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Physico-chemical pollutants

Measures
- sampling
- continuous measurements

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1

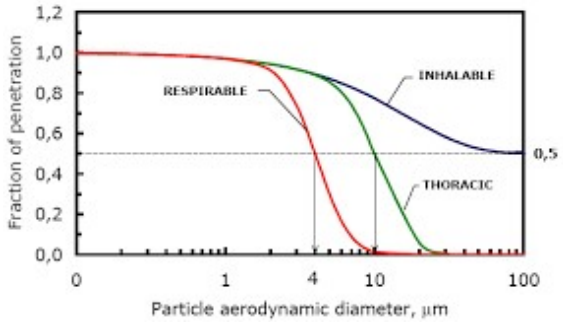
Sampling

- Sampling on filter
  - Different geometries
    Particle size fraction, sampling rate (1-10 l/min)
  - Type of filter
    cellulose ester, teflon, fiberglass, quartz...
- Special features
  - Individual measure
  - Easy to implement
  - Dosimetry
  - Allows for subsequent analysis
    gravimetry, atomic absorption, GC-ionic,

2

Sampling (particles)

– Selection sampler
  - The right granulometric fraction
  - Aerodynamic diameter
  - Mass fraction



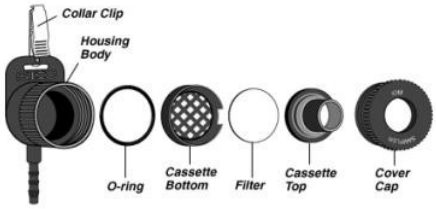
*For a number of pollutants, the measurement metric is a **Proxy** of the relevant toxicological measure.*

3

3

Sampling of inhalable dusts

IOM head
- sampling of the inhalable fraction
- 2.0 l/min
- personal sampling
- physicochemical analysis
- gravimetric analysis.



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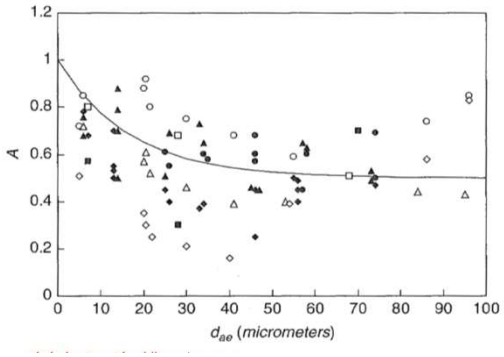
4

Sampling of inhalable dusts

Relative efficiency of the IOM sampling head

- close to the inhalation curve
- variability due to ambient air currents

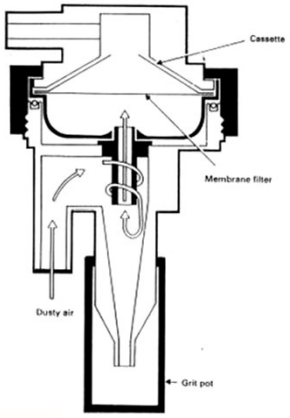


5

Respiratory dust sampling

Cyclone

- sampling of the alveolar fraction
- inertial dust separation
- ~2.0 l/min
- personal sampling
- physicochemical analysis
- gravimetric analysis.



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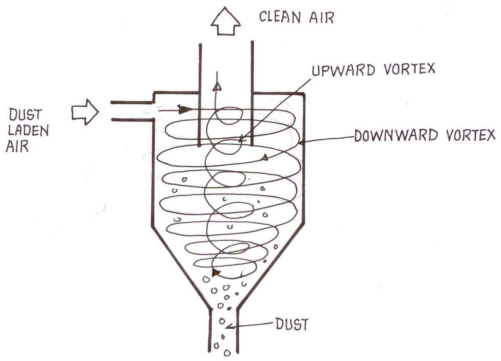
6

Respiratory dust sampling

Separation by sedimentation and impaction.

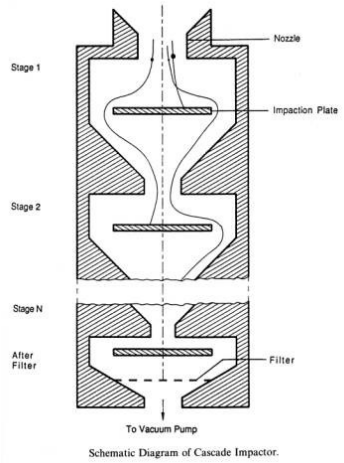


the rotation is initiated by the geometry of the inlet.

- the large particles are pushed out of the vortex by the centripetal force
- performance depending on the geometry of the cyclone

7

Impaction sampling



Schematic Diagram of Cascade Impactor.

Key parameters:
- flow width
- spacing between plates
- geometry of the openings
- air speed

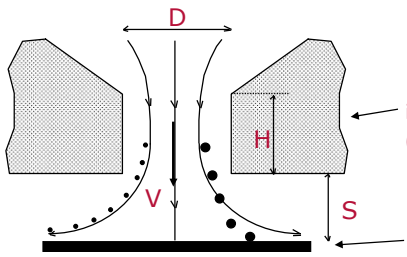
Impaction in **descending** order of particle size

Example:
Personal environmental monitor (PEM) SKC

8

Inertial impaction

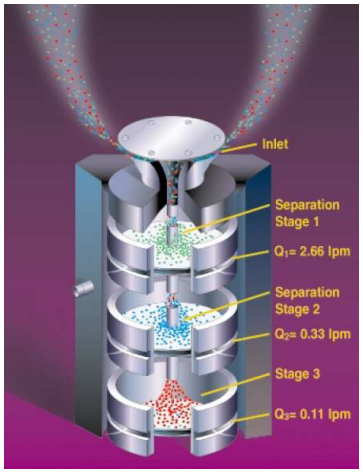
V: air speed in the nozzle



- The air velocity (V), the particle size and the obstacle dimension (D, S, H) are the parameters that determine whether a particle impacts or not.
- The impaction parameters are related to the geometry and the aerosol.

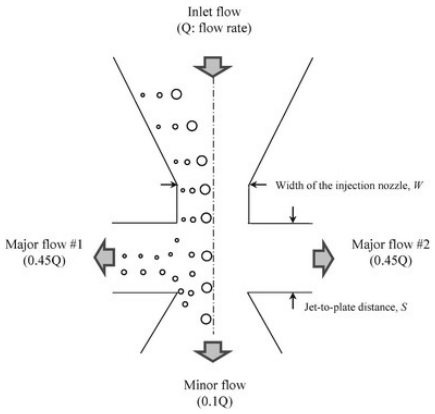
Virtual impactors

- Cascade impactor
  - sampling of several particle size fractions
  - dust separation by impaction
  - personal sampling
  - physicochemical analysis
  - gravimetric analysis.



Virtual impactors

Same principle as the classic impactor, but the collection surface is replaced by an active zone



Impaction in order of **increasing** particle size

11

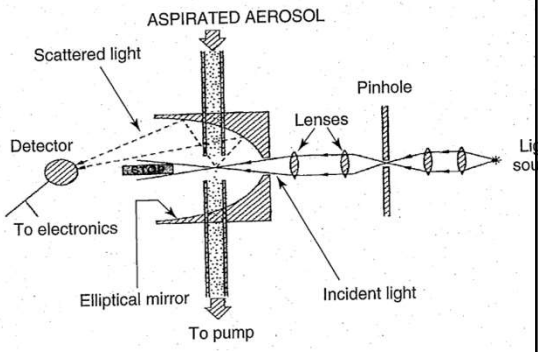
Continuous measurements

- Nephelometric detector
  - With or without sampling head
- Special features
  - Instantaneous results, continuous measurements
  - Allows for subsequent analysis
  - Pre-calibration

12

Continuous measurements

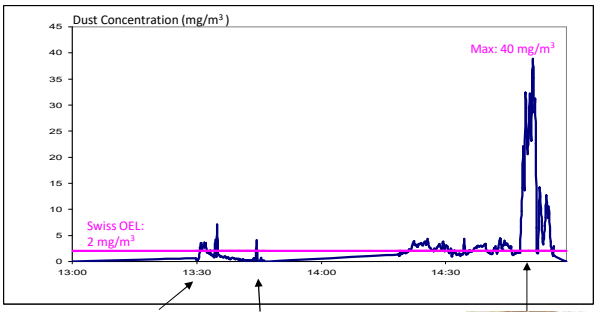
- Nephelometric measurement
  - Particle concentration
  - Particle size fractions

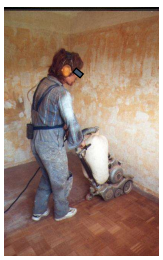


  - Other techniques
    - Specific surface, particle counter...

13

Example, sanding dust





Sanding (standing)

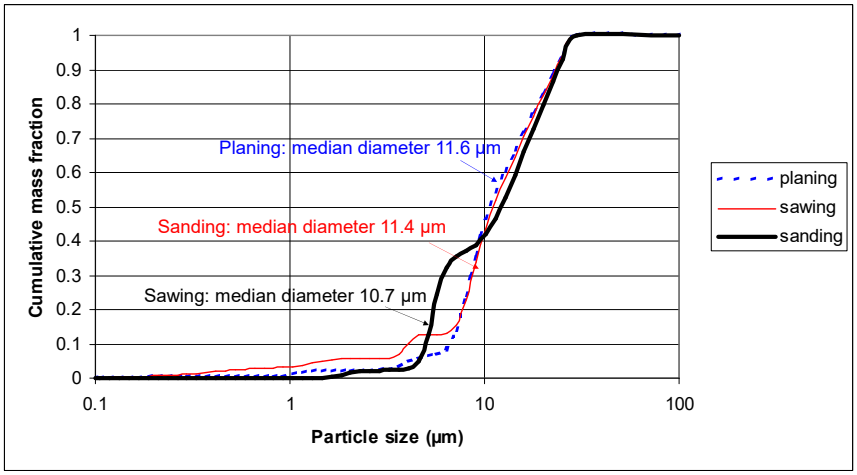
vacuum cleaner

scan

Manual sanding (squatting)

14

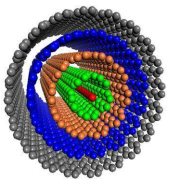
Example: wood dust

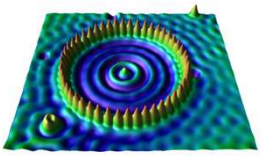


15

Physico-chemical pollutants

Nanomaterials





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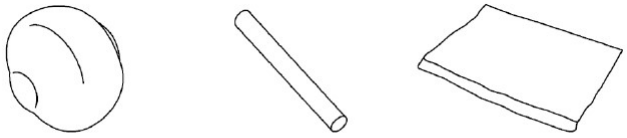
16

Typology

- materials in the order of magnitude of viruses
- sometimes used for several decades
- ISO/TS definition of nanoparticles (September 26, 2008)

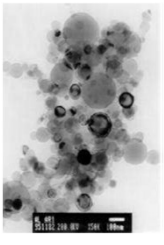


a) particle b) rod c) plate

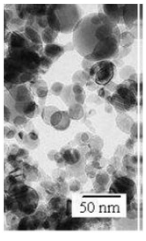
17

Typology

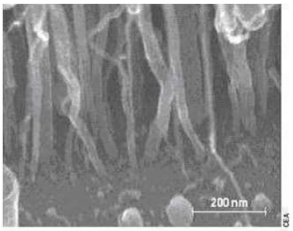
- **Nanomaterials:** materials consisting of manufactured nanoparticles with a size of less than 100 nm



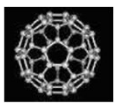
Aluminium nanoparticles (Champion and Bigot, 1998)



Copper nanoparticles (CNRS)



Carbon nanotubes (CEA)



Fullerene (CNRS)

18

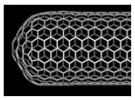
Properties

- Description of the main families of nanomaterials

New properties: mechanical, electrical, optical, thermal, magnetic, chemical, barrier, surface, etc.

Examples:

- Gold: Gold nanoparticles have particular catalytic properties, especially for CO.



- Carbon nanotubes: the structure of carbon nanotubes is one hundred times stronger and six times lighter than steel, very good thermal conductivity, electrical conductor or semiconductor, etc.

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19

Areas of use

Carbon nanotubes: improving the performance of rackets, manufacturing ultra-resistant textiles, etc.

Silicon oxide: anti-graffiti paint (anti-adhesive function)

Silica: improving tire performance

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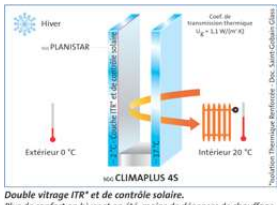
20

Areas of use

TiO_2 : solar cream (improvement of anti-UV properties)
Self-cleaning glazing

Silver : anti-bacterial cushions
Anti-cold glazing



Double vitrage ITR⁺ et de contrôle solaire.
Plus de confort en hiver et en été, moins de dépenses de chauffage.

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21

Production methods

- Bottom up" methods
  - construction of structures atom by atom or molecule by molecule

    Examples: metals, oxides, carbon nanotubes, fullerenes, etc.

    > production 10^5 to/year
- Top Down" methods
  - production from successive fractions of a microstructured material

    Concerns all types of materials (ceramics, metals, polymers, semiconductors)

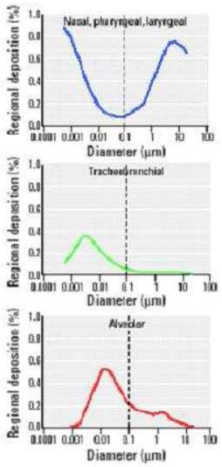
    production 10^{2-3} to/year

    the manufacturing process determines the type of impurities found in the final material

22

Toxicity to humans

- Toxicology of ultrafine particles
- Toxicology of manufactured nanoparticles
  - Few studies to date
  - Potential factors: size, air and surface reactivity, chemical composition, shape, number, agglomeration capacity, presence of process-related impurities, etc.
  - Routes of exposure: inhalation (predominant), skin contact and ingestion

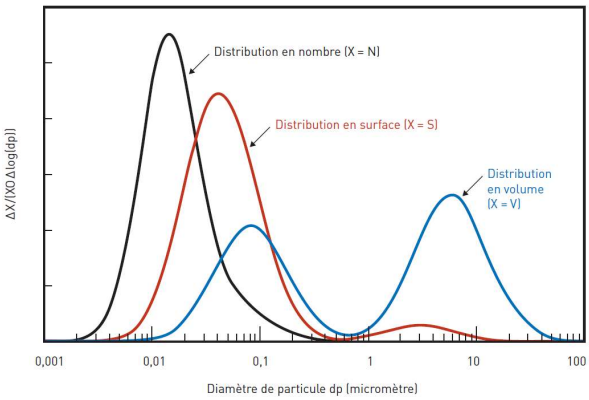


Nanoparticle deposition sites (Oberdörster et al., 2005)

23

Fine and ultrafine particles (UF)

Almost all aerosols are expressed in mass concentrations (exception: asbestos, radioactive aerosols)



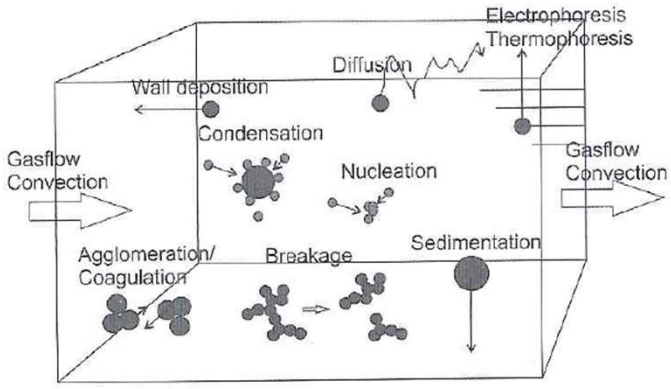
UF represent almost always a very small mass fraction of the aerosol

INRS. ND 228-199-05.Note documentaire. Ultrafine particles and occupational health - Sources and characterization of exposure. 2005

24

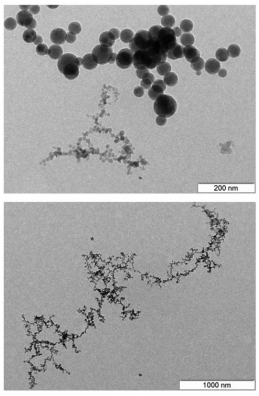
Fine and ultrafine particles (UF)

Behavior of ultrafine particles

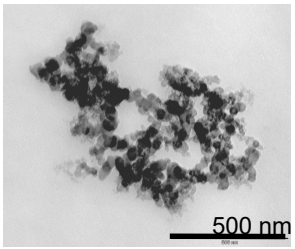


25

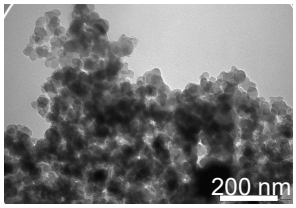
Examples, nucleation & condensation



Stainless steel welding



Diesel particle



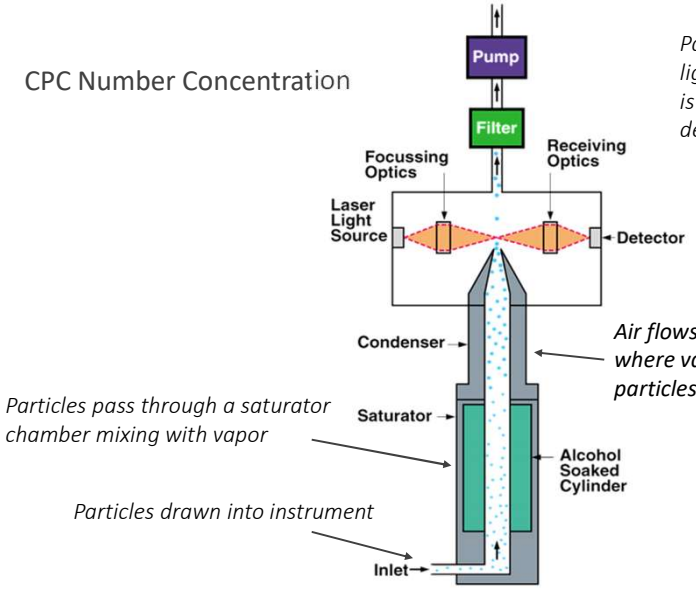
Hexane soot

26

26

Measurement of UF particles

CPC Number Concentration



Particles scatter laser light which is detected by a photo-detector

Air flows through a condenser where vapor condenses onto the particles

Particles pass through a saturator chamber mixing with vapor

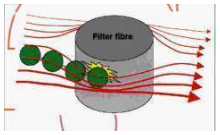
Particles drawn into instrument

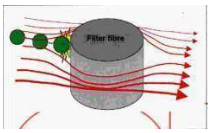
27

27

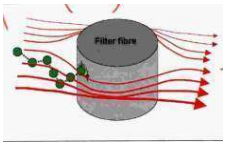
Prevention of exposure

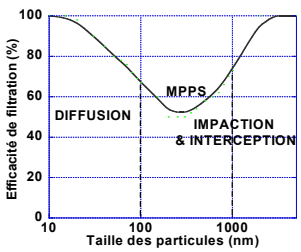
- Efficiency of "classic" filtration
  - Inertial deposition - Interception deposition





  - Deposit by diffusion





28