

Particulate Matter – PM10 and PM 2.5

Particulate matter is the term for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets. Some particles are large or dark enough to be seen as soot or smoke. Others are so small that individually they can only be detected with an electron microscope.

Some particles are directly emitted into the air from a variety of sources, including cars, trucks, buses, factories, construction sites, tilled fields, un-paved roads, stone crushing, and the burning of wood. Other particles may be formed in the air from the chemical change of gases, these are secondary pollutants. They are indirectly formed when gases from burning fuels react with sunlight and water vapor. These can result from fuel combustion in motor vehicles, power plants, and in other industrial processes. Although there are many sizes of particulate matter, two size categories are focused on in particular.

PM10

Particulate matter 10 microns or less in diameter (PM10) has been U.S. EPA's indicator for the short and long-term health related particulate standards. In establishing this particulate standard, U.S. EPA considered the following:

- Biological responses to particles that penetrate and are deposited in the various regions of the respiratory tract influence health risks posed by inhalation.
- Particles deposited in the thorax (trachea, bronchial and alveolar regions) pose the greatest risk.
- Particles deposited elsewhere in the body pose relatively low risks.

At the time, U.S. EPA chose the 10 micrometer "cut point" in setting the size-specific indicator for the standard. This indicator ensured that the standard accounted for the full range of particles capable of penetrating to sensitive lung areas.

PM 2.5

Since 1987, epidemiological* research has shown that adverse health effects and increased mortality occur at particulate levels below the current PM₁₀ NAAQS. Other research suggests that particle size fractions smaller than 10 microns may contribute significantly to the most serious health effects. This is due to the ability of the finer particulate matter to penetrate deeper into the lungs. Based on this research, U.S. EPA re-evaluated the 10 micrometer cut-point and adopted a second particulate matter standard with 2.5 microns as the "cut point" (PM 2.5).

* Epidemiology investigates the associations between levels of a given pollutant (fine particles) and health responses like absence from school or work, decreased lung function, increased emergency room visits, increased hospital admissions and increased mortality.

Sources

Most small particles are "secondary" particulates, i.e., they are particles or aerosols formed in the atmosphere from other vaporous or gaseous pollutants. For example, sulfates are small particles formed when sulfur dioxide oxidation products combine with water vapor or ammonia. Fine carbon particles are formed when organic compounds, in the presence of catalytic particles, are reduced to elemental carbon. In addition, certain materials processing operations such as coal mining, mineral refining and quarrying activities may suspend PM₁₀ in the air.

Health Effects

Particulates under 10 microns in diameter may lodge deep in the lungs. PM10 can affect health in many ways. For example:

- Short-term exposure can irritate the lungs and perhaps cause immune responses; lung constriction, producing shortness of breath and cough may result.
- Materials dissolving from the particles can damage cells.
- Long-term, lower level exposure may cause cancer and premature deaths. (A series of studies has related daily mortality in some U.S. cities with PM₁₀ concentrations.)

Those with a known history of asthma or chronic lung disease are especially sensitive to these effects. The elderly or those with pre-existing heart conditions may also have severe reactions, since the resulting lack of oxygen may strain the heart.

Particulates which cause mechanical irritation include soot, fly ash, pollen, fungi, yeast and salt.

Particles may also be composed of compounds which form acids when mixed with moisture in the lung.

Zinc ammonium sulfate is often reported as a constituent of smog, and particles of this compound form sulfuric acid in the lungs. Animals exposed to approximately 1 micrometer particles of this compound were more susceptible to respiratory infection than animals exposed to other particulates of similar sizes.

Particles of this compound also cause bronchial tubes to constrict more easily than particles of other compounds, especially in asthmatics and those who have chronic lung diseases.

Soot, fly ash, automobile and diesel exhaust particles contain many compounds such as benzo(a)pyrene, which the U.S. EPA classifies as probable human carcinogens. (Chronic inhalation exposure to these types of particles induces a number of different cancer types in laboratory animals.) Diesel exhaust particles are particularly potent tumor inducers.

Other Effects

Particulate matter is a major cause of reduced visibility (haze) in parts of the United States. Particles can be carried over long distances by the wind and settle on the ground or water. The effects of this settling can include

- Making streams and lakes acidic.
- Changing the nutrient balance in coastal waters and large river basins.
- Depleting the nutrients in soil.
- Damaging sensitive forests and farm crops.
- Affecting the diversity of ecosystems.

Soot, a type of particulate matter, can also stain or damage stone and other materials