THESE MATERIALS PROVIDED BY
BALL STATE UNIVERSITY LIBRARIES
NOTICE: This material may be protected
by Copyright Law (Title 17, US Code)

Air-Borne Matter, Part I

Characteristics and Industrial Implications

By Henry L. Muntgomery Larcombe

THE centralisation of industrial activity in and around the great cities of the world has resulted in the pollution of the surrounding air by a great variety of air-borne matter. This matter may range from heavy process dust to smoke particles beyond human visibility. It may be a direct product or an indirect product, but it is essentially a nuisance. The direct importance of collecting dust that has commercial value is obvious. In addition, there should be taken into consideration the indirect financial importance of eliminating or collecting all kinds of dust, fog, fume or smoke, to reduce building and equipment maintenance, to increase human comfort and well-being, eliminate dangers of occupational disease and generally increase the efficiency of the industrial machine.

The average impurity content of the atmosphere in country districts is less than 1 mg. of solid matter per cu. m. This increases in a city to an average of 3 mg. per cu. m. and as much as 5 mg. in an industrial centre.

This has been confirmed by dust counts with apparatus designed especially for this work. The number of particles counted in 1 cu. ft. of air varies, but the dust count is basically dependent on the manner in which the dust counter collects the particles on glass slides and upon the degree of magnification. Dust determination made with the Aitken dust counter in Glasgow found 3,736,000 particles per cu. in. In the United States experiments made with the Hill dust counter in a number of large cities have resulted in an average of 9,700 particles per cu. ft.; an average of 500,000 particles per cu. ft. was counted during an investigation of the open atmosphere of New York City by means of the Owens jet apparatus.

Between the hours of 8 a.m. and 6 p.m. in winter months the average impurity content is in the region of 0·56 lb. per 10,000,000 cu. ft. of free atmosphere. In London it has risen to a peak content of 1·1 lb. per 10,000,000 cu. ft. of free atmosphere.

Air-borne matter is not confined to the free atmosphere. The dust hazards in factories and mines are of an extremely dangerous nature, and comprise the most important section so far as health is concerned. Any figures we may give for the free atmosphere are dwarfed by the dust content of air in mines and factories where concentrations of anything up to 400 mg. per cu. m. are experienced.

The field of study of dust technology is such a vast one and touches so many schools of science, that all its branches cannot be covered in any single work. It is the purpose of this discussion to review the fundamental characteristics of air-borne matter which must be set down before any detailed research can be made on any particular branch.

Origins of Air-Borne Matter

Dust dispersoids or aerosols in the air are generally assumed to be originated in the following manner :—

(1) *Combustion and Explosion.* Reduction of solid and liquid fuels to ashes, fumes and smoke.
(2) *Crushing.* Disintegration of concrete and asphalt, process dust, milling, pulverised coal, etc.
(3) *Mechanical Dispersion of Liquids.* Spray evaporation, particles of salt in the atmosphere of seaboard districts.
(4) *Condensation of Gases and Vapours.* Formation of rain from water vapours. Condensation of metallic vapours.
(5) *Chemical Reaction.* Production of chemical smokes in industrial plants.
(6) *Various Natural Origins.* Pollens, animal excreta, fungi, soil, sand, bacteria and particles of dead insects.

Measurement of Particle Size

Particles of very small dimensions have a relatively large surface area as compared with their weight. Therefore, when suspended in a gaseous medium they are carried freely by virtue of the viscosity of this medium. The consequent system is not in equilibrium, and is subject to constant and numerous changes. The degree of instability is dependent on the properties and size of the particles, the medium of suspension and the influence of external forces such as gravity, centrifugal force, convection currents or magnetic force.

Measurement of Particles.—These dispersoids may be of a solid or liquid nature. If they are liquid they may take on a spherical form. Solid particles, however, are not usually round, their outline depending upon the structure of the material of origin, and upon the process by which they were generated. They are generally reproductions of the original materials; silicaceous particles assume the form of irregular broken stones; wood dust has the appearance of minute splinters.

The unit of measurement of particle size is now almost universally accepted to be the micron (1/1,000 mm.). For this branch of science it is obvious that the microscope is the chief instrument of size classification. The detection of many ranges of dust necessitates the use of polarised light.

For a standard of comparison the diameter of the human hair varies from 60 to 150 microns, the average being in the region of 90 microns, and an object of 10 microns diameter is generally considered to be the absolute limit of unaided human vision. Considering the above remarks, it is not surprising that such a small unit of measurement is required for this particular work.

Arithmetical Mean.—To indicate the size of such particles, the diameter is usually given. Only perfectly round particles have an accurate diameter, and as has already been pointed out, solid particles have usually an irregular form. Therefore, for these particles another method of measurement is introduced; that is, the arithmetical mean, which is a single figure, and will be the equivalent of the diameter in a spherical particle. This figure is the mean of length, width and height. In the case of particles of which the length is considerably greater than the other dimensions, which include fibres and other elongated shapes, a correction factor must be applied when the laws of settling have to be considered.

Surface Mean Diameter.—When studying dust in the form of a very fine and fairly even powder, it is usually more accurate and convenient to work with the surface mean diameter of the powder. This can be calculated after the arithmetical mean diameter has been determined.