CAN WE REMOVE IT?

Practical odour abatement solutions

for commercial and critical environments

Dinesh Asokan, M.Eng
Camfil Australia

camfil

Asia-Pacific Odour CONFERENCE 2026

Topics for discussion

1. Outdoor air quality & regulatory limits
2. Molecular filtration principles
3. From residence time to ISO 10121-3 – and the standards landscape
4. Reading the classification correctly
5. Outdoor air data, worked example & filter performance
6. Applications, the bushfire challenge & a hospital case study
7. A practical six-step selection method
8. Conclusion

camfil
CLEAN AIR SOLUTIONS

Can a particle filter remove odour?

Answer: C

PM Particles and molecules need different capture mechanisms

Introduction – Outdoor Air Quality & Limits

- Bushfire smoke, urban pollution, industrial emissions & traffic increasingly affect commercial buildings and critical facilities
- Particulate filtration alone cannot remove gaseous pollutants that drive odour, discomfort and potential health impacts
- Key contaminants: VOCs, ozone (O_3), NO_2, SO_2, diesel exhaust, bushfire smoke by-products
- Most exposed: healthcare facilities, airports, buildings near busy roads or industrial areas

NEPM Ambient Air Quality Standards (Australia)

VOCs | **O_3 / NO_2 / SO_2** | **Diesel exhaust** | **Bushfire smoke**

NEPM = National Environment Protection (Ambient Air Quality) Measure – Australia's legal framework setting maximum outdoor pollutant concentrations to protect human health.

Pollutant	Averaging Period	Max. Concentration
Carbon monoxide	8 hours	9.0 ppm
Nitrogen dioxide	1 hour / 1 year	0.08 / 0.015 ppm
Ozone (Photochemical)	8 hours	0.065 ppm
Sulphur Dioxide	1 hour	0.075 ppm
Particles PM10 / PM2.5	1 day	50 / 20 μg/m^3

Note: there are no maximum allowable exceedances.

The gap this talk addresses:

Particulate filters meet PM limits - but do nothing for the gaseous pollutants that drive odour complaints and NEPM exceedance risk.

Why outdoor odours become an indoor-air problem

Bushfire smoke
PM + VOCs + combustion gases

Traffic / diesel exhaust
NO_2 + VOCs + odorous exhaust

Industrial sources
SO_2 + VOCs + process odours

Hospital helipad
Aviation exhaust + VOCs + NO_2

OUTDOOR AIR

Air Handling Unit (AHU)
Outdoor air intake

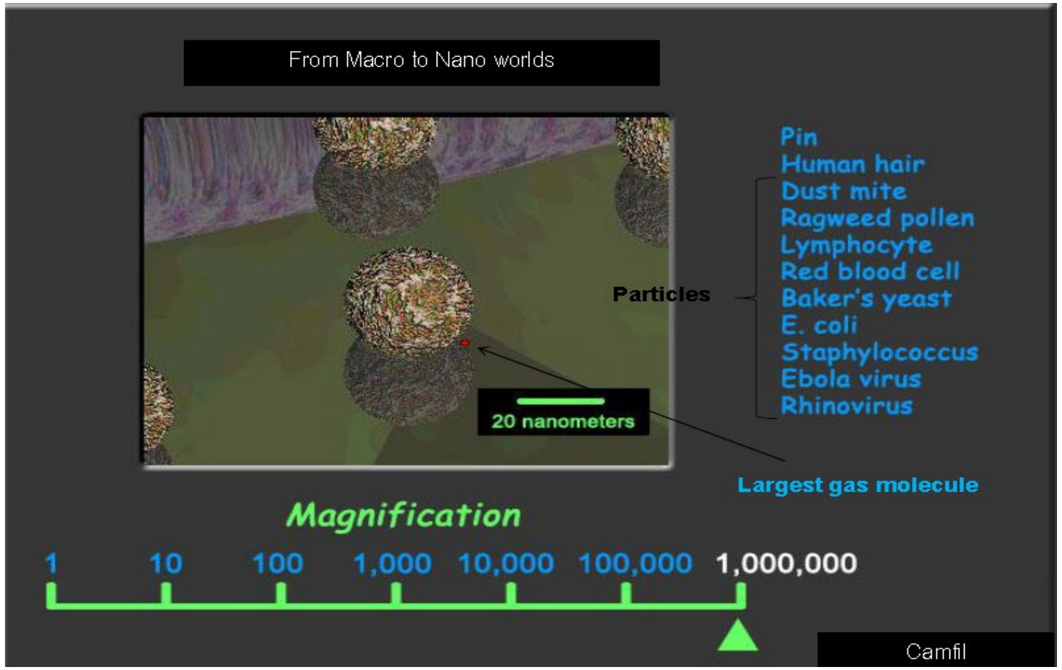
INDOOR IMPACT

Odour complaints
What occupants notice first

Comfort / health
Irritation and exposure concerns

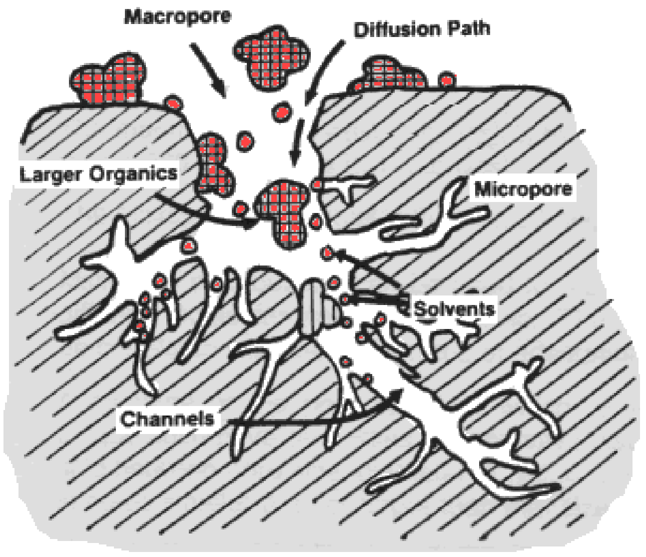
Critical spaces
Patients, staff and sensitive processes

Why we say particle filtration does not remove odour

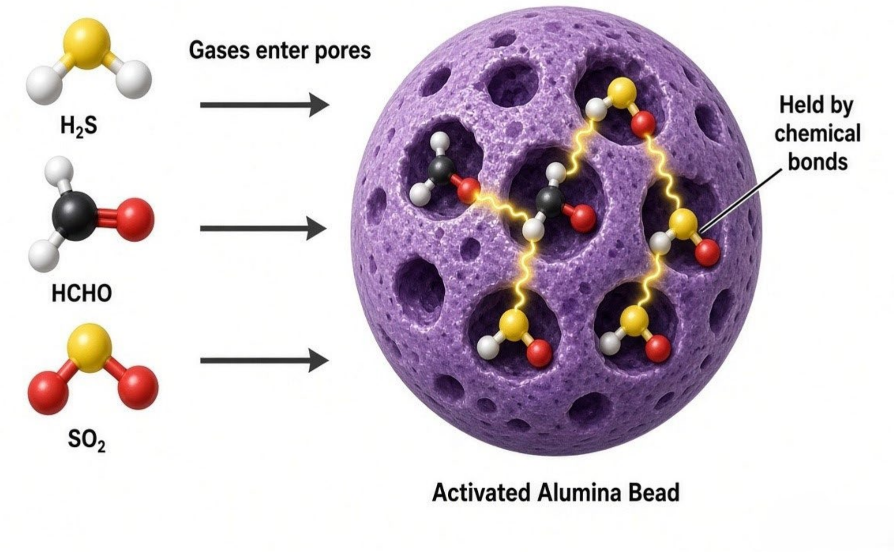


Molecules are approximately **1,000–10,000× smaller** than the most penetrating particles targeted by HEPA/ULPA filters.

How molecular filtration works



Scanning electron microscope image of Activated Carbon (very high magnification)



1

Enter the pores
Gas molecules diffuse from the air stream into the porous adsorbent.

2

Adsorb
Activated carbon physically attracts molecules onto its very large internal surface.

3

Chemisorb
Impregnated media can chemically react with selected acidic or reactive gases.

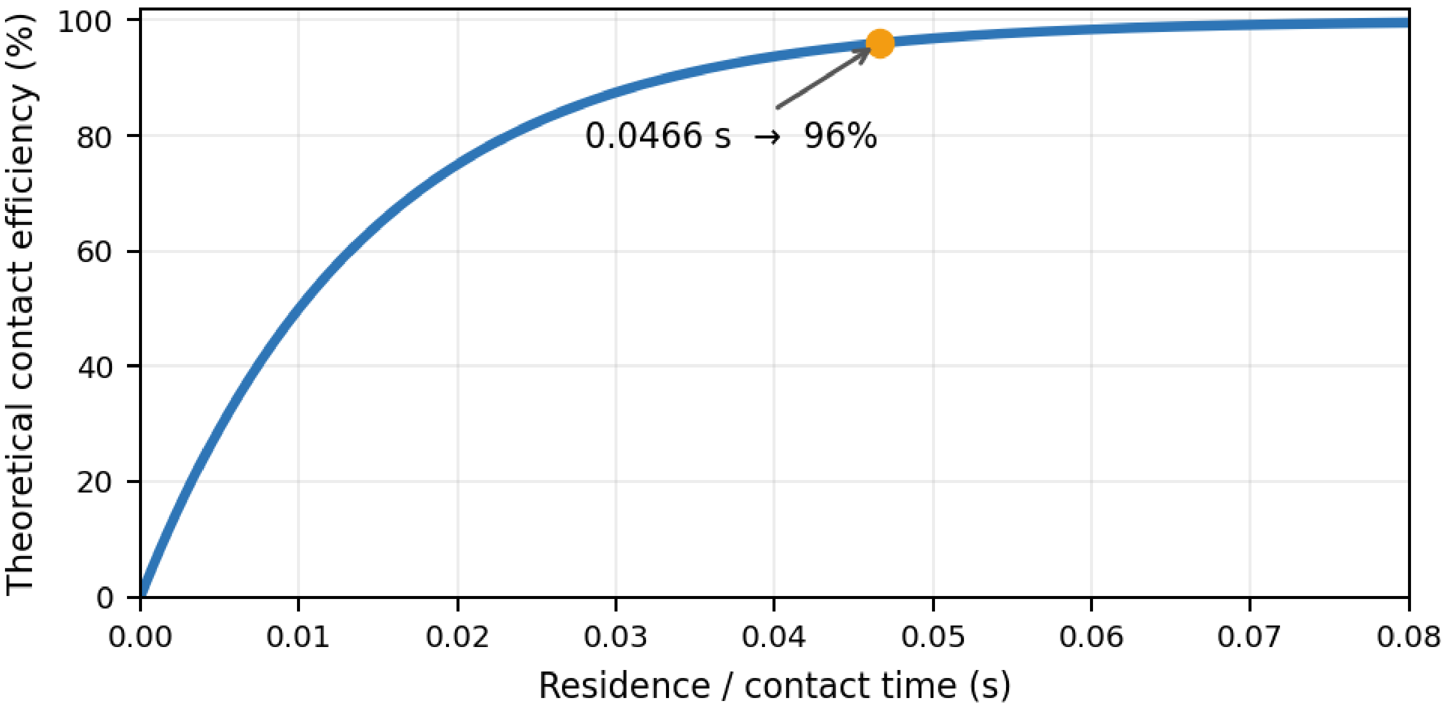
From Residence Time to ISO 10121-3

Old approach: residence time could give “96%” — but 96% of what?

- Historically, molecular filtration was selected using residence time and contact efficiency calculations
- Provided rough comparisons between systems, but no standardised classification comparable to particulate filters (AS/ISO 16890)
- Could not answer the key engineering question:

“How long will the filter stay efficient?”

- Real-world contaminant loading and breakthrough were never quantified



Residence contact time t = Volume / Q (Flow rate)

Air Flow 944 L/s	**Media volume** 44L	**Residence time** 0.0466 s	**Theoretical contact efficiency** ≈ 96%

camfil

The gap: no target gas, no capacity/breakthrough rating, and no common device classification.

Asia-Pacific Odour CONFERENCE 2026

ISO 10121: from testing to a usable classification

ISO 10121-1
Test molecular filtration media

ISO 10121-2
Test the complete gas-phase air cleaning device

ISO 10121-3
Standardised classification system for gas-phase air cleaning devices (GPACDs) in general ventilation

Four reference gases used for classification

O_3
Ozone

SO_2
Sulphur dioxide

NO_2
Nitrogen dioxide

C_7H_8
Toluene / VOC surrogate

What changes for designers?

- Selection can now combine measured efficiency, dose/capacity and contaminant-specific performance
- Enables selection in the same way AS/ISO 16890 does for particulate filters

ISO 10121: The Standards Landscape

Duty class = predicted lifetime / capacity

LD	MD	HD
Light Duty baseline dose	**Medium Duty** ≈ 4× LD dose	**Heavy Duty** ≈ 16× LD dose

How to read a classification code

HD	95
Duty / capacity tier	Average efficiency (%)

- Standardised comparison between molecular filtration devices
- Better prediction of media life expectancy
- Improved alignment between outdoor air quality and filter performance
- Quantifiable contaminant removal performance
- The classification test follows efficiency versus gas dose and stops once efficiency falls below 50%

Minimum dose to reach each class (g/m^2 face area)

Gas	LD	MD	HD
Ozone	72	288	1,152
SO2	96	384	1,538
NO2	69	276	1,104
Toluene	138	553	2,211

Product Depth	**CityPleat** 95 mm	**City-Flo** 534 mm	**CityCarb I** 292 mm	**CamCarb XG** 595 mm
Reference gas				
Ozone	HD 60	HD 85	HD 80	HD 95
SO_2	LD 65	MD 55	MD 50	HD 85
NO_2	vLD 35	LD 85	LD 70	HD 70
Toluene	MD 70	MD 80	MD 80	HD 95

Reading an ISO 10121-3 class: efficiency + duty

- The classification is an INTEGRAL (average) efficiency across the whole loading cycle – rounded DOWN to the nearest 5% increment
- Test continues until efficiency falls below 50%
- Result: filters starting at 95%, 98% or 100% initial efficiency can all report the same class

Important nuance: Integral (average) efficiency is rounded down to 5% increments. A measured 99% therefore reports as 95%
A 95% classification is not the same as "95% efficient" – ask for the efficiency curve, not just the class label

Worked example

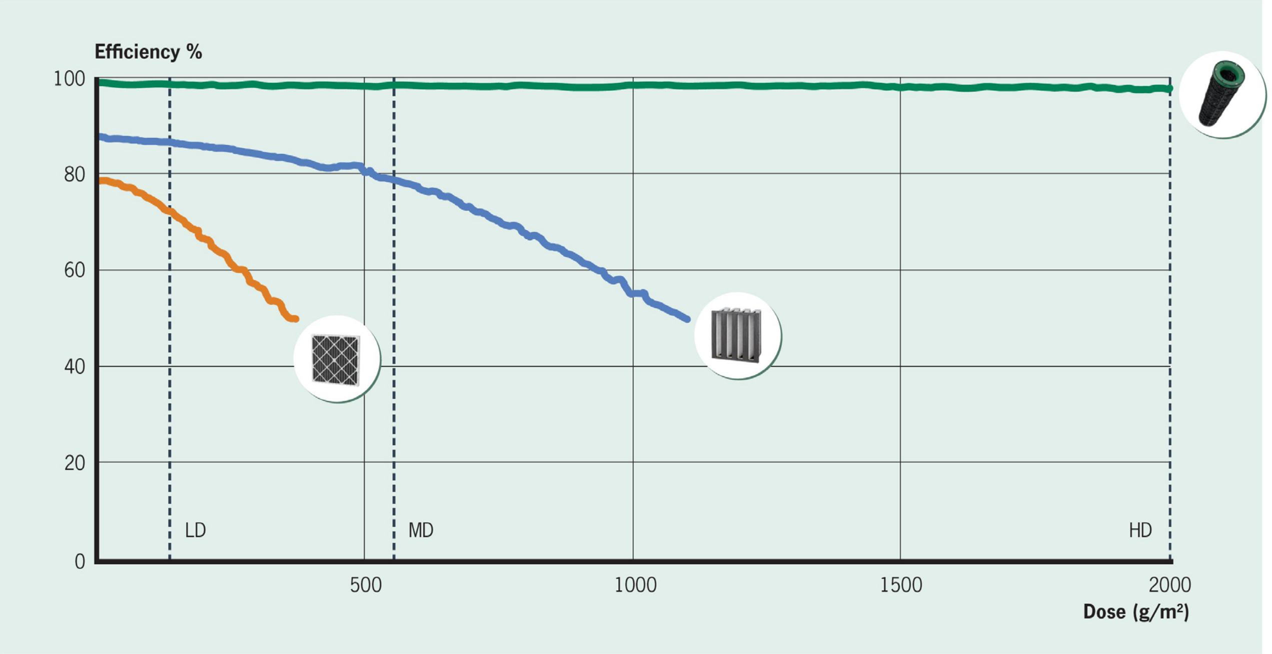
A high-capacity conical filter measuring 99–100% initial efficiency for Toluene and Ozone can still classify as HD95 – the same headline class a filter starting at 95% would receive

Why this is still a genuine improvement:

Rounding down protects against over-claiming, and combining efficiency with capacity gives a far more meaningful engineering selection tool than the old residence-time method ever could

Example: conical molecular filter module

Ozone HD 95	**SO_2** HD 85
NO_2 HD 70	**Toluene** HD 95



% value = average efficiency sustained over that lifetime, e.g. HD60 = 60% average efficiency over a very long lifetime.

2024 Victorian outdoor-air data: what are we designing for?

Ozone (O_3)	Nitrogen dioxide (NO_2)	Sulphur dioxide (SO_2)	Toluene*
35.6 µg/m^3	13.13 µg/m^3	1.83 µg/m^3	16.8 µg/m^3
			4.4 ppb · project maximum exposure reading

Operating assumptions used in the screening calculation

21 °C	Temperature
101,325 Pa	Pressure
24.14 L/mol	Ideal gas volume
2.0 m/s	Filter face velocity
24 h/day	Operating time
2,679 m^3/h	Flow per 610×610 filter
64,299 m^3/day	Daily flow per filter

Measured concentration + airflow → gas mass loading → ISO capacity & efficiency → screening life

Source:

- *EPA Victoria 2024 AirWatch data Calculations reviewed for ambient Ozone, SO_2 and NO_2 concentrations*
- **Toluene not measured at EPA stations. Sourced from Victorian Big Build (West Gate Tunnel) peak industrial exposure monitoring not an annual average.*
- *Annual averages and peak concentrations compared against ISO 10121-3 classifications to predict filter class and service life*

Worked example: from outdoor Ozone concentration to predicted conical carbon filter life

1

Mass entering / day

35.6 µg/m^3 × 64,299 m^3/day

2.289 g/day

2

Apply average efficiency

2.289 g/day × 95%

2.174 g/day captured

3

ISO dose capacity

Conical module · O_3 HD

428.66 g capacity

4

Screening life estimate

428.66 g ÷ 2.174 g/day

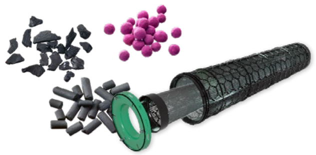
≈ 197 days

Interpretation: this is a screening estimate based on Ozone in the airstream, not a guaranteed change-out interval. Peaks, humidity, competing gases and operating strategy can shift real life.

Calculated from the 2024 ozone concentration and assumptions in 2024_All_sites_air_quality_hourly_avg on EPA Victoria historical data; Conical module filter for Ozone class HD 95.

One dataset, four filter formats: efficiency and capacity both matter

Based on 2024 average conditions dataset

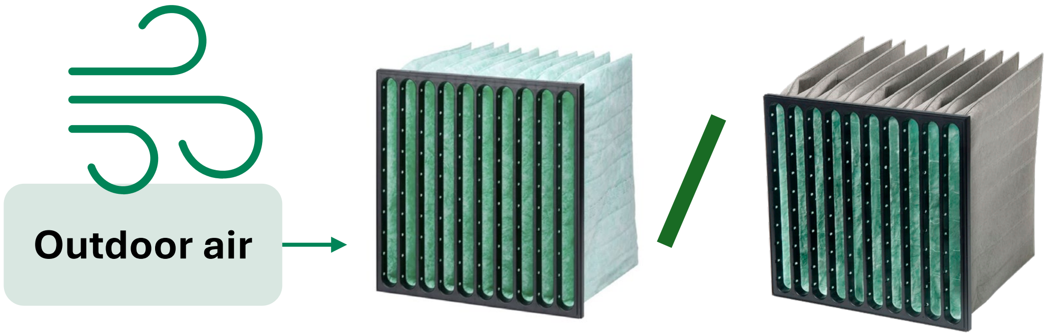
	Filter Type	Ozone	SO_2	NO_2	Toluene
	Compact Panel Filter (CityPleat)	**HD 60%** 312 Days	**LD 65%** 468 Days	**vLD 35%** No data	**MD 70%** 272 Days
	2-in-1 Bag Filter (City-Flo)	**HD 85%** 220 Days	**MD 55%** 2,212 Days	**LD 85%** 35 Days	**MD 80%** 238 Days
	2-in-1 Rigid Filter (CityCarb)	**HD 80%** 234 Days	**MD 50%** 2,433 Days	**LD 70%** 43 Days	**MD 80%** 238 Days
	Conical Module (CamCarb XG)	**HD 95%** 197 Days	**HD 85%** 5,733 Days	**HD 70%** 694 Days	**HD 95%** 801 Days

Selection rule: Do not choose on “days” alone. A lower-efficiency filter can appear to last longer simply because it captures less gas. Consider efficiency first, duty/capacity second, then predicted life.

Source: Bushfire Calculations from 2024_All_sites_air_quality_hourly_avg_AIR on EPA Victoria historical data;
**Toluene data from Victorian Big Build / West Gate Tunnel monitoring, not a statewide annual average.*
Days are screening estimates at stated assumptions.

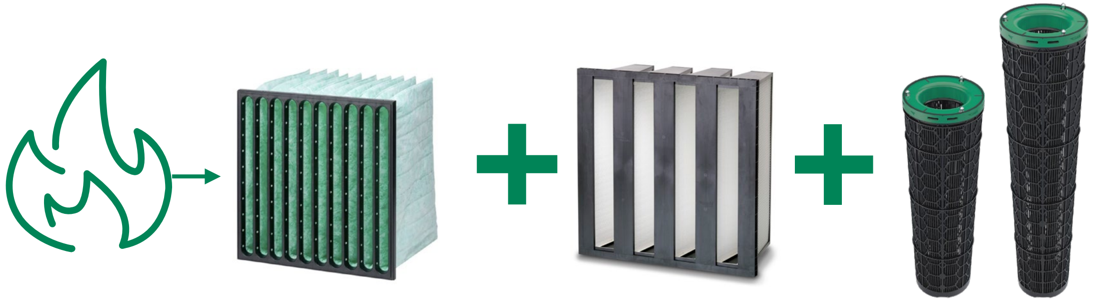
Bushfire smoke: Two-part problem - particles + gases

NORMAL OUTDOOR AIR



Routine control of Particle + background gases if required

BUSHFIRE / SEVERE SMOKE EVENT



Combined particulate + molecular filtration is critical

Combined function particulate + molecular filters

- Molecular bag & rigid filters remove particulate (ePM1 70 – 85% as per AS/ISO 16890) and gaseous contaminants in a single stage
- Lower AHU space and capital penalty, well suited to bushfire smoke events

Cylinder-type molecular filters

- Enhanced odour control and longer service life for higher contaminant concentrations or critical environments
- Tailored blends of activated carbon and activated alumina

Case Study

Hospital helipad: short, intense odour events at a sensitive intake

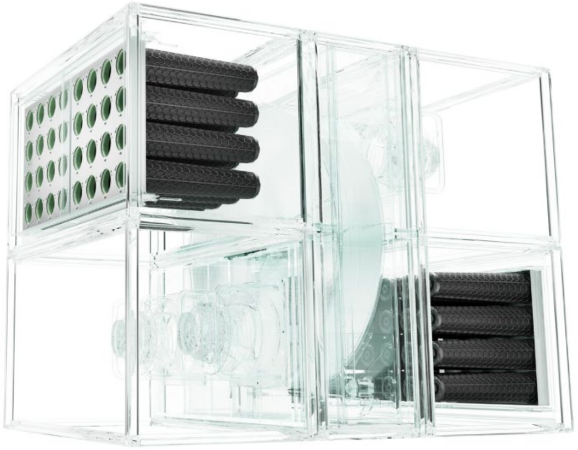
- Helicopter landing / take-off can create short-duration exhaust plumes near outdoor-air intakes.
- Key concerns include VOCs, NO_2, SO_2 and aviation-fuel / diesel-related odours.
- Patient areas have a very low tolerance for odour breakthrough.

Data first: concentration, exposure duration, airflow and target gases are needed to model performance and life.

Design response

Particulate pre-filtration + targeted molecular filter. For higher gas loads, deeper cylinder/conical modules allow tailored activated carbon / activated alumina blends

Design trade-off: deeper molecular stages add AHU space and capital cost – match media to the application, not the other way round.



Practical odour abatement: six decisions that make it work

1 **Identify the contaminant**

Target gas, source, average + peak concentration

2 **Assess outdoor air**

Baseline conditions + event / episodic exposure

3 **Choose the right media**

Activated carbon, impregnated alumina or tailored blend

4 **Design the airflow**

Velocity, contact time, pressure drop + AHU footprint

5 **Select by measured performance**

ISO 10121-3 efficiency + LD / MD / HD duty

6 **Verify in operation**

Monitoring, inspection + change-out strategy

Get one of these wrong → breakthrough • premature saturation • higher cost • persistent complaints

Applications → Hospitals • Commercial building • Airport • Tunnels • Data centers

Can we remove it?
YES we can!... when we design for the contaminant

The goal is not simply to install carbon filtration, it is to deliver measurable, sustained odour control

1 QUANTIFY

Target gas + average / peak concentration

2 SELECT

Contaminant-specific efficiency + duty / capacity

3 VERIFY

Service life + monitoring + change-out performance

Important

- **Particles ≠ gases**
- **Residence time ≠ measured performance**
- **Capacity ≠ efficiency**

Measured inputs. Measured performance.
Safer, more comfortable and more resilient buildings

Thank You! – Any questions?

Dinesh Asokan · dinesh.asokan@camfil.com

camfil

Asia-Pacific Odour CONFERENCE 2026