Airborne particulates

liveAirData Air quality monitoring

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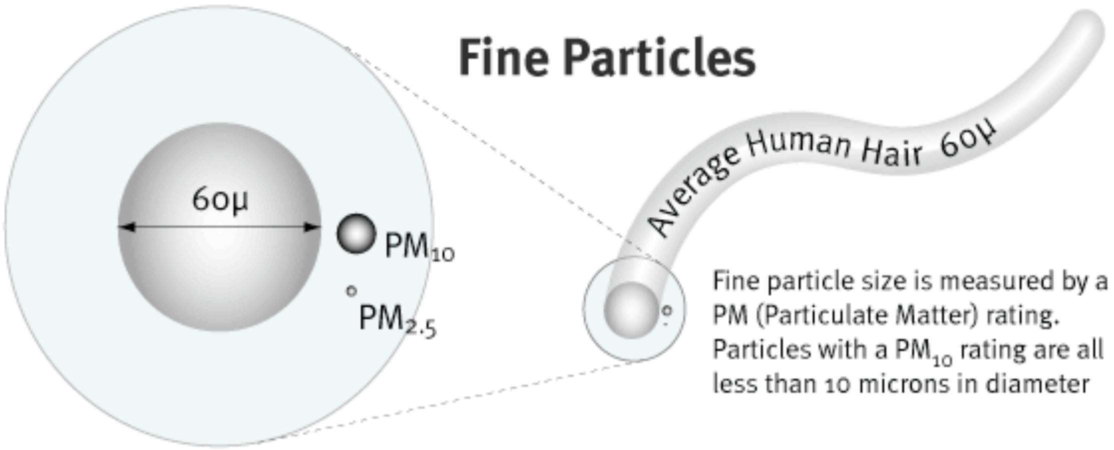
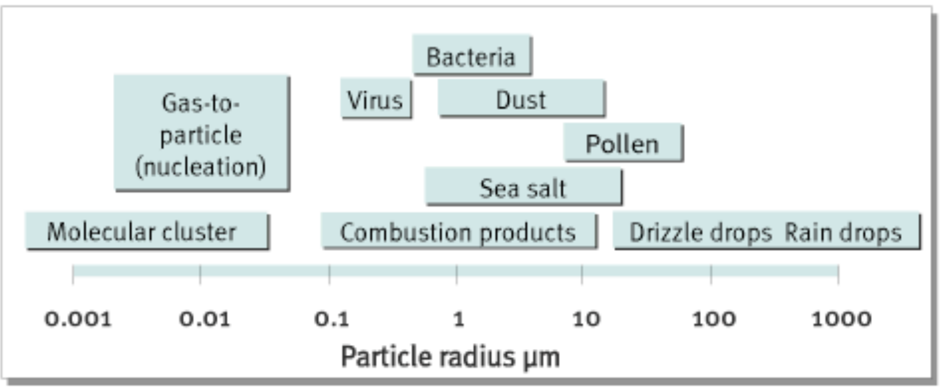
Particulate matter is the term used to describe particles that are suspended in the air. Particles may be solid or liquid and are one of the most obvious forms of pollution as they are visible in the hazes that cover a city or region.

Size is the main determinant of the behaviour of an atmospheric particle. The size is usually expressed in terms of the 'aerodynamic diameter' which refers to unit density of spherical particles with the same aerodynamic properties, such as the falling speed.





Queensland Government Environmental Protection Agency

Larger particles (greater than 50µm) usually only remain in the air for a few minutes and settle near the source. A µm is one millionth of a metre, or 0.000001m). Smaller particles (less than 10µm, known as PM_{10}) can remain in the air for several days and can be spread by winds over wide areas or long distances from the original source.

Fine particles (between 0.1-2.5µm) may remain in the atmosphere indefinitely. Fine particles are capable of scattering light, causing a reduction in visibility.

Particles are generally removed from the atmosphere by rain or when they come into contact with surfaces. Some particles may have other pollutants attached to them, which may react with those surfaces.

Windblown dusts, pollens from plants and sea salts are natural sources of particles in the atmosphere. Bushfires, agricultural and forest hazard-reduction burning release smoke particles into the air.

Combustion processes using coal and other fossil fuels, such as power generation, industrial operations and motor vehicle fuels, emit most of the particulate matter in urban areas. Other noticeable sources of particles include agricultural burning practices (e.g. burning of sugar cane prior to harvesting) and emissions from domestic solid fuel heaters and woodstoves

Environmental effects of particulate matter
Particulate air pollution can cause a wide range of damage to surfaces and materials. Merely by requiring more frequent cleaning, particulates can accelerate deterioration. If the particle is corrosive or has other pollutants, for example sulfur dioxide, attached to it then it may also react with or corrode the surface or material.

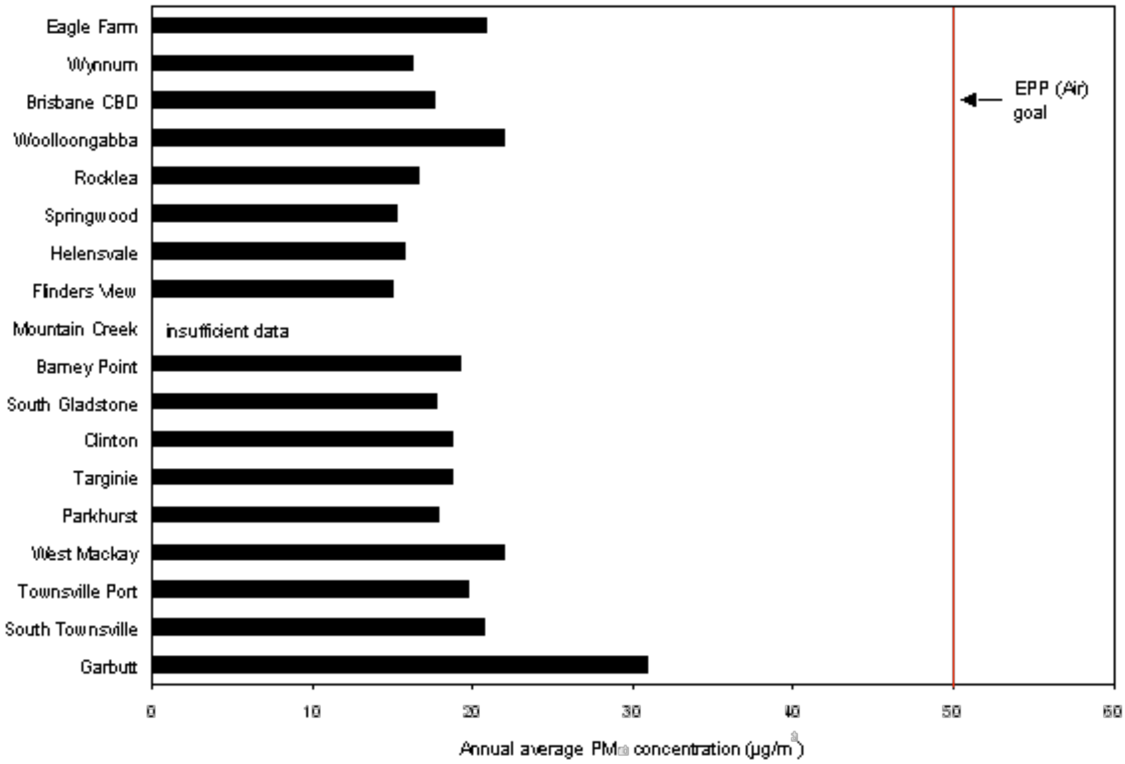
Health effects of particulate matter
Under normal conditions a human respiratory tract in good health is able to deal with inhaled particles without undue stress or long-term effects. In sensitive individuals, or when high levels of particles are present, particulate matter may contribute to increased rates of respiratory illnesses and symptoms.

Studies indicate that such adverse effects are dependent on a number of factors, including:

- particle size (whether particles can penetrate the lower airways),
- the intensity of the exposure,
- the chemical nature of the particles and their interaction with human tissue,
- the presence or absence of pre-existing conditions (especially diseases of the respiratory tract), and
- meteorological factors such as winds, humidity, a temperature inversion, rain or thunderstorms.

Air quality goal
Inhalable particles (those with diameter less than 10µm) are commonly understood to pose the greatest risk to human health. There have been extensive studies into the health effects of different levels of particles and pollution mixes. However, no studies have yet determined a threshold value for long-term or short-term exposure below which no adverse health effects are observed.

The national 24-hour exposure standard for PM_{10} in the Air NEPM is 50 µg/m^3. This is the same as the EPP(Air) goal for annual average PM_{10} concentrations. The EPA monitors PM_{10} in south-east Queensland, Gladstone, Rockhampton, Mackay and Townsville. The annual PM_{10} average in these areas for 2001 were below the EPP(Air) goal (see below). See what the current PM_{10} concentrations are at the EPA's monitoring stations throughout Queensland.



Measurement of particulate matter

Dustfall deposit gauge

Dustfall measurements are commonly used to determine if a particle source poses an unacceptable level of nuisance to nearby residents.

The dustfall deposit gauge is a simple piece of monitoring equipment. The gauge comprises a glass funnel supported in the neck of a large glass bottle, which can be mounted in a steel bucket on an elevated stand if necessary. The photo (right) shows a dustfall deposit gauge set up on the ground.

The gauge is typically left for one month so that a measurable quantity of dust is collected. At the end of the period the gauge is returned to a laboratory for analysis.

The rate of dustfall is calculated by dividing the weight of insoluble material (milligrams) collected by the cross-sectional area of the funnel (metres^2)and the number of days over which the sample was taken. The units of measurement are milligrams/metre^2/day.

Levels in industrial areas are usually found to be higher than in other areas. Chemical analysis of the dust can identify pollutants and assist in identifying the likely emission source.

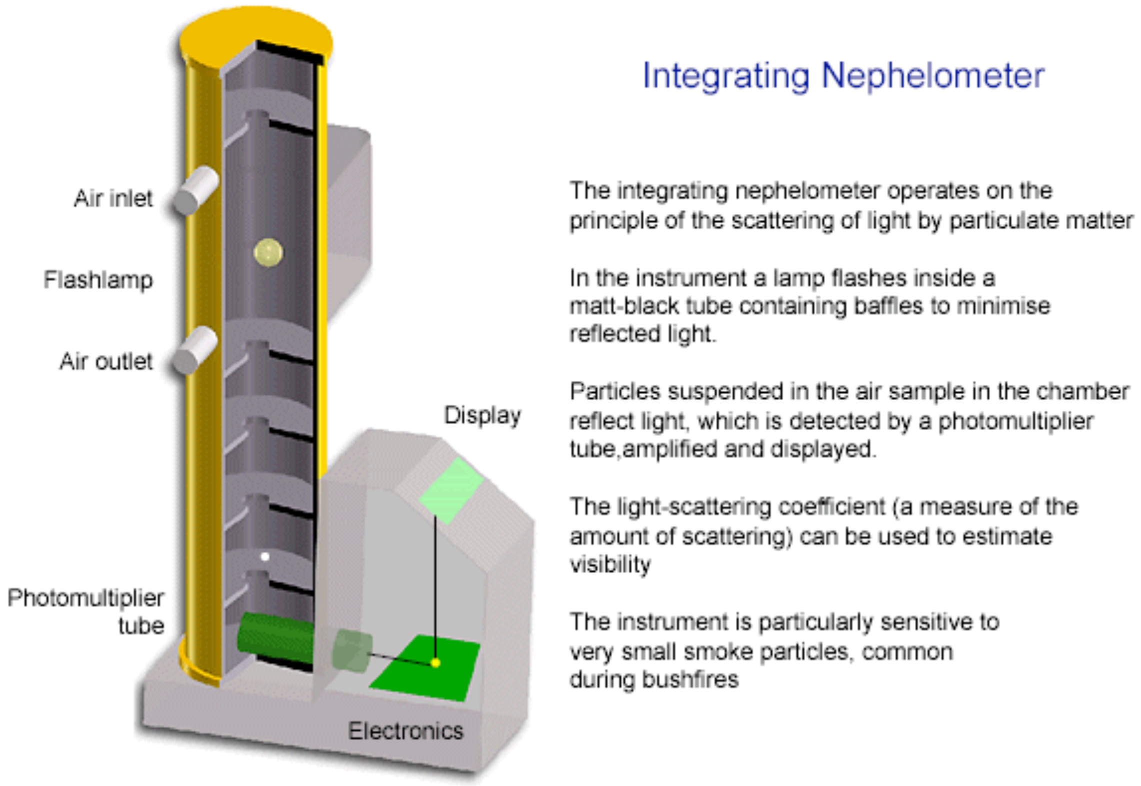
Monitoring of aerosols

Aerosol monitoring is usually conducted to determine the amount of visibility loss due to fine particles present in the air.

Monitoring of aerosols is achieved by light scattering measurements in an instrument known as a nephelometer (shown right) which essentially comprises a light source, sample tube and light detector.

A schematic of the operation is shown below. Note in the diagram how the detector is situated to measure light at right angles to the axis of the beam, to avoid any direct (un-scattered) incident light.

The light detector reading gives a visibility measurement corresponding to the extent of haze.



Total suspended particulate matter (TSP)

TSP monitoring is used to determine the total amount of suspended particular material present in the atmosphere. Samples are currently used for lead determinations.

Total suspended particulate matter (TSP) is measured using a high-volume air sampler that draws a large known volume of air through a pre-weighed filter for 24 hours. After sampling, the filter is re-weighed and the difference in filter weight is the particulate mass.

The concentration of TSP in the air is calculated as the particulate mass divided by the volume of air sampled. The particulate matter retained on the filter can be analysed to determine the concentration of other pollutants, such as lead or other metals.

The design of the air inlet means that airborne particles with diameters greater than 50µm are unlikely to be drawn into the sampler. TSP sampling takes place at six-day intervals.

PM$_{10}$

The health effects of particles smaller than 10µm are of particular concern as these particles can enter the human respiratory system and penetrate deeply into the lungs, causing adverse effects.

PM$_{10}$ is generated by diesel and petrol motor vehicles and other combustion processes that burn fossil fuels, such as power generation, industrial processes and domestic solid fuel heaters. Smoke particles from bushfires are another sporadic source of PM$_{10}$ emissions.

PM$_{10}$ is measured using either a high-volume air sampler or a tapered element oscillating microbalance (TEOM) sampler.

PM_{10} high-volume air samplers

The PM_{10} high-volume air sampler is similar to that described above for TSP,except that the air sample is drawn through a size-selective inlet (the gold dome shown in the picture) which removes particles larger than 10µm by impaction, while particles less than 10µm in aerodynamic diameter pass through the instrument onto the pre-weighed filter.

High-volume air samplers are programmed to take a 24-hour sample at six-day intervals. The filter is weighed before and after the sample is taken to determine the concentration of PM_{10} particles in the air.

PM10 tapered element oscillating microbalance (TEOM) samplers

The second technique uses a tapered element oscillating microbalance (TEOM) sampler (right) fitted with a size-selective inlet to monitor PM_{10} concentrations.

These samplers draw air through a filter mounted on a vibrating glass tube. As PM_{10} particles get trapped on the filter the additional weight changes the oscillating frequency of the tube. This frequency change is converted into a particulate mass that can be divided by the volume of air being drawn into the instrument to produce a PM_{10} concentration.

TEOM samplers operate on a continuous basis and do not need filter changes as frequently as high-volume air samplers.

An advantage of continuous monitoring is that it can provide additional information, such as the time of day that peak concentrations occurred. Such information may be used in conjunction with meteorological data to help identify the source of an emission.

At some stations in south-east Queensland high-volume air samplers and TEOM samplers are located together for quality assurance purposes to ensure that data obtained from the two instruments is comparable.

PM_{10} TEOM samplers are also operated in conjunction with $PM_{2.5}$ TEOM samplers at two stations in south-east Queensland to investigate particle size distribution.

$PM_{2.5}$

Of the total PM_{10} fraction those particles with aerodynamic diameters below 2.5 micron, or $PM_{2.5}$, are now considered to be the major contributor to human health effects, as these particles can penetrate and block the very small passages of the lungs.

$PM_{2.5}$ comes from the same sources as PM_{10}, mainly fuel combustion processes. As the particles are so small and fine they can remain suspended in the atmosphere for very long periods. These fine particles are capable of scattering sunlight, resulting in reduced visibility over long distances.

In Queensland, $PM_{2.5}$ is measured using TEOM samplers similar to the instruments that measure PM_{10}. The picture on the right shows the $PM_{2.5}$ sampling inlet head used on the TEOM air sampler.

Last updated: 07 April 2006