx 40%	SOx 35%	NOx 45%
O_3 30%	VOCs 30%	O_3 25%
VOCs 20%	NOx 25%	VOCs 20%
SOx 10%	O_3 10%	SOx 10%

2 Define the Target Air Quality

Determine the acceptable indoor concentration based on:

- Health guidelines
- Local or international standards
- Odour control objectives

Some environments require **very low gas concentrations**, especially:

- Healthcare Environments
- Museums and Archives

3 Define the Target Air Quality

Using the classification system, engineers can select a molecular filter capable of removing the **specific pollutants of concern with the required lifetime performance.**

This ensures that:

- The filtration system targets the correct gases
- Performance expectations are clearly defined
- Filtration solutions are comparable between suppliers

* These percentages are not absolute atmospheric values but indicate relative importance for filtration design and vary with geography, season (especially ozone), and proximity to emission source

traffic	photochemical	organic compounds	industrial/combustion

Beyond the Standard: Engineering the Right Solution

While ISO 10121-3 provides a valuable classification framework, effective molecular filtration also depends on **system design.**

Important engineering factors include:

- Airflow velocity and contact time
- Filter depth and adsorbent volume
- Upstream particulate filtration
- Humidity and temperature conditions
- Maintenance and replacement strategy

For optimal performance, molecular filtration should always be integrated into **a complete air-quality engineering approach.**

The Future of Air Quality Engineering

As awareness of air pollution increases, ventilation systems must address **both particulate and gaseous contaminants.**

ISO 16890		ISO 10121-3
For particles	+	For gases

creates a more comprehensive framework for designing **clean air solutions.**
This approach helps building designers, engineers and operators deliver **healthier, safer and more resilient indoor environments.**

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