Determination of average particle size (according to Blaine)

Basic principle

Blaine's method determines the surface area of powders and deduces the average grain diameter from this figure.

Procedure

The substance to be measured is added to a measuring cell and compacted with a pestle to a given volume. The specific gravity of the substance, the initial weight and the volume are used to calculate the porosity of the packed-down material. The manometer filling is drawn up to the upper mark on the right leg of the apparatus, and the tap then closed. The air can now flow only through the packed powder. The time taken for the liquid level to pass from one of the two central marks to the other is measured. The porosity and the flow time are used to calculate the surface area of the powder. From this figure, the average grain diameter is deduced, assuming that the particles are spherical. Substances of known surface area are used to calibrate the apparatus. This method of measurement is practicable only for relative measurements.

A detailed description is given in DIN 1164, part 4 (Nov. 1978) or in ASTM C 204. Blaine's method is similar to the well known but more complicated FSSS method (Fisher sub sieve sizer). Long term experience has shown that both methods are comparable and normally give same or very close test results for zirconium and titanium products.

Supplier of the porosity tester acc. to Blaine:

Tonindustrie Prüftechnik
Voltastraße 5
13355 Berlin
Tel.: 030/4633096

or:

Ströhlein Instruments
Girmeskreuzstraße 55
41564 Kaarst
Germany

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Calculation

$$O = \frac{1362 \cdot \sqrt{e^{-3}}}{s \cdot (1-e)} \cdot \sqrt{t} \qquad 1-e = \frac{E}{s \cdot 1.85} \qquad O = \frac{6}{s \cdot d}$$

This can be summarized to yield the grain diameter:

$$d = \frac{\frac{E}{1.5} \cdot \frac{1}{\sqrt{t}}}{\left(1 - \frac{E}{1.85 \cdot s}\right) \cdot 419.95 \cdot s}$$

E = Initial weight of powder
s = Specific gravity
t = Flow time
d = Grain diameter
O = Surface area
e = Porosity
1.85 = Powder mass volume
1362 = Apparatus factor determined with calibration substance

For a constant initial weight and a given specific gravity, the first part of the equation can be condensed into a single factor:

$$d = f \cdot \frac{1}{\sqrt{t}}$$

It is more practical to calculate with f/100 and $100/\sqrt{t}$.
The f/100 factor can be recorded in tabulated form; the expression $100/\sqrt{t}$ yields a straight line when plotted logarithmically against t.

Multiplication of the two values f/100 and $100/\sqrt{t}$ supplies the required average grain diameter in micron.

Edition: January 2001

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