METHODS FOR ESTIMATING STATISTICS DESCRIPTIVE OF GRAPHITE POWDER MIXTURES WITH ILLUSTRATIONS OF SOME PRACTICAL APPLICATIONS*

by

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ABSTRACT

The characterization of the particle "size" distribution of a powder is important not only from the standpoint of material comparison, but as a basis for the quantitative evaluation of the behavior of the powder in process. The intent of this article is to show proper methods of computing and comparing the statistics defining the "particle size distributions" of mixtures of powders. Two common observations demonstrate the necessity of considering the "size" distributions of mixtures of powders. 1) A powder can often be made more amenable to a process or operation by adding a proportion of another powder having different distributional characteristics. 2) Design requirements often necessitate the use of composite materials, e.g. cermets and reactor fuels. There are two advantages in a method for computing statistics from mixture component data rather than from data obtained from measurements made on the mixture. 1) The component particle shapes and/or densities, or the range of sizes may differ such as to make measurement of the "size" distribution of the mixture unpractical or impossible. 2) Computation of statistics for the mixture is more convenient and in general gives results as accurately as performing a "size" analysis on the mixture.

The classification of data generated by any particle "size" measuring device into one of two general types is illustrated to demonstrate the variety of related meanings of the general term "particle size." The tabular summary of the expressions used to compute and compare sample statistics from interval or non-functional data forms illustrates the relationships between particular definitions of particle "size" and shape factor, and the basis for the use of the generalized log normal function to describe sample data.

The method outlined for the quantitative determination of an average volume shape factor, C_3, from two methods of "size" analysis is based on the general expression

$$C_k \approx \exp\left[\hat{\mu}_{z_k} - \hat{\sigma}_{z_k}\left(\frac{\hat{\mu}_{xk}}{\sigma_x} - \hat{\sigma}_{z_k}\right)\right]$$

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derived from the log normal model. An approach to the evaluation of C_3 for interval or non-functional data is outlined.

The development of methods for computing statistics for a mixture requires the development of conversion between weight fraction α, and frequency or count fraction β for mixtures, for example,

$$\alpha_{(j)} \approx \frac{\beta_{(j)} \sum_{1}^{I} \rho_{(j)} C_{3(j)} \left[\frac{n_{i(j)}}{N_{(j)}}\right] d^3_{Mi}}{\sum_{1}^{J} \beta_{(j)} \sum_{1}^{I} \rho_{(j)} C_{3(j)} \left[\frac{n_{i(j)}}{N_{(j)}}\right] d^3_{Mi}}$$

and

$$\alpha_{(j)} \approx \frac{\beta_{(j)} \rho_{(j)} C_{3(j)} \exp\left[3\hat{\mu}_{x(j)} + 4.5\hat{\sigma}^2_{x(j)}\right]}{\sum_{1}^{J} \beta_{(j)} \rho_{(j)} C_{3(j)} \exp\left[3\hat{\mu}_{x(j)} + 4.5\hat{\sigma}^2_{x(j)}\right]}$$

for non-functional and log normal data models respectively. The conversions $\alpha_{(j)} \leftrightarrow \beta_{(j)}$ and similar forms required for computation and comparison of sample statistics for mixtures are presented in tabular form.

Several sets of Type I and Type II particle "size" data for graphite powders are treated by the methods outlined, and C_3 values are computed. The results of proper and improper data treatment are compared.