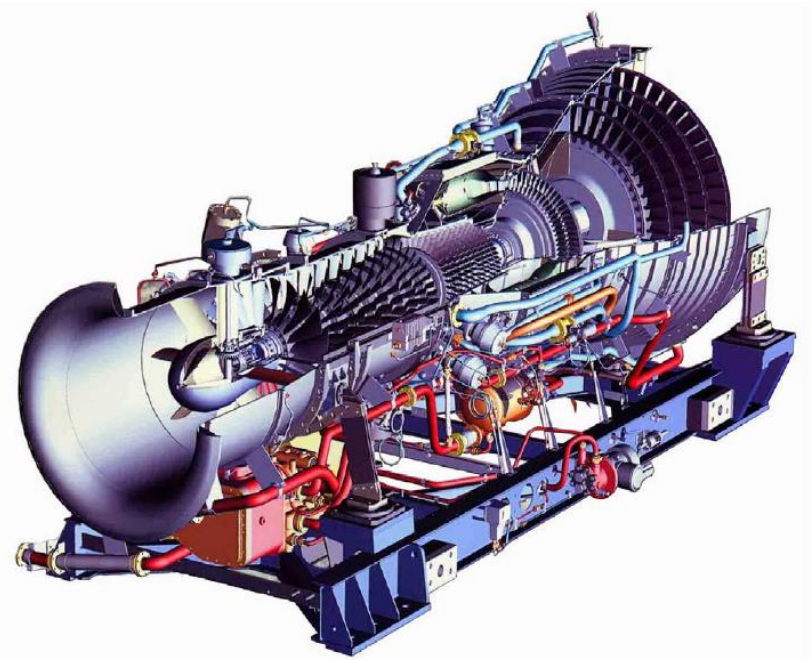
IRAN FILTECH

شرکت علمی و تحقیقاتی اصفهان

تاثیر فیلتر هوا بر عملکرد توربین

Subtitle



Impact of air filter on turbine performance

Subtitle

Gas Turbine Inlet Air System

Filter Pressure Loss

Thermodynamics
Data for Deviations from Design Conditions

SIEMENS
Power Generation
Gas turbine

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1 Conversion of thermodynamic design data for other ambient conditions

The thermodynamic design data given in table H.2.1 were calculated under ISO conditions (see Sheet H.1). These design data can be **approximately** converted to other ambient conditions using appropriate correction factors. Diagrams H.2.3 to H.2.10 depict these correction factors as curves plotted as a function of the individual ambient conditions. Data calculated with these correction factors must **not be used as guarantee data**. Guarantee data for conditions other than ISO ambient conditions must be calculated with the current version of the cycle calculation program "KREISPR" and the corresponding type file.

a) Output at generator terminals

$$P_{GT\text{-}CORR} = P_{GT} \cdot P^*1 \cdot P^*2 \cdot P^*3 \cdot P^*4 \cdot P^*5 \cdot P^*6 \cdot P^*7 \cdot P^*10$$

where

$P_{GT\text{-}CORR}$	Corrected output at generator terminals
P_{GT}	Output at generator terminals under ISO conditions per Sheet H.2.1
P^*1	Correction factor for ambient pressure per Sheet H.2.3
P^*2	Correction factor intake pressure drop per Sheet H.2.6
P^*3	Correction factor for exhaust pressure drop per Sheet H.2.6
P^*4	Correction factor for lower heating value per Sheet H.2.7
P^*5	Correction factor fur humidity per Sheet H.2.5
P^*6	Correction factor for speed per Sheet H.2.9
P^*7	Correction factor for ambient temperature per Sheet H.2.4
P^*10	Correction factor for aging per Sheet H.2.10

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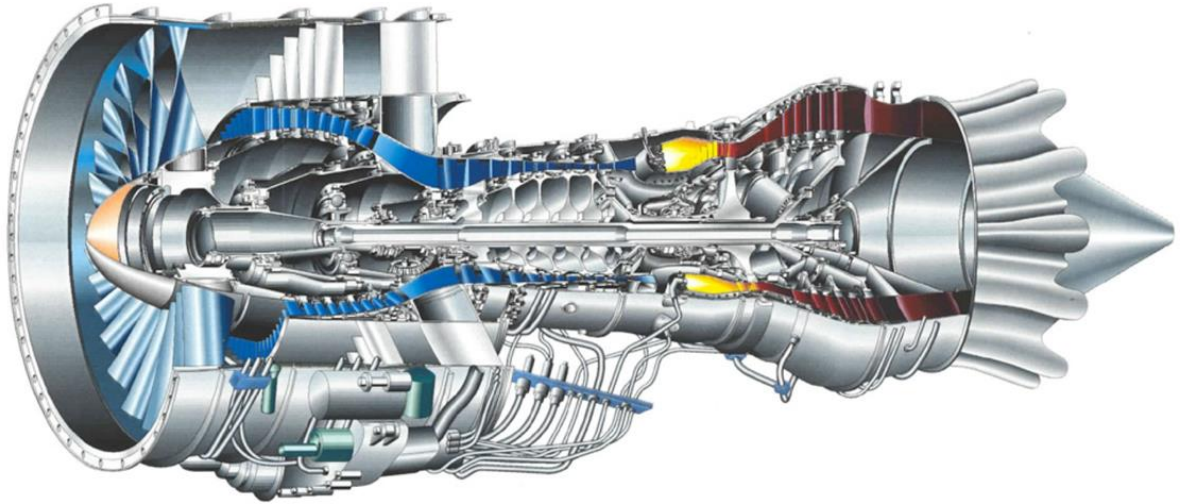
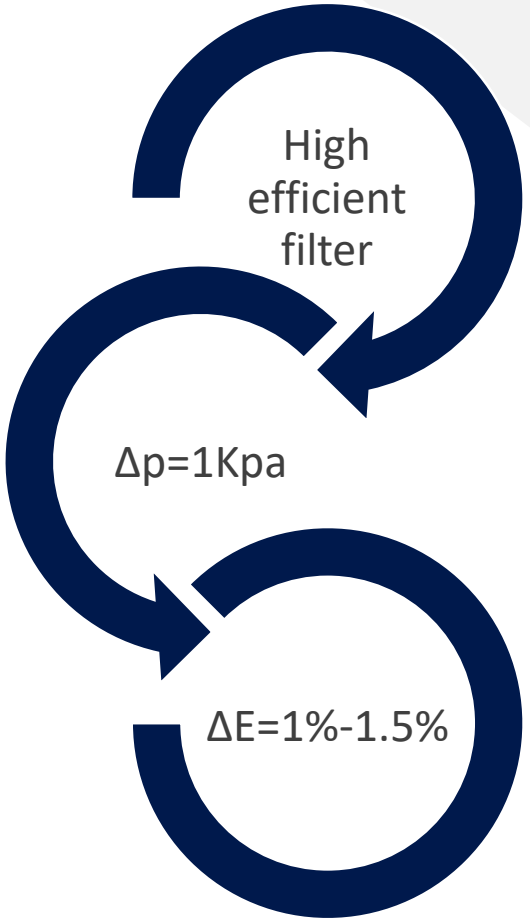
Air intake filtration

pressure drop vs turbine Efficiency

- For example if there is a 40 MW gas turbine and ΔP=1kPa then get loss at least 400 KW.

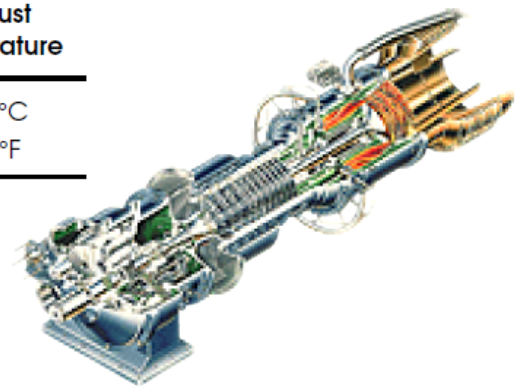


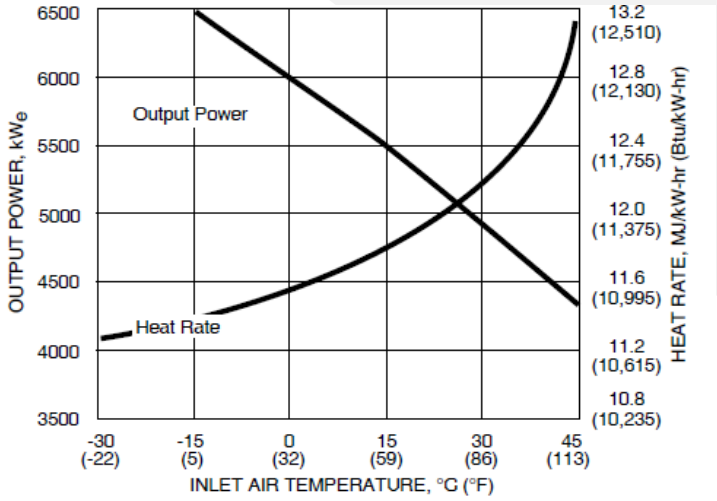


Ambient Temperature Loss

Taurus 60 Generator Set Performance

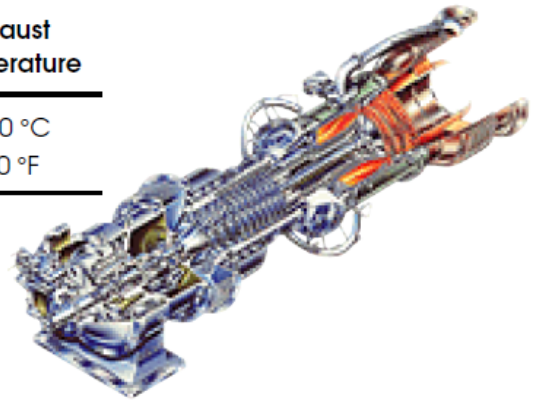
ISO Continuous Duty Output	Heat Rate	Exhaust Flow	Exhaust Temperature
5500 kWe	11 840 kJ/kW-hr	78 820 kg/hr	510 °C
	11,225 Btu/kW-hr	173,770 lb/hr	950 °F

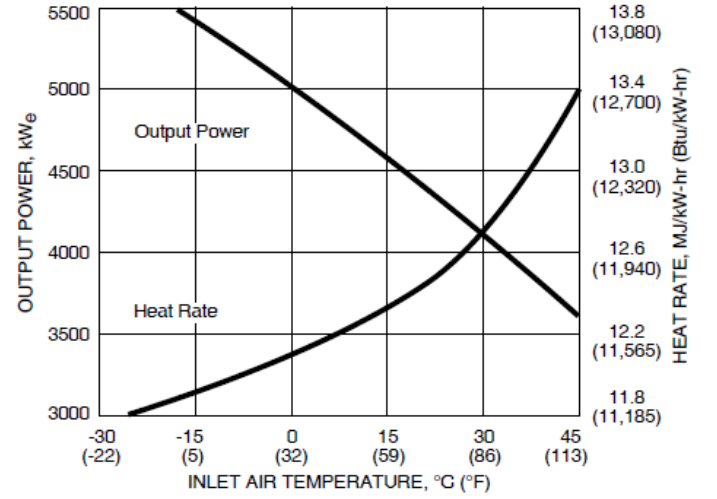




Centaur® 50 Generator Set Performance

ISO Continuous Duty Output	Heat Rate	Exhaust Flow	Exhaust Temperature
4600 kWe	12 270 kJ/kW-hr	68 680 kg/hr	510 °C
	11,630 Btu/kW-hr	151,410 lb/hr	950 °F





Air quality

Air quality in gas turbine

Gas turbine manufacturer
GE
SIEMENS
ANSALDO
ZORIA

- Particulate

With micron size of < 10 micron

  - GE : In 95% of the time,<0.0076 ppm
  - Siemens: <0.08 ppm
  - Ansaldo : <0.08 ppm
- Water: 0.5% of the inlet air flow
- Salt : <0.0015

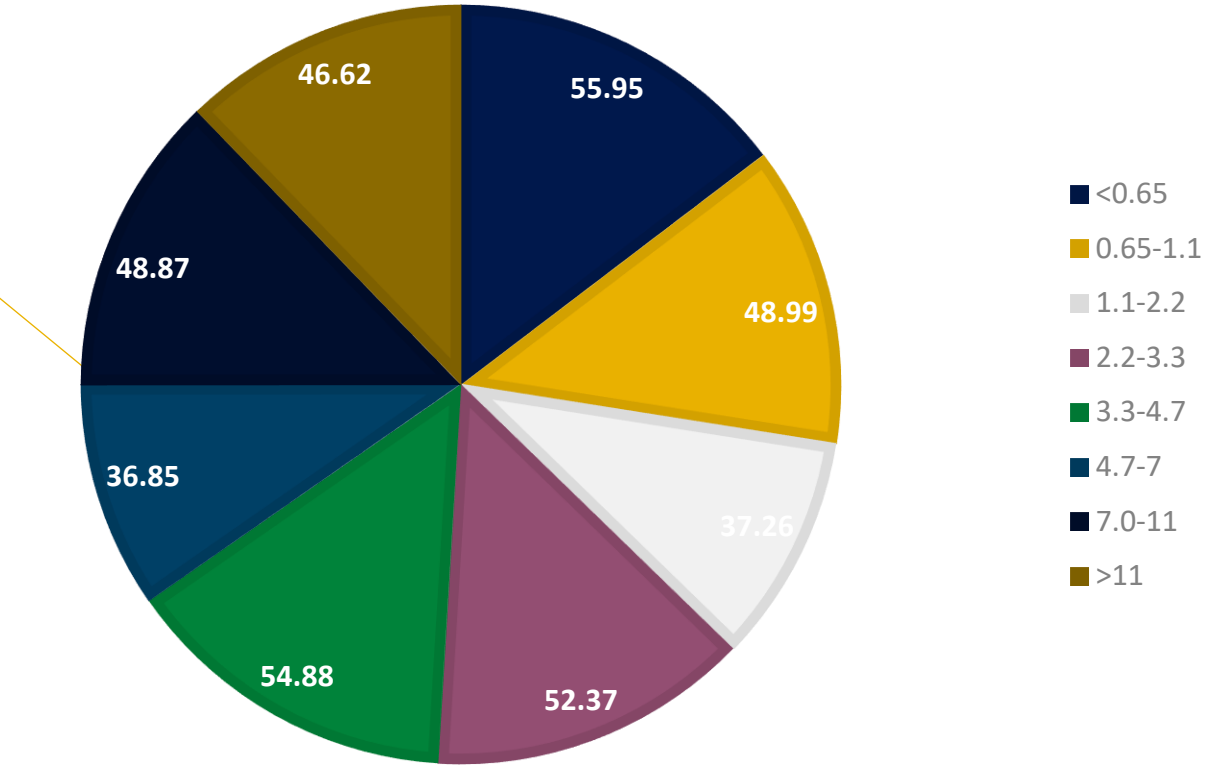
هواي ما چه ميزان تميز ميباشد؟

تعداد ذرات در ليتر	محيط مورد آزمايش:
10	اطاق تميز
10,000	قطبين
100,000	اقيانوس
1,000,000	ييلاقات
100,000,000	شهر
1,000,000,000	اتوبانهاي شهري
100,000,000,000	دود سيگار

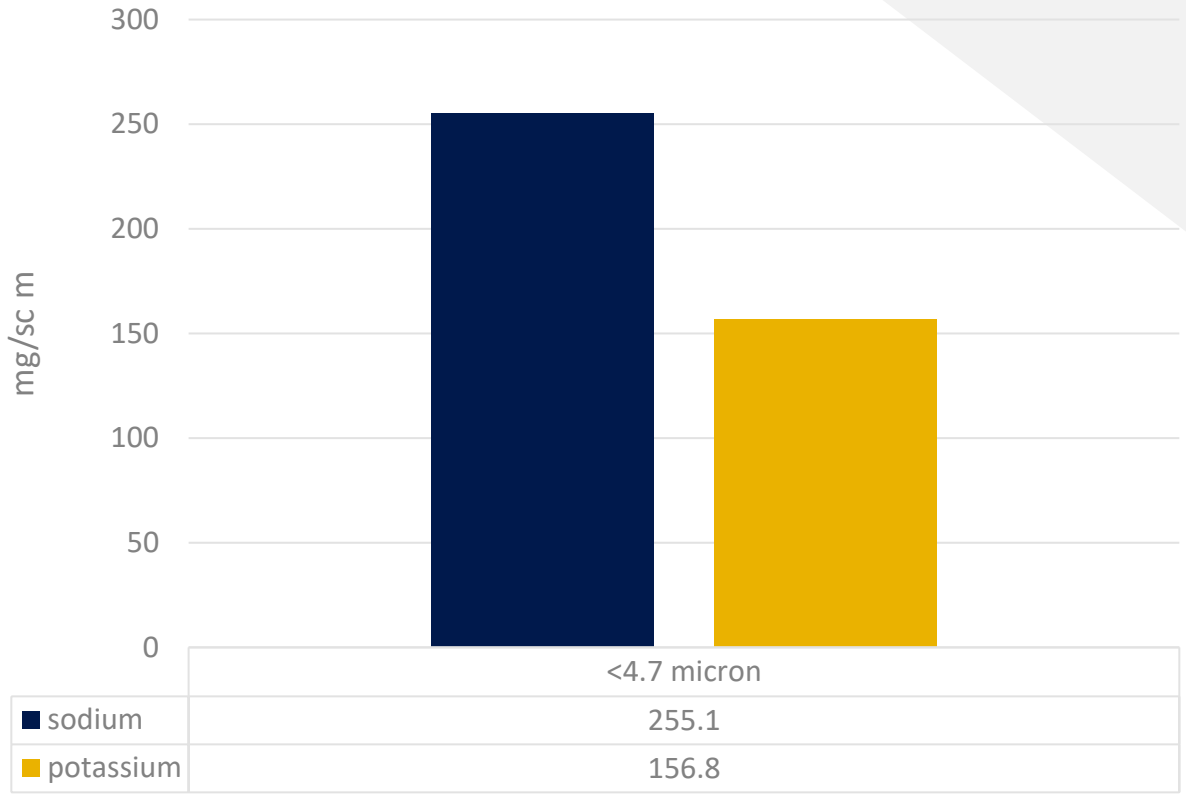
Air quality

Air quality in gas turbine

توزیع ذرات بر حسب میلی گرم بر متر مکعب

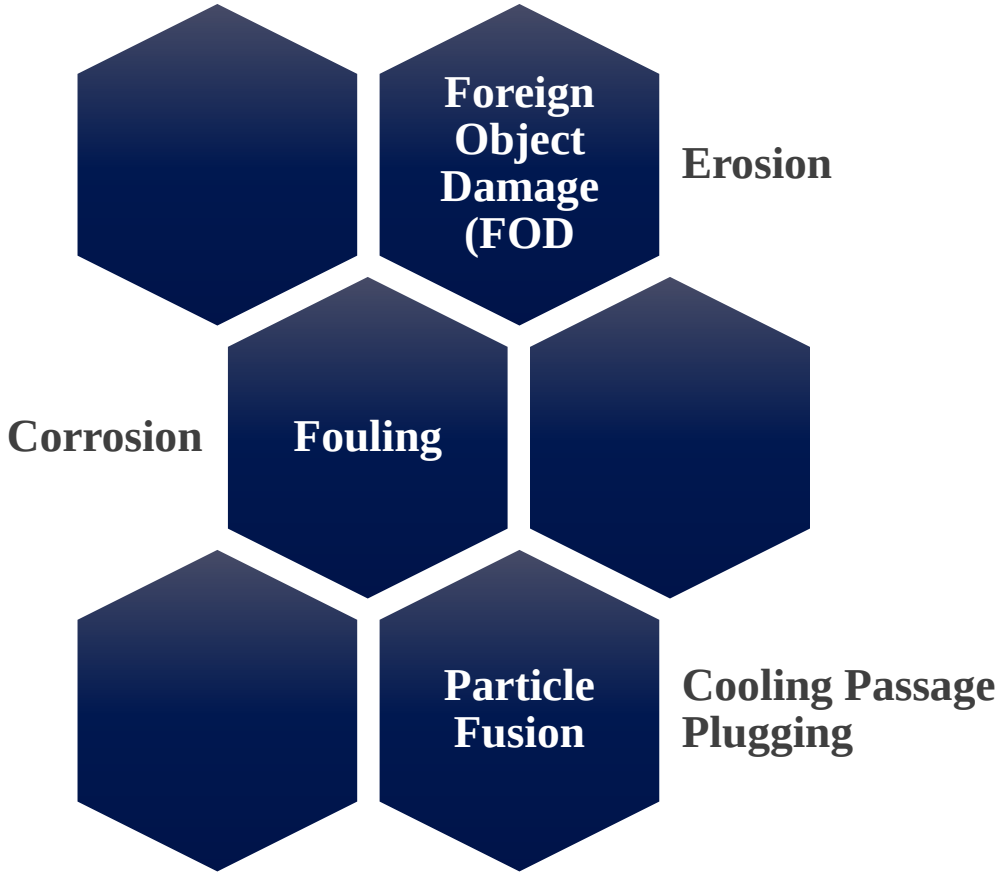


بیشترین تراکم عناصر خورنده



Air quality

six common consequences of poor inlet air filtration



Air quality

Foreign Object Damage (FOD

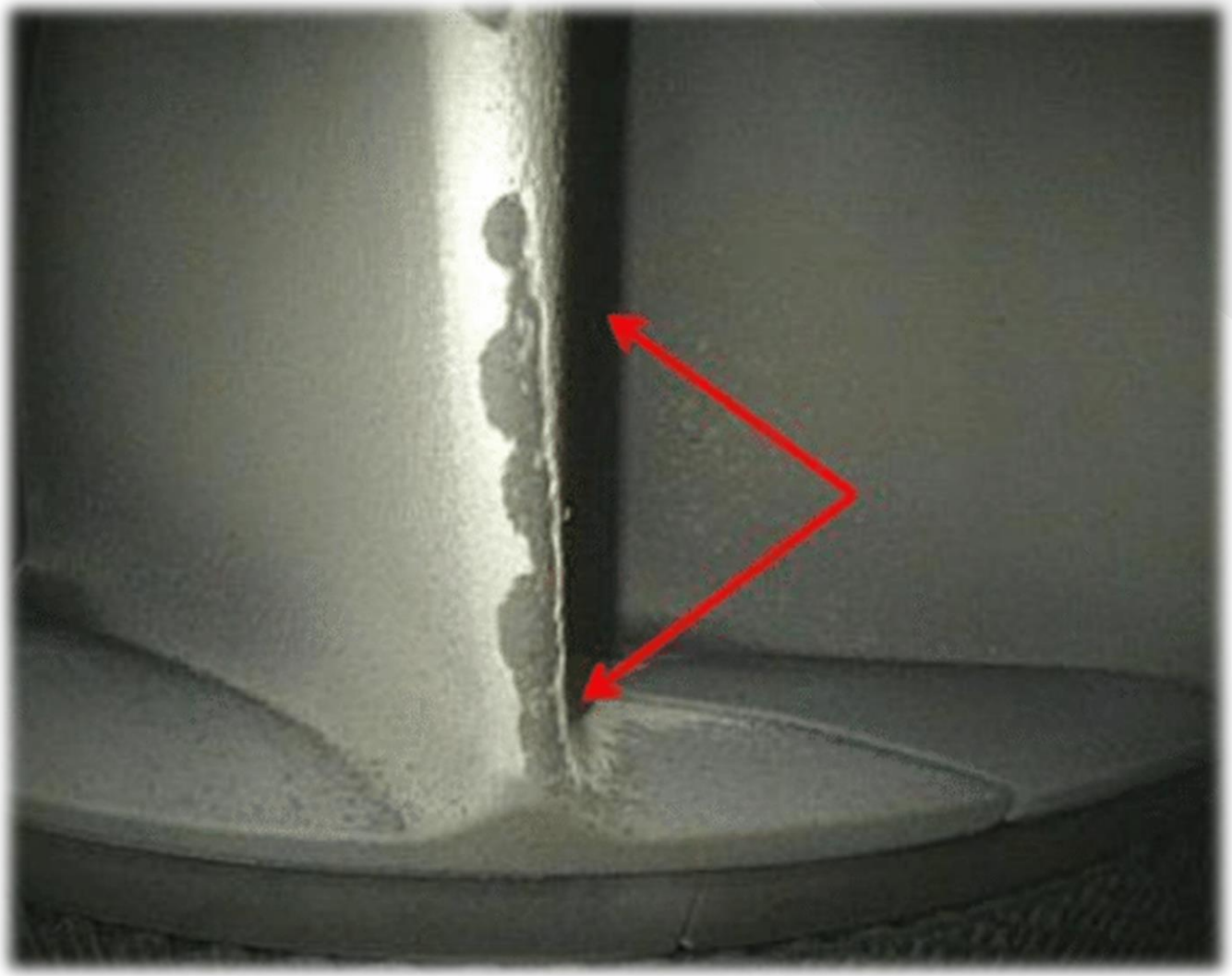
- External FOD hazards include bird strikes, hail, ice, sandstorms, ash-clouds or objects left on the runway.

Air quality

Erosion

- Erosion occurs when solid or liquid particles approximately 10 µm and larger impact rotating or stationary surfaces in the gas turbine.

However, particles 10 µm and larger are easily removed by commercial filters.

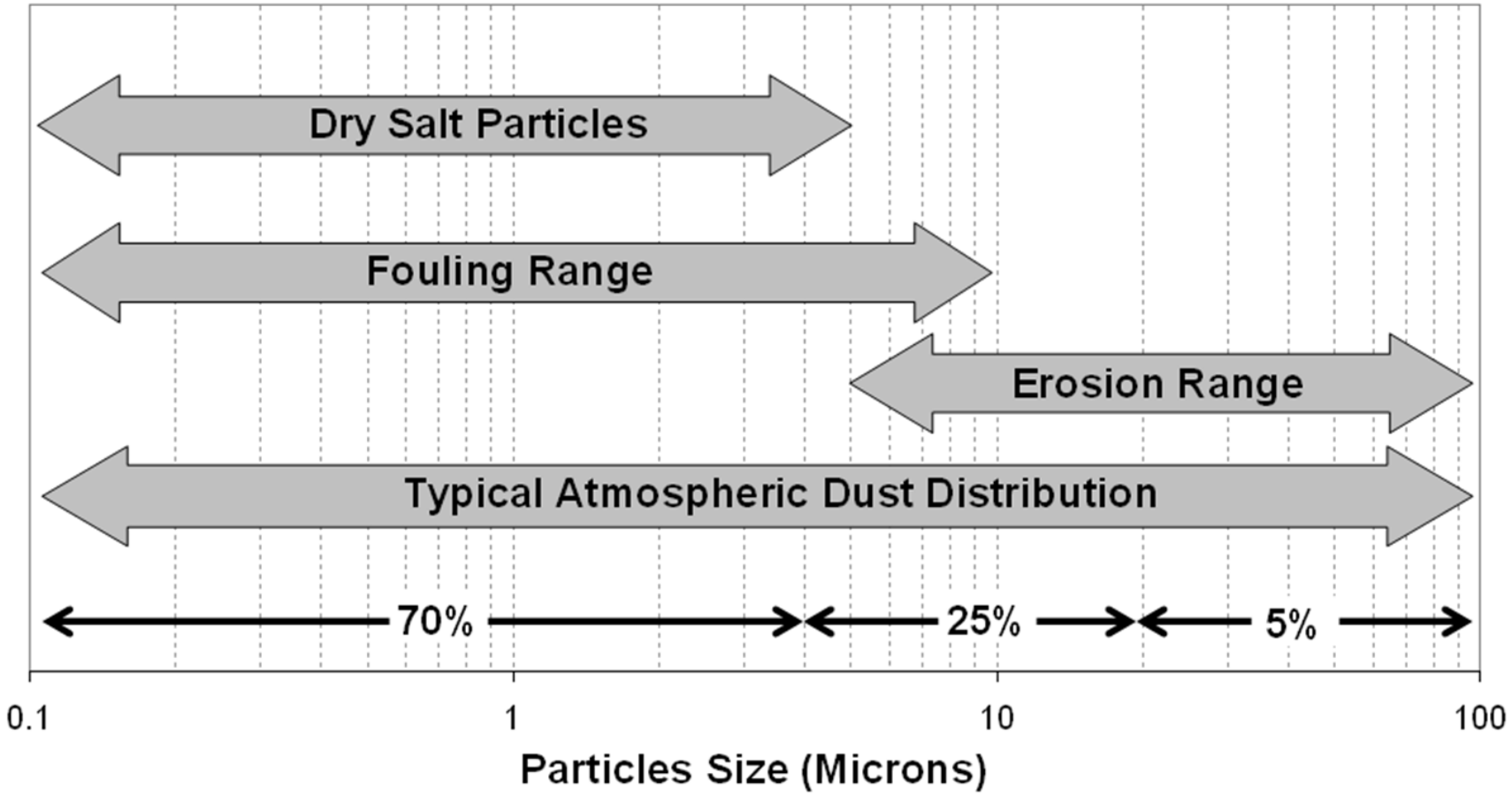


Air quality

Fouling

- Fouling is caused by the adherence of particles to airfoils and annulus surfaces. Particles that cause fouling are typically smaller than 2 to 10 µm. Smoke, oil mists, carbon, and sea salts are common examples. Fouling can be controlled by an appropriate air filtration system and often reversed to some degree by detergent washing of components.

Erosion & Fouling



Air quality

Cooling Passage Plugging

- Contaminants and particles reduce this cooling efficiency leading to an over-heated engine and engine failure

Air quality

Particle Fusion

- the particles will melt and stick to turbine’s internal surfaces; a condition called particle fusion.

Air quality

corrosion

Corrosion

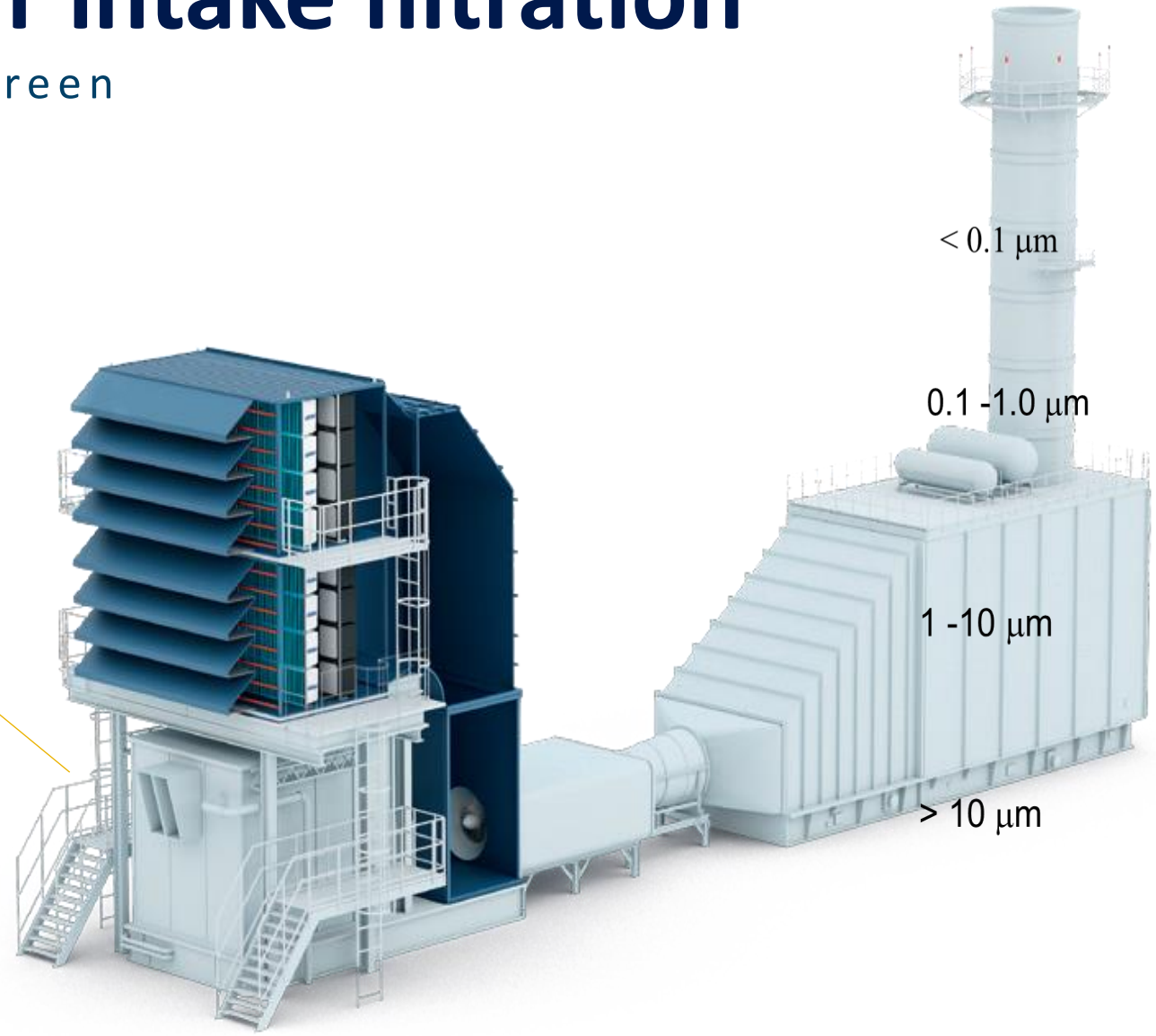
- Cold corrosion
- Hot corrosion

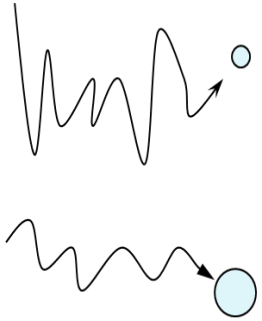
Solution

Air filtration

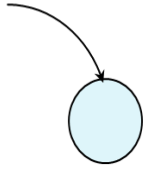
Air intake filtration

bird screen

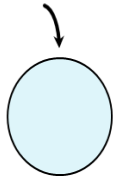




حرکت براونی (همانند دود سیگار)

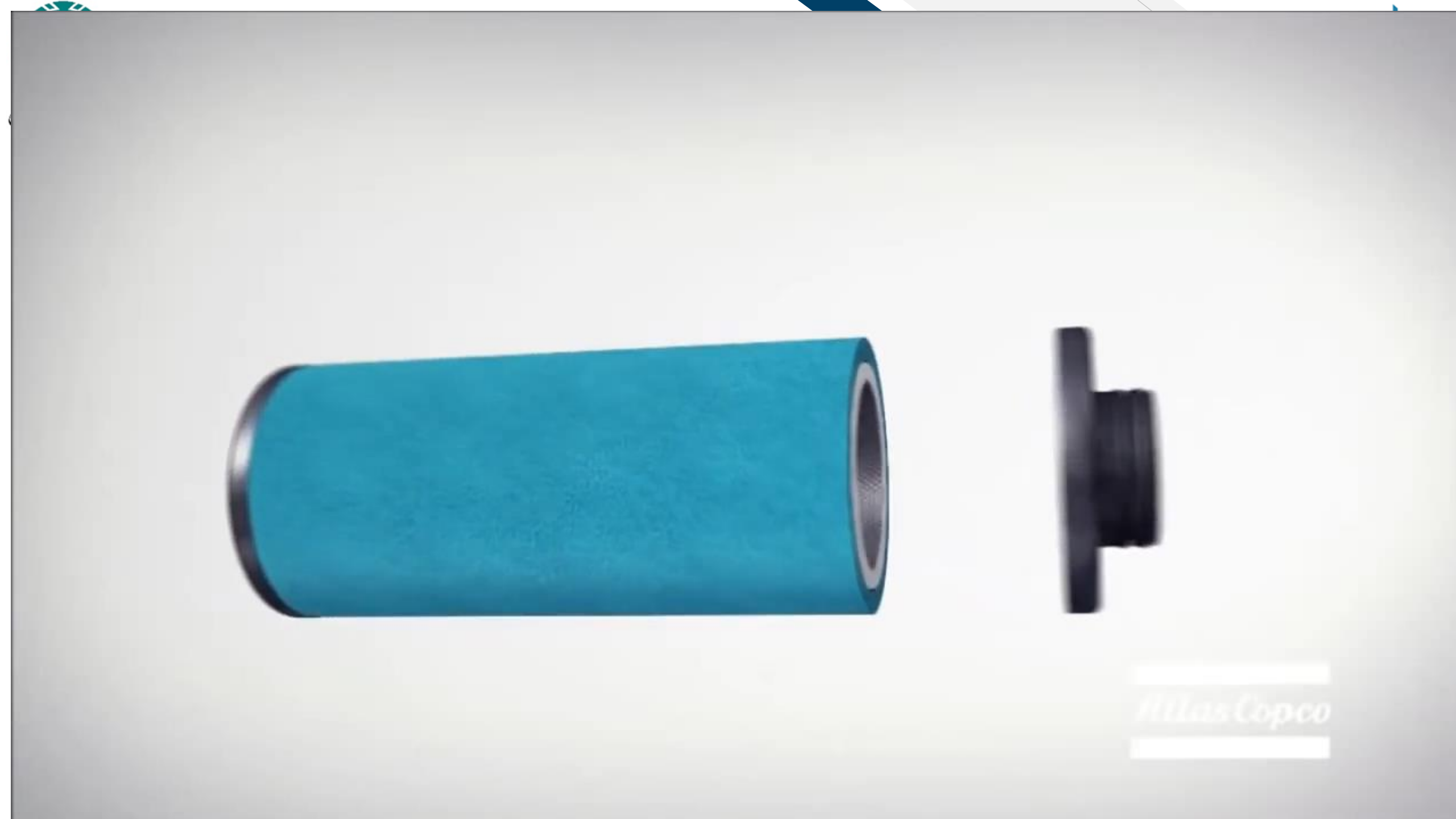


نشست ذرات (همانند گرده گیاه یا ماسه بادی)



روشهای به دام انداختن ذرات

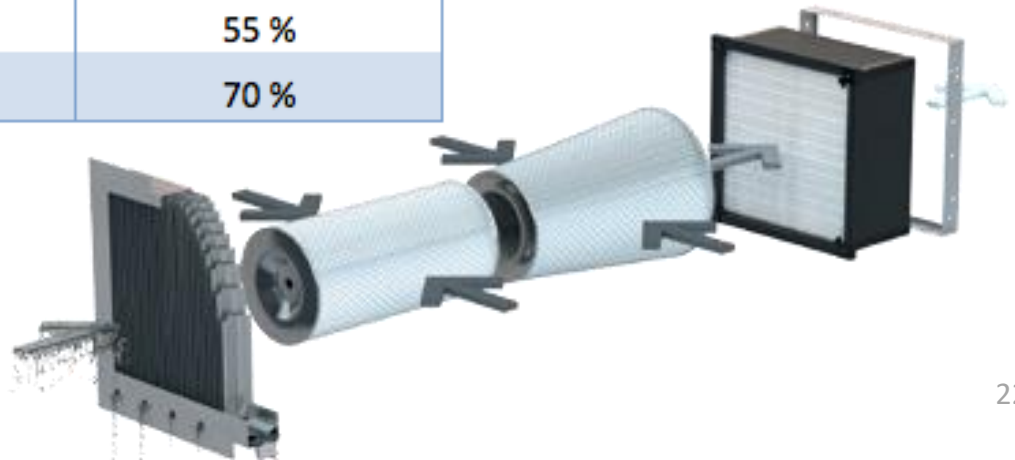
- Straining
- Inertia
- Interception
- Diffusion
- Electrostatic
- Bridge
- Gravity


Atlas Copco

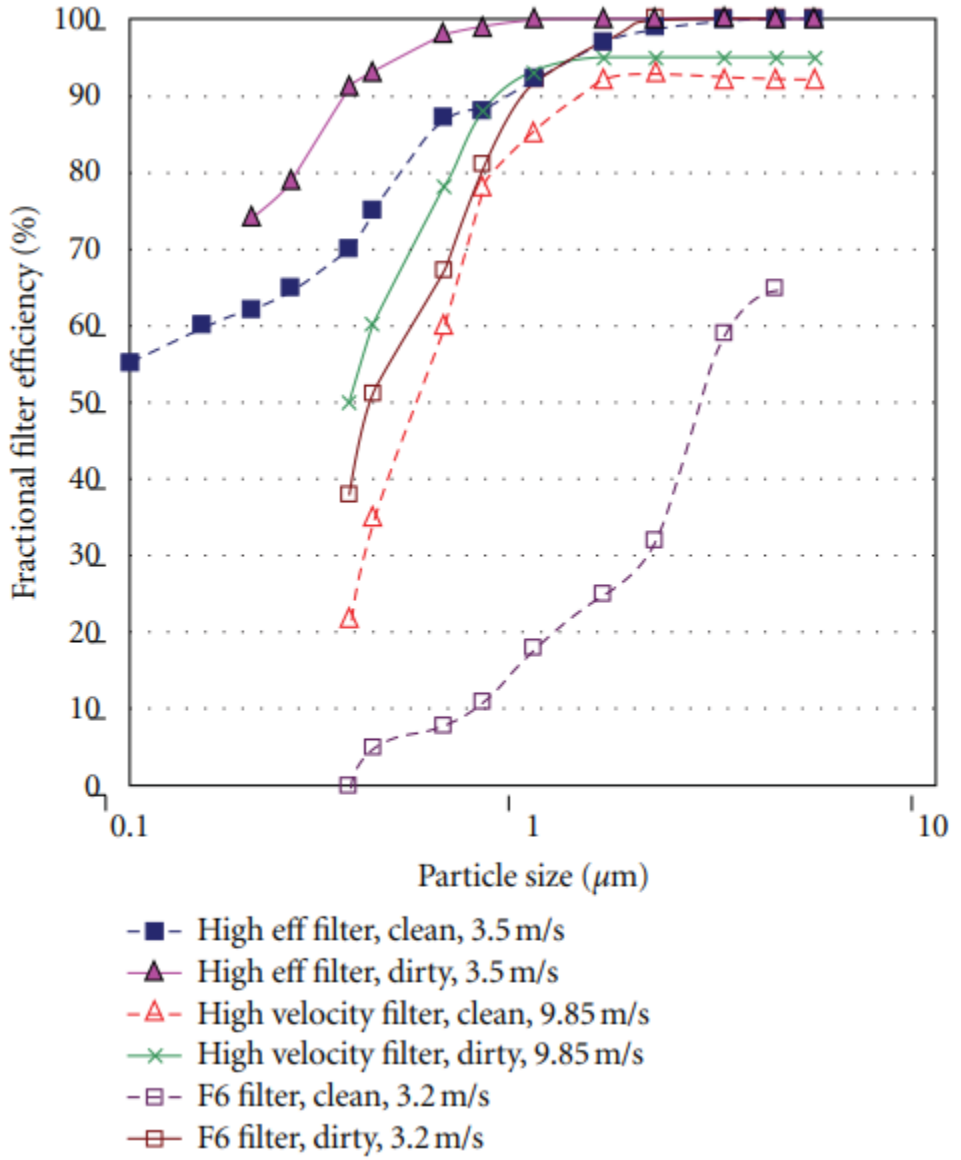
Air intake filtration

EN 779

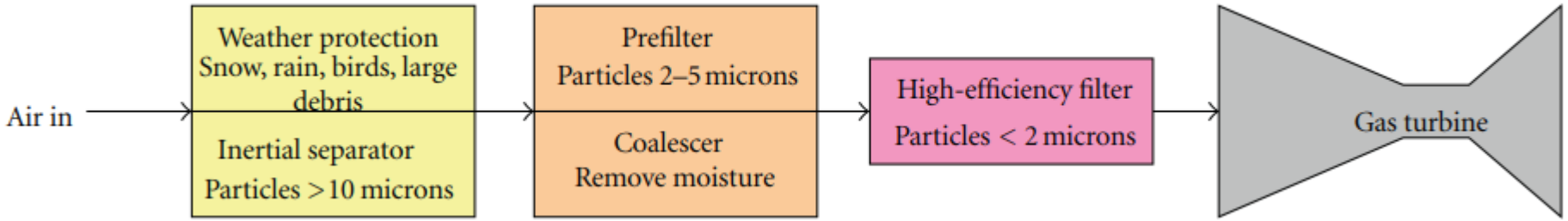
	Group	Filter class	Average arrestance (Aa) with synthetic dust	Average efficiency (Ae) on particles of 0.4µm	Minimum efficiency on particles of 0.4µm
Coarse dust filters	Gross	G1	50 % ≤ Aa < 65 %	-	-
		G2	65 % ≤ Aa < 80 %	-	-
		G3	80 % ≤ Aa < 90 %	-	-
		G4	90 % ≤ Aa	-	-
Fine dust filters	Medium	M5	-	40 % ≤ Ae < 60 %	-
		M6	-	60 % ≤ Ae < 80 %	-
	Fine	F7	-	80 % ≤ Ae < 90 %	35 %
		F8	-	90 % ≤ Ae < 95 %	55 %
		F9	-	95 % ≤ Ae	70 %



Air intake filtration



Air intake filtration

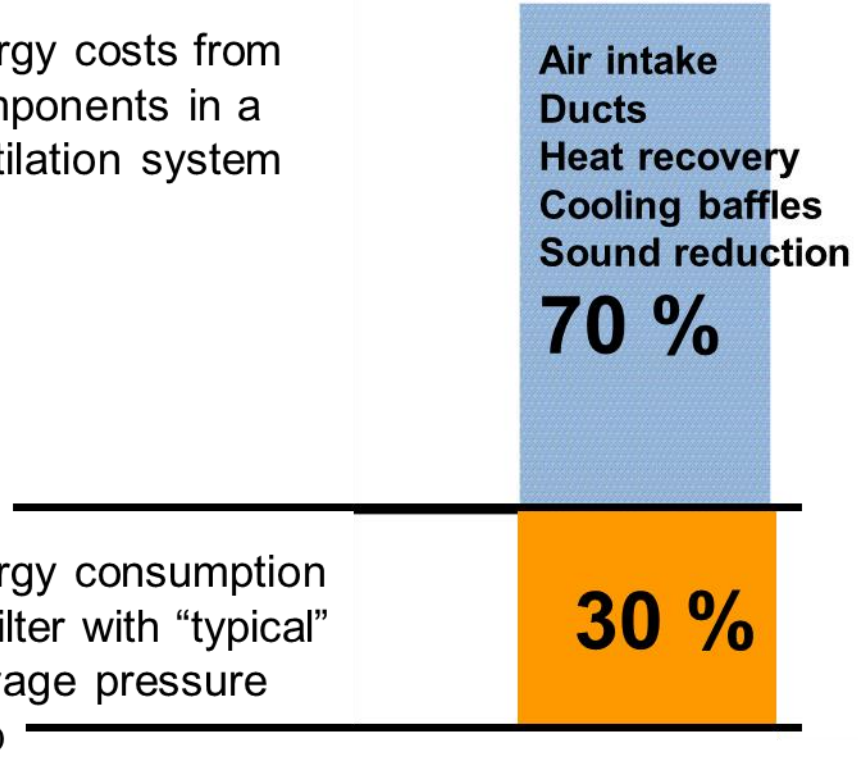


Air intake filtration

Cooling Air & Anti-Icing System

Pressure drop in system = energy loss = higher operational costs

Energy costs from Components in a Ventilation system



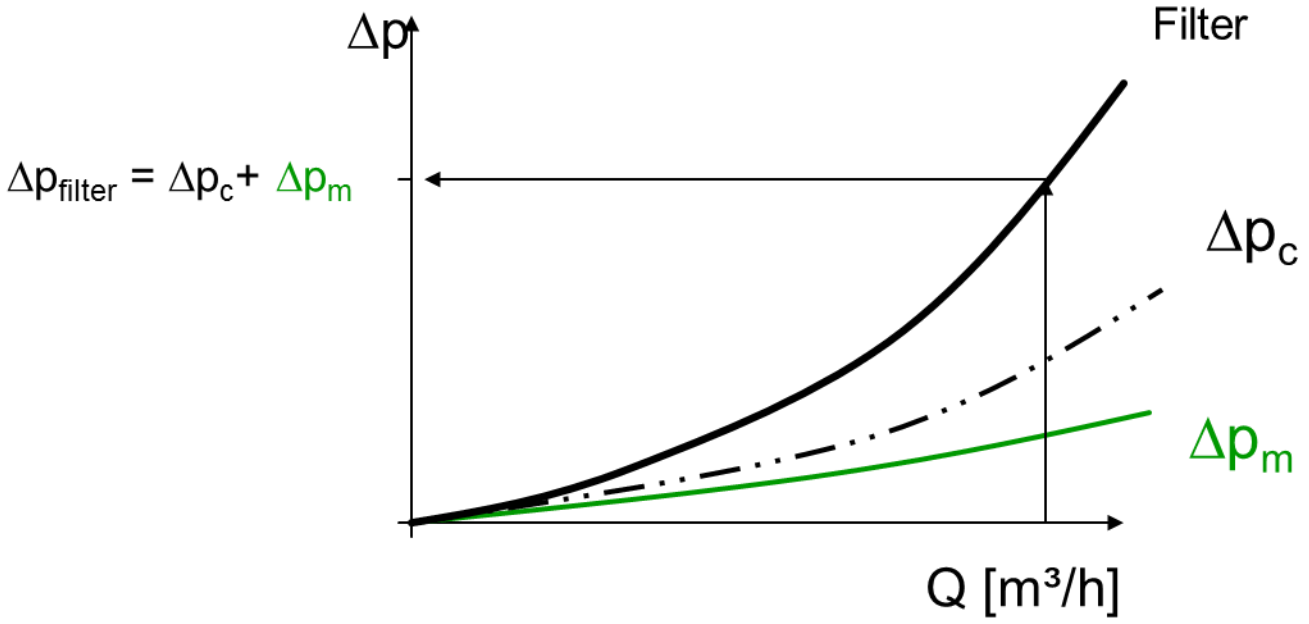
Energy consumption for filter with “typical” average pressure drop

Pressure drop of filter

- Air flow
- Media type
- Filter construction

Pressure drop

- media pressure drop (Δp_m)
- construction pressure drop (Δp_c)



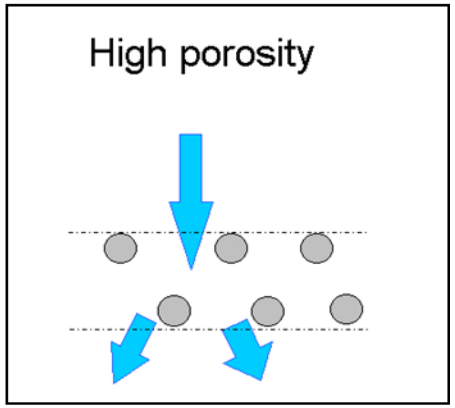
Media pressure drop, Δp_m

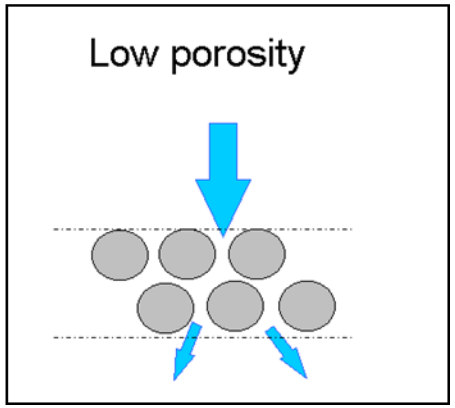
Low Δp_m by:

- High porosity
- Low media velocity (airflow)

<u>Good efficiency</u> and <u>low pressure drop</u> => fine fibres.

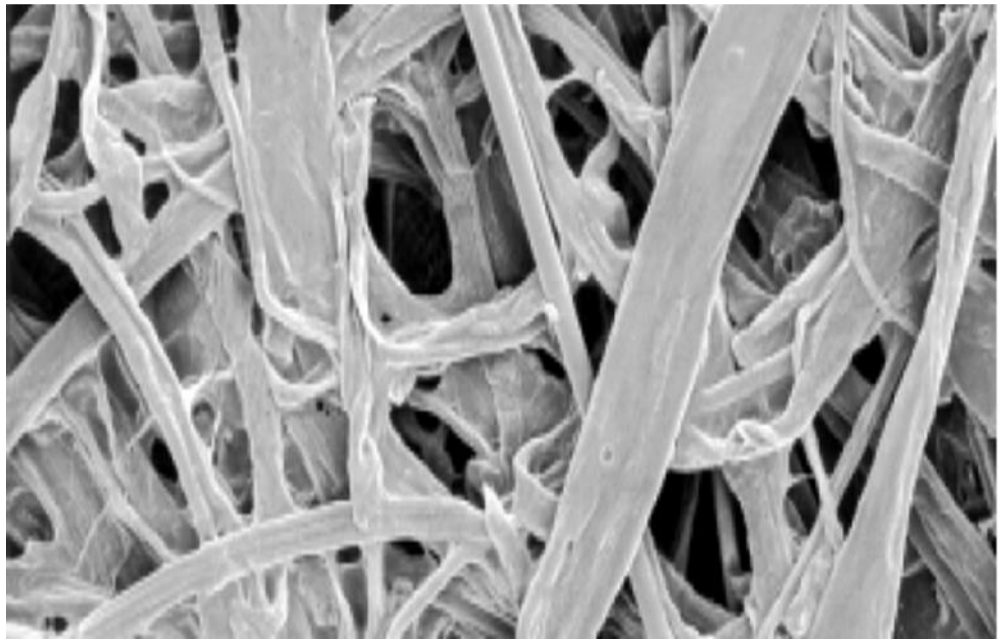
Higher efficiency typically gives higher dP therefore it is important to optimise media



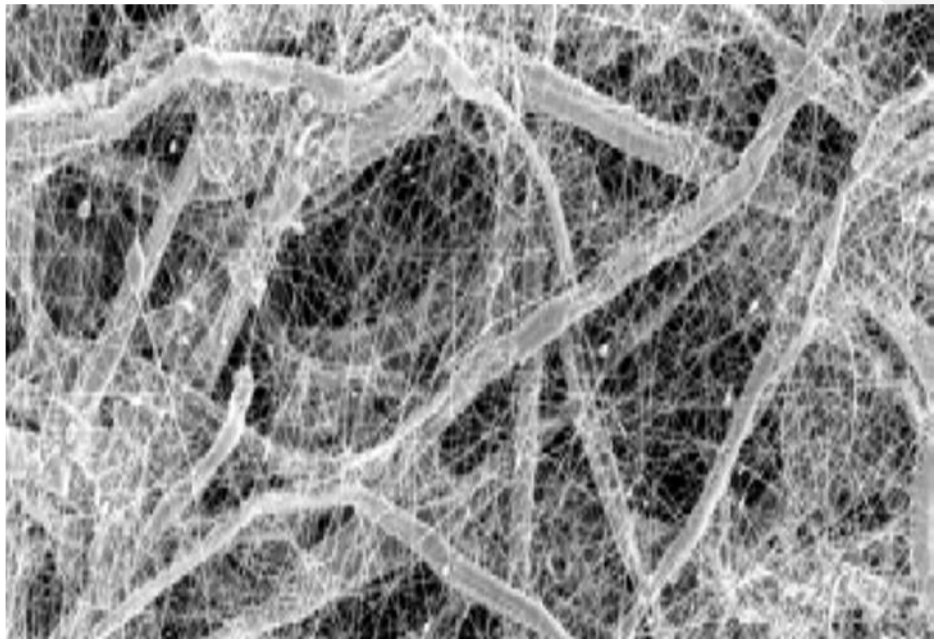


Air intake filtration

مدیای نانو نشده



مدیای نانو شده با الیاف PVDF



Thank You.

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