**Lecture topics:**

• Atmospheric processes - role of aerosols

• Characterization of aerosol particles

• Forces and interactions

• Inntation 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: ".... Quote from indoor air paper: the unknowns.

**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 vapour 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 vapour; 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:

i) measurement for the determination of the quantity;

i) data deconvolution 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 drop 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)