significant size, this factor of unresolved particles may be of considerable importance.

Holden and Hyatt[60] propose that in the evaluation of exposures to dusts containing free silica, a sufficiently large sample of air-borne dust be collected and sized by allowing the suspension in alcohol to settle for a measured time. The larger particles settle out leaving in suspension the particles 5 μ or less in diameter; the silica content of this latter fraction is determined in order to appraise the relevant silica dust exposure.

C. WEIGHING THE SAMPLE

It is possible to evaluate certain classes of particulate samples by weight. This may be true of impinger samples (especially useful with soluble dusts) as well as samples collected by filtration or by electrostatic precipitation. In this manner the milligrams of toxic contaminants per cubic meter of air may be determined, and by ignition the sample may be divided into combustible and incombustible matter. Bloomfield and DallaValle,[61] by weighing 611 impinger samples upon which counts had been made, found a certain amount of correlation between the weight and count, as given in Table 5. Since particle-size distribution

TABLE 5

Correlation between Particle Counts and Weights of Air-Borne Industrial Dusts

Kind of dust	Coefficient of correlation	Millions of dust particles equivalent to 1 mg.
Bituminous coal	0.847	31
Anthracite coal	0.771	44
Granite	0.755	31
Metal grinding and polishing	0.698	19
Cement	0.694	15
All dusts	0.726	35

is a tremendous factor to be considered in any attempt to evaluate weight or count in terms of the other, in most cases such a conversion is not practical and if attempted is apt to be translated into erroneous conclusions.

D. ANALYZING THE DUST

1. Chemical Analysis for Toxic Materials

Dusts collected by the impinger, the paper thimble or other filtration medium, or the electric precipitator may be analyzed by chemical methods, due consideration being given to the amount of sample in relation to the sensitivity and precision of the method. Methods of analysis for the toxic elements and

[60] F. R. Holden and E. C. Hyatt, *Annual Meeting Ind. Hyg. Foundation Amer.*, Pittsburgh (1945).

[61] J. J. Bloomfield and J. M. DallaValle, *U. S. Pub. Health Bull.* No. **217** (1935).

nonmetals will be discussed individually in Volume II of this book. Differentiation of free silica (SiO_2) from silicates cannot be accomplished satisfactorily by chemical means. However, the quartz content of dusts containing representative particles 10 μ or more in diameter may be satisfactorily determined in samples weighing 0.1 g. or by combining chemical and petrographic techniques. For such samples to be truly representative of an exposure they should be collected in the breathing zone of the workman. Nevertheless, ledge or rafter samples are not to be entirely scorned, and when selected with due consideration to obtaining air-borne rather than projected or sifted deposits, they offer useful information regarding dusts frequently more reliable than the analysis of unselected deposits or unprocessed material.

2. Determination of Quartz

By Combined Chemical and Petrographic Analysis. If one is interested only in the determination of free silica, especially quartz, in a sample of dust ranging in size from 10 μ or greater, it is only necessary to clean the dust, removing as much as possible of particles other than free silica, and to estimate the free silica in the residue by the use of petrographic methods. The procedure may be simplified and standardized as follows. A portion of the dust, between 0.1000 and 0.5000 g., is weighed. If considerable organic matter is present the weighed sample should first be ignited, otherwise it is placed directly in a pyrex beaker and 30 ml. of concentrated hydrochloric acid plus 10 ml. of concentrated nitric acid are added. The contents of the beaker are heated to boiling on a hot plate for 20 minutes, diluted with about 200 ml. of hot water, heated to boiling, filtered through No. 42 Whatman filter paper, and washed with hot water. The paper and residue are then transferred to a weighed crucible, dried, ignited at about 600° C. until the carbon has been burned off, cooled, and weighed. To examine the residue with a petrographic microscope, a few particles are transferred to a microscope slide by means of a dissecting needle, a drop of immersion oil of n_D 1.545 is placed on the specimen, and it is covered with a cover slip.

Sets of immersion oils may be prepared covering the refractive index range of 1.46 to 1.65 by mixing light refined paraffin oil (1.46) with monochloronaphthalene (1.62). Similarly monobromonaphthalene (1.65) may be used. If the refractive index of each constituent is multiplied by the percentage of that oil present, and those products are added, the sum is approximately the refractive index of the mixture. The oils should be thoroughly mixed and the refractive index at 25° C. determined by means of an Abbe refractometer.

The specimen is examined at about 450x magnification: a 45x objective and 10x ocular have proved very satisfactory. Should the particles be large enough to be identified as quartz, diatomaceous earth, chalcedony, cristobalite, or other form of free silica, or an easily estimated mixture of these with other materials, the calculation may be completed by counting or estimating particles in representative fields. A 14.3x objective is very useful for such estimation. If the