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CHAPTER 11

AIR CONTAMINANTS

Classification of Air Contaminants; Sizes of Airborne Particles; Industrial Air Contaminants, Flammable Gases and Vapors; Combustible Dusts; Air Pollution; Radioactive Air Contaminants; Fallout; Atmospheric Pollen; Airborne Bacteria

AIR is a mechanical mixture of many gases. Normal air will consist of approximately 21 percent oxygen, 78 percent nitrogen, 1 percent argon, and 0.03 percent carbon dioxide. In addition, there are trace amounts of other inert gases, including hydrogen, neon, krypton, helium, ozone, and xenon, plus varying amounts of water vapor and small quantities of microscopic and submicroscopic solid matter, sometimes called *permanent atmospheric impurities*.

Man is dependent upon air to sustain life, but significant variations in the percentage composition of these *normal constituents* may render the air unfit for his use. In addition, the presence of other foreign materials which may be classified as *contaminants* may also render the air unfit. The ventilating and air-conditioning engineer should recognize that air is subject both to variation and contamination, since he is responsible for both the quality and quantity of air provided.

Variation in Air Composition

The composition of air may be changed accidentally or deliberately. In locations such as sewers, sewage treatment facilities, or utility tunnels, the oxygen content of the air may be reduced to such low levels that man cannot remain conscious or survive. Man's normal respiratory functions also can reduce the oxygen content in a similar manner and cause a buildup of carbon dioxide. However, this is of most concern in sealed atmosphere capsules.

For the pilot of high altitude aircraft, air composition is deliberately changed by the addition of oxygen. When man is required to work at extreme depths, it is common to increase the percentage of helium in his atmosphere and reduce the nitrogen concentration.

Air Contaminants

Normal air contains varying amounts of foreign materials commonly referred to as *permanent atmospheric impurities*. These materials can arise from such natural processes as erosion, wind storm, sea spray evaporation, and volcanic eruption. The concentrations in the air will vary considerably, but usually will be far below the concentrations caused by man-made activity.

Man-made contaminants are those materials, including ozone and various chemical sanitizers, deliberately added to

The general responsibility for this chapter is assigned to TC 4.3, Industrial Environment.

the air for purposes of disinfection, as well as materials added incidentally, through such processes as combustion, manufacturing, transportation, and agriculture.

CLASSIFICATION OF AIR CONTAMINANTS

Air contaminants may be classified at various times as *organic* or *inorganic*, *visible* or *invisible*, *submicroscopic*, *microscopic*, or *macroscopic*, *particulate*, or *gaseous*, *toxic* or *harmless*. A classification based chiefly on the origin or method of formation of the material consists of the following groups: (1) dusts, fumes, and smokes, which are *solid particulate matter*, (2) mists and fogs, which are *liquid particulate matter*, and (3) vapors and gases, which are *non-particulate*.

Dusts, Fumes, and Smokes

Dusts are solid particles projected into the air by natural forces such as wind, volcanic eruption, or earthquakes, or by mechanical processes including crushing, grinding, demolition, drilling, shoveling, screening, and sweeping. Some of these forces produce dusts by the reduction of larger masses, while others simply disperse materials that are already pulverized.

Generally, particles are not called *dust* unless they are smaller than about 100 microns. Dusts may be *mineral*, such as rock, metal, or sand; *vegetable* such as grain, flour, wood, cotton, or pollen; or *animal* including wool, hair, silk, feathers, and leather.

Fumes are solid particles commonly formed by the condensation of vapors from normally solid materials. Metallic fumes are generated from molten metals and usually occur as the oxide because of the highly reactive nature of finely divided matter. Fumes may also be formed by sublimation, distillation, galvanization, or chemical reaction whenever such processes create airborne particles predominantly smaller than one micron. Fumes which are permitted to age tend to *flocculate* into clusters of larger size. This phenomenon is used often to facilitate the removal of fumes from air.

Smokes are extremely small, solid particles, produced by incomplete combustion of organic substances such as tobacco, wood, coal, oil, and other carbonaceous materials. The term *smoke* is commonly applied to the mixture of solid, liquid, and gaseous products, although distinction is made in the technical literature between such components as *soot* or *carbon particles*, *fly ash*, *cinders*, *larry matter*, *unburned gases*, and *gaseous combustion products*. Smoke particles vary con-