

"Subscreen sizes" require well-engineered equipment to remove them from air or gas, and the difficulty of separation increases as particle size decreases. "Sub-micron" particles, which include many varieties of solid fumes, demand the most effective separating equipment, exceedingly well engineered and incorporating features that often result in high-cost installations.

The determination of particle-size distribution is necessary for correct application of air-cleaning equipment. This subject is treated in Chapter VII and Volume III.

Terminal Settling Velocity. A highly useful concept in the air-cleaning field is the *terminal velocity* or constant settling velocity reached by a particle falling under the influence of gravity. A particle less than about 1000 μ in size will fall with a velocity at which the resistance to its motion offered by the fluid balances the gravitational force tending to accelerate its motion toward the earth.

Foley⁴ presented convincing reasons for expressing particle size, mass, and shape by means of terminal velocity when required to predict the performance of inertial separators against solid particles. In fact, it was noted that terminal velocity already has been adopted in some European countries for specifying the performance of gas-cleaning systems.

The behavior of particles in a moving gas can be measured directly by such devices as the Roller Air Elutriator, described in Volume III.

Particle Shape. Although terminal settling velocity integrates particle shape with size, density, and porosity, it does not describe completely the behavior of particles that deviate strongly from the spherical, in the direction either of disks or of discs or flakes. It is well known that a solid object of irregular shape tends to present its largest cross section perpendicular to its direction of movement through a fluid. Accordingly, the orientation of a particle during its approach to a filter medium can influence the probability of its capture. The best common example is the ease with which lint can be separated in home air conditioners by relatively open filter media.

Fibers may acquire a spinning or rotating tendency, while discs or flakes may move with an oscillating or sideslipping action. Particles of less definite shape will exhibit combinations of spin and sideslip, and these complex movements may be helpful in the process of filtration. It is suggested, therefore, that terminal velocity specifications be supplemented with information on particle shape when the performances of filters and inertial devices are compared in research or product-development studies.

Fractionation of Air-borne Materials. An estimate of the character of air-borne matter can be made by examining the materials charged into or produced by a process. Care is necessary, however, to account for any tendency of the process to fractionate such materials, resulting in a distribution of size, phase, or chemical species, as suspended in the air, that is different from that in the bulk form.

⁴ R. B. Foley, *Trans. Am. Soc. Mech. Engrs.*, 69, 101-108 (1947).

The use of long ducts between a process and the air-treating equipment is liable to change the nature of heterogeneous suspensions. Gravitation, condensation, adhesion, flocculation, frictional charging, and even leakage, all contribute to the gradual fractionation of the suspended matter.

It is reasonable to assume that fractionation will occur in one way or another, and an assertion to the contrary should be supported by convincing evidence. The true character of contaminated air entering a cleaning system should be determined by a series of samples taken directly from the air stream at that point.

IV. Specification of Performance

A statement of the performance of air- or gas-cleaning equipment on a given occasion should include most or all of the following factors:

1. Amount of material retained or discharged (to be discussed in this section).
2. Size distribution of particles retained or discharged.
3. Air-cleaning capacity in cubic feet per minute.
4. Air velocity at a specified location.
5. Resistance or pressure drop through the equipment.
6. Space requirement in cubic feet or in floor area.
7. Storage or holding capacity for contaminant.
8. Life under specified conditions of service.

If the object of air cleaning is the recovery of suspended materials, it is important to know the percentage or amount of material collected or retained in the cleaning process. On the other hand, in air-pollution-control and air conditioning, the percentage of material collected is only incidental information. If the object is to provide air of better quality for supply to occupied spaces, or of lower nuisance character before discharge outdoors, then performance should be specified in terms of the amount of contaminant in the outgoing air stream.

Measurement of the degree of cleaning usually is done with sampling devices employing representative separating and collecting systems with the highest possible efficiency. It is therefore apparent that performance of an air- or gas-cleaning system is based on the performance of the sampling device used in determining the nature and amount of contaminants at the inlet and outlet of the cleaning system. Accordingly, the method of testing should be specified in a statement of performance, and if it is not standard in the field, with known capability, the testing device itself should be described well enough to be duplicated. (A thorough discussion of air- and gas-sampling equipment is presented in Volume III.)

A. EFFICIENCY OR EFFECTIVENESS

It should be understood that the word "efficiency," in the field of air or gas cleaning, does not refer to the proportion of energy used effectively in the cleaning process. Instead, it is used almost exclusively to indicate the proportion of matter removed from the air stream, without regard to the amount of power required.