PARTICLE TECHNOLOGY

DETERMINATION OF SHAPE FACTOR

DEFINITION AND OBJECTIVE:

Particle characterization is important in all aspects of particle production, manufacturing, handling, processing and applications. Characterization of the particles is the first necessary task required in a proses involving solid particles.

The complete characterization of a single particle requires the measurement and definition of the particle characteristics such as density, size, shape and surface morphology. Because the particles of interest are usually irregular in shape and different in surface morphology, there are many different ways and techniques to characterize the particles.

Projected area diameter (d_a): The projected area diameter, d_a, is defined as the diameter of a circle having the same projected area as the particle viewed in a direction perpendicular to the plane of the greatest stability of the particle.

$$d_a = \sqrt{\frac{4.S}{\pi}}$$

Sieve diameter (d_A): The sieve diameter (d_A), is defined as the width of the minimum square aperture in the sieve screen through which the particle will pass.

All of the multiple combination that change proportionally with surface area and volume of the particles is called shape factor. f and k are determined as surface shape factor and volume shape factor respectively.

METHOD:

A- Microscopic Method:

"L-B-T" dimensions of particle are measured by using stereo (binocular) microscope and the Table 3 is prepared. Size measurements are performed with micrometer on microscopy.10 mm scale is divided into 100 equal parts. The smallest unit of micrometer is expressed as "Division"

1 div. = 0.1 mm = 100 µm
Depending on the objective extension:
X1 extension: 1 div. = 100 µm
X2 extension: 1 div. = 50 µm
X4 extension: 1 div. = 25 µm

Table 3. The size measurement results of sample

Particle No:	Lenght (L)	Breadth (B)	Thickness (T)
1			
2			
.			
.			
.			
n			
Mean	S L/n	S B/n	S T/n

$$S = f\,d_a^2$$
$$V = k\,d_a^3$$
$$S = 2.(L.B+B.T+L.T) = f\,d_a^2$$
$$V = L.B.T = k\,d_a^3$$

B- Heywood Method: Heywood defined three orthogonal limiting dimensions. Also, particle shape were measured by Heywood.

Length of particle: It is distance between two parallel plane which are perpendicular to the planes defining thickness and breadth and are tangential to opposite sides of the particle.

Thickness of particle: Distance between the horizontal plane of greatest stability and a parallel plane tangential to upper surface of particle.

Breadth of particle: The minimum distance between two parallel planes tangential to outline of particle, and perpendicular to plane of greatest stability.

Two ratios were determined with using these definitions by Heywood.

Elongation Ratio: n = L/B Flatness Ratio: m = B/T
Heywood equations are used in order to calculate f and k values for geometric particles.

Volume shape factor: $k = \frac{k_c}{m\sqrt{n}}$

Surface shape factor: $f = 1.57 + C\left(\frac{k_c}{m}\right)^{\frac{4}{3}} . \left(\frac{n+1}{n}\right)$

$$f = 1.57 + C.k^{\frac{4}{3}}.\left(\frac{n+1}{\sqrt[3]{n}}\right)$$

In these equations;

C: is a constant depending on geometrical form

k_c: is value of k for the corresponding equivalent dimensional shape. Heywood separated particles to shape groups and calculated k_c and C values for these groups.

Table 2. Coefficient values for various shapes

SHAPE GROUP		k_C	C	$C.k_c^{4/3}$
GEOMETRIC	TETRAHEDRAL	0.328	4.360	0.898
	CUBIC	0,696	2.550	1.571
	SPHERICAL	0.524	1.860	0.785
NON-GEOMETRICAL	TETRAHERAL ANGULAR	0.380	3.300	0.910
	PRISMATIC ANGULAR	0.470	3.000	1.100
	SUB-ANGULAR	0.510	2.600	1.060
	ROUNDED	0.540	2.100	0.920

C- Weight Method: Firstly, sieve analysis are carried out and the samples are separated different size fraction in order to calculate shape factor of its. And then any size fraction is selected and weighed. The density of the sample is determined by pycnometer and the following are calculated as follows;

Particle number of sample: n Sample amount: M (g) Density of sample: d (g/cm^3)
Total sample volume: V (cm^3)

$$V = \frac{m}{d} \qquad (cm^3)$$

The volume is found for one particle,

$$v = \frac{V}{m}$$

$$S = f\, d_a^2$$

$$V = k\, d_a^3$$

The evaluation of results:

a) General information section which contain detailed knowledge and references should be prepared relative to shape factor definition and determination methods.
b) The measurements for each method should be expressed in detail.
c) General evaluation table should be prepared so as to compare measurement results and then the results are commented for each method.