Classification of Air Contaminants

Composition of the Atmosphere

Under natural circumstances, the air we breathe contains (by volume) approximately 78% nitrogen, 21 % oxygen and trace amounts of argon, neon, helium, krypton, hydrogen, nitrous oxide and xenon as permanent gases. Variable gases in the atmosphere are water vapour (0 to 7% by volume), carbon dioxide (.03%) and much smaller amounts of methane, carbon monoxide, ozone, ammonia, nitrogen dioxide, sulphur dioxide and hydrogen sulphide. The atmosphere is also a host to natural atmospheric impurities in the form of particles and gases that originate from wind erosion, sea spray evaporation, volcanic eruption and biological processes such as sporing and pollinating.

Definition of Air Contaminant

When a substance enters the atmosphere in large enough quantities to disrupt the natural balance of gases and permanent atmospheric impurities in the air, it is a contaminant (or pollutant). Air contaminants may be chemically organic or inorganic; their sizes range from submicroscopic and microscopic substances to those which are visible to the human eye (macroscopic). The effect which a contaminant has on the environment may range from toxic to harmless. The response of living things to a given contaminant often depends on the sensitivity of the individual organism.

Air contaminants may be particles or gases. A particle is a solid or a liquid that has definite physical boundaries; a gas does not have specific physical limits for it can expand indefinitely. Particles and gases acting together as contaminants are sometimes called 'dispersoids' and solids and liquid particles suspended in a gas are often referred to as 'aerosols'.

Measurement of air Contaminants by Size, Count and Weight

The unit of measurement used to describe the size of particles and gases is the micron.One micron equals one-millionth (1/1,000,000 or.000001) of a metre; 25,400 microns equal one inch.

An average diameter of 10 microns is considered to be the dividing line between visible and invisible particles. An electron microscope can resolve particles down to 0.005 micron in diameter. If air currents do not aid their suspension, visible particles greater than 10 microns in diameter settle quite rapidly because of gravity. The visible particles, however, constitute a minor percentage of the particles in the air.

Particles less than 1 micron in diameter has so little mass that gravity has negligible effect on them.

On a particle count basis over 99% of the particles in a typical atmosphere are below 1 micron in size . . . even clean country air will normally contain over 1,000,000 particles per cu ft2.

The weight of a particle increases proportionally to the cube of its diameter. Even though particles about 0.01 micron make up 80% of ihe number of particles in the atmosphere, they contribute only 1 % of the weight of all particles for a specified volume. It is particles ranging from 1 to 10 microns in diameter that contribute the majority of the weight for air contaminants.

Types of Air Contaminants

The following classification of air contaminants into types is based on the physical state of the contaminant (solid, liquid or gas) and the normal physical state of the material from which it originates.

Dusts are minute solids projected into the air by the breaking apart of large solid masses or simply by the scattering of pulverised material. When natural forces such as wind, volcanoes and earthquakes produce excessive amounts of atmospheric impurities in the form of dusts and flyash they become contaminants. Mechanical processes that create dusts often include crushing, grinding, demolition, blasting, drilling, shovelling, screening and sweeping.

Dust explosions can be produced when organic or mineral dusts are exposed to a source of ignition in an enclosed area. The high concentration of organic dust in flourmills and grain elevators is a prime example of locations where dust explosions might occur. Often a primary explosion occurs from the ignition of a small amount of dust. This can dislodge large accumulations of dust on horizontal surfaces, which produces a larger secondary explosion.

Generally, dust clouds require high temperatures, a sufficient amount of dust, an adequate supply of oxygen and an enclosed space for ignition. Explosive dusts are potential hazards whenever the dust escapes uncontrolled to disperse in the atmosphere or settle on horizontal surfaces such as beams and ledges.

Fumes are very fine solids formed by the condensation of vapours of combustion from materials that are normally solid. Metallic fumes such as iron, copper and zinc oxide are generated from molten metals and usually occur as oxides because of the chemically reactive nature with the available oxygen in the air. Fumes which are permitted to age are said to ‘flocculate' into clusters of larger size.

Pollen which comes from weeds, grasses and trees is responsible for hay fever and some allergies. Although ragweed pollen ranges from 15 to 25 microns in diameter, most pollen grains vary widely in size and their weight varies according to the relative humidity.

The pollen count is determined by exposing an adhesive-coated glass plate outdoors for 24 hours and then counting calibrated areas under the microscope. Daily pollen counts reported during the hay fever season represent the number of grains found on 1.8 square centimetres after 24 hour exposure of the glass plate. However, the pollen count per cubic yard may vary from 2 to 20 times the number found on the calibrated gravity slide depending on grain diameter, shape, specific gravity, wind velocity, humidity and location of the collecting plate. Hay fever sufferers may notice their first symptoms when the pollen count is 10 to 25. In some localities the pollen count may reach 1,000 during the peak of the hay fever season depending on the methods used for counting the pollen.

Airborne Micro-Organisms are frequently a public health hazard because they cause diseases. Commercial enterprises may be further concerned because mould or yeast, which range from 1 to 10 microns in diameter may cause product loss. Wild yeast, for example, can use the air as a transfer medium to destroy a batch of beer or wine. Also some industries involved in rnedical, space and computer technology need to develop their produces in environments free from airborne micro-organisms.

Most micro-organisms become airborne by their attachment to dust particles. Bacteria derived from the soil are likely to be spore formers, minute unicellular organisms that are capable of surviving in hostile environments. Other airborne bacteria, especially within closed occupied spaces, often originate from droplet nuclei caused by such actions as sneezing. The concentration of microorganisms in the atmosphere varies over a wide range from a few to several hundred per cubic foot of air.

Mists are liquids dispersed into very small droplets. Atomizing, spraying, chemical reactions, bubbling gases through liquids or allowing a gas to escape from a liquid under pressure are all ways to produce mists. Sneezing constitutes a mist which contains some contaminants that are micro-organisms.

Smokes are extremely small, solid and/or liquid particles produced by incomplete combustion of organic substances such as tobacco, wood, coal, oil and other carbonaceous materials. Although a distinction is made in technical literature between soot, carbon particles, flyash, cinders, tarry matter, unburned gases, and gaseous combustion products, smoke is often used in place of all these terms. Smoke particles vary considerably in size, the smallest being much less than 1 micron, often in the range of 0.1 to 0.3 micron.

Smog implies an air mixture of smoke, mists and fog particles of such concentration and composition in the air that they impair visibility and may be irritating and harmful. While smog composition varies widely between different locations and at different times, the term is often applied to the haze caused by sunlight-induced photo-chemical reaction involving the materials in motor car exhausts. The most common chemical constituents of this haze are varying amounts of nitrogen compounds, hydrocarbons and ozone. Smog is often associated with temperature inversion in the atmosphere which prevents the normal dispersion of air contaminants.

Gases are actually formless fluids which tend to occupy a space or enclosure completely and uniformly. Proper temperature and pressure control may be used to liquify or solidify gases. Gas molecules are less than 0.0001 micron in size. Typical man-made gas pollutants of the atmosphere are carbon monoxide, sulphur oxides, hydrocarbons and nitrogen oxides.

Fogs are usually formed by the condensation of a vapour from a material that is normally a liquid. Condensed water vapour in the atmosphere is a common occurrence of harmless fog.

Radioactive Pollutants present distinctive problems because the concentration at which most such materials are hazardous are much lower than hazardous concentrations of ordinary pollutants. The properties of radioactive material which may be a particle or a gas and can be removed from the air by filters and absorption traps, must be distinguished from the radiation given off by the material. Radiation may be composed of alpha, beta or gamma particles.