**Lecture topics:**

• Atmospheric processes - role of aerosols

• Characterization of aerosol particles

• Forces and interactions

• In nation and measurements

• Health effects of particles

• Applications

• Standards and guidelines

• Aerosols in indoor and outdoor environment

• Motor vehicle emissions

• Other

**Aims of the lecture series:**

•To provide students with a broad understanding of all aspects related to environmental aerosol science, with a focus on physics.

• To show the scientific depth and complexity.

• To present applications and current directions.

**Why study environmental aerosols?**

**Reason 1**: Because particles constitute one of the most important pollutants affecting human health. (Evans. Et. al 1984): "We are of the opinion that the cross-sectional studies reflect a causal relationship between exposure to airborne particles and premature mortality... However, we are in the minority in taking this view." (Dockery et al 1993).

**Reason 2**: Approaches taken in environmental aerosol studies could be used in any other area of environmental studies or in any other type of interdisciplinary studies.

**Reason 3**: Understanding of aerosol processes and interactions, can be used in the most advanced areas of industry and technology such as material synthesis, microelectronics, and pharmacy.

**Reason 4**: For the challenge of it - if you do not do it, the others might do it, or nobody will do it!

**Definitions of**:

**Aerosol**: an assembly of liquid or solid particles suspended in a gaseous medium long enough to enable observation or measurement. Generally, the sizes of aerosols are in the range from 0.001 to 100μm.

 **Dust**: solid particles formed by crushing or other mechanical breakage of a parent material. These particles generally have irregular shapes and are typically around 0.5m.

**Fog & mist**: liquid aerosol particle of 10μm – 100μm ion diameter. \*

**Fume**: particles that are usually the result of vapor condensation with subsequent agglomeration usually <0.05mm.

**Particle**: small discrete objects.

**Particulate**: a particle.

**Smog**: an aerosol consisting of solid and liquid particles, created at least in part, by the action of sunlight or vapor; thus <2μm.

 **Smoke**: a solid or liquid aerosol, the result of incomplete combustion or condensation of supersaturated vapor; typically, <1μm.

**Nature of Aerosols**:

*Natural sources*: soil and rock debris, forest fires, sea salt, volcanic debris, biogenic (pollen, viruses, bacteria, etc.)

*Anthropogenic sources*: Fuel combustion and industrial processes, industrial processes fugitive emissions, nonindustrial fugitive emissions, transportation, etc. The investigation of airborne pollutants is basically entered within **Environmental sciences**.

Its main aspects are:

• Interdisciplinary by nature;

• Science of the interactions;

• crosses the boundary between science and non-science;

**INSTRUMENTATION AND MEASUREMENTS**

**1. Measurement techniques**

What to measure?

• Particle mass;

• Particle number;

• Mass or number size distribution;

• Chemical composition;

• Biological composition;

• Radioactivity;

• Combination of these;

**How to measure**? In general, each aerosol measurement technique covers a unique range of particle characteristics such as:

• Concentration;

• Size;

• Shape;

• Chemical or biological composition;

Choosing the proper instrument for a particular application is of critical importance.

A thorough understanding of the principles and limitations of each measurement method is essential.

**Type** of aerosol measurements

• sample collection and real time measurements (on site);

• active (e.g., pump) and passive sampling (exposure of collecting device);

• personal and area sampling (in either case should be representative);

• continuous measurements or grab sampling (e.g., once an hour);

• sampling from flows - isokinetic sampling;

The **degree of comprehensiveness** in air quality assessment is a function of the endpoint

• Basic research;

• Regulatory compliance (sampling procedure to achieve comparable results);

• Remedial action;

Detection is a two-stage process:

1) Measurement for the determination of the quantity;

2) Data convolution for the determination of the quality

**a) Mass** measurement techniques

Sample collection methods (static):

• Filter collection;

• Inertial and gravitational collection;

• Diffusional deposition;

• Electrostatic deposition;

Dynamic methods

• Piezoelectric mass monitor;

• Tapered-Element Oscillating;

• Microbalance Method (TEOM);

• Optical techniques: light scattering;

• Aerosol photometer – nephelometer;

**b) Number concentration** measurement techniques - concentration of atmospheric particles is most commonly performed using (both techniques provide no information about the size distribution):

• Condensation nucleus counters;

• Aerosol electrometers;

**c) Size distribution** measurement techniques: for atmospheric particle size classification, it includes:

• optical particle counters (inlets determines which sort of particles may be measured);

• electrostatic classifiers;

• diffusion batteries;

**d) Combination of physical measurement techniques**:

 Information on particle size distribution is generally obtained by combining a dynamic aerosol detection technique with a size classification technique.

**2. Filter collection**:

 Filter collection is conducted for further:

• Gravimetric analysis (mass – standard filters do not allow microscopic analysis)

• Microscopic analysis (shape, number, elemental composition, morphology)

• Micro chemical analysis (chemical composition; organic and inorganic; elements and

 compounds)

• Radioactivity measurements

 Filter holders can be:

• Opened-faced

• In-line

• Cassette variety

**General consideration:**

in setting up a filtration sampling system:

• Selection of a filter (according to application must for example withstand elevated temperatures);

• ensuring a positive seal (leakages falsify results);

• flow rate stability and measurements; e.g. [m3/s];

• minimizing particle losses in the system;

• filter performance testing;

**Selection of a filter -** Criteria for selecting a filter:

• Collection efficiency of the filter for the aerosol size distribution to be tested;

• Pressure drops across the filter;

• Compatibility of filter with the sampling conditions (such as temperature, pressure, humidity, corrosiveness, etc);

• Cost constrains relating to sampling effort and the number of filters required (filters may cost up to AU$ 100 apiece).

\*

نصف القطر الأيوني

نصف القطر الأيوني هو نصف قطر أيون لذرة ما. على الرغم من صعوبة تحديد شكل نهائي للذرات أو للأيونات، إلا أنه يمكن اعتبارها على شكل كرات ذات أنصاف أقطار، بحيث أنه في مركب أيوني يكون مجموع نصفي قطر الكاتيون والأنيون يعطي في النهاية المسافة بين الأيونات في الشبكة البلورية