THE DETERMINATION OF THE SIZE DISTRIBUTION OF PARTICLES IN AN OPAQUE MATERIAL FROM A MEASUREMENT OF THE SIZE DISTRIBUTION OF THEIR SECTIONS

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ABSTRACT

A new method is proposed for determining the particle-size distribution based on the principle that the distribution of random cross-sectional areas of any body depends only on its shape. The method is applicable to both spherical and non-spherical particles, whereas all existing methods are applicable only to spherical particles. The proposed method is also very simple and less elaborate than most existing procedures.

INTRODUCTION

One of the most difficult problems of stereology is the determination of the number of particles per unit volume and their size distribution. The methods so far used have been applicable only to spherical particles. These methods are based on the measurement of the distribution of section diameters (E. Scheil. H. Schwartz S. Saltikov), section areas (W. Johnson, S. Saltikov) or chord lengths (A. Spector et al). All these procedures are fairly elaborate. The investigation of H. Aaron, R. Smith and E. Underwood(1) shows that these procedures are approximately equal in precision and are in good agreement with one another. It has been our objective to devise a method which is suitable both for non-spherical as well as for spherical particles and to simplify the computational procedure.

PARTICLE DISPERSION

In our analysis the following assumptions will be made about the particle dispersion:

a. The particles may be mono- or poly-dispersed, that is all the particles may be of the same or different sizes.

b. All the particles must have the same shape and differ from one another only in size.

c. The shape of the particles must be such that a random

H. Elias (ed.), *Stereology*

plane can intersect a particle only once. The distribution of particles in space should be statistically uniform, so that the number of particles per unit volume, N_V, has a statistically constant value.

d. The particles are randomly oriented in space.

The shape of the particles may be that of a cube or some other regular polyhedron, nonregular polyhedron, ellipsoid or cylinder but must be the same for all particles in the dispersion.

Since the shape of all the particles is the same, only one linear parameter is necessary to specify the size. A convenient parameter for this purpose is $\bar{H}$, the mean caliper diameter of the particle which is equal to the distance between tangent planes averaged over all orientations of the particle. For a sphere $\bar{H}$ is equal to its diameter. For a cube H varies from a to $a\sqrt{3}$, where a is the edge length of the cube. (Fig. 1)

In many cases the value of $\bar{H}$ may be calculated analytically or by using the known stereological correlation. For example, the latter method yields for a cube

$$\bar{H} = (3/2)\, a .$$

If it is difficult to estimate the value of $\bar{H}$ analytically, it may be determined experimentally from a model of the particle having the same shape.

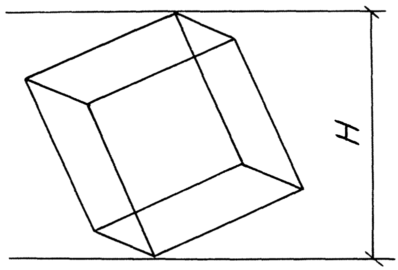

Fig. 1

As has been previously shown by the author[3], the number of particle intersections, N_A, per unit area of the sectioning plane is given by:

$$N_A = N_V \bar{H} \tag{1}$$

or, for spherical particles:

$$N_A = N_V D . \tag{2}$$

The parameter $\bar{H}$ is thus of great significance.

It is obvious that there will usually be a continuous distribution of sizes of particles in a material. However,